NOVEL CERTIFICATION PROCEDURE FOR THE SUSTAINABLE IMPORT OF WOOD PELLETS TO POWER PLANTS IN BELGIUM

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ABSTRACT: Belgium has developed two targeted green certificate systems coupled with an obligation and a penalty of 10 to 12,5 c€/kWh. The system in Flanders in based upon the energy balance such that fossil energy used along the supply chain reduces accordingly the number of granted certificates. This includes the energy that is used for pelleting the wood and for transporting the final product on site of the power plant. The second system in Wallonia is similar but based upon avoided fossil CO_2 emissions with respect to a reference being the combined cycle power plant firing natural gas with an efficiency of 55%. In 2005, to cope with those obligations, Electrabel has retrofitted two existing pulverized coal power plants for firing imported wood pellets. Electrabel was since 2002 already co-firing imported biomass like olive cake and coffee ground in other power stations. For granting green certificates to those plants, Belgian authorities impose an extensive analysis of the bio-fuel supply chain. All bio-fuel suppliers must undergo an energy audit, identify their biomass resources and detail the energy balance of the whole supply chain. SGS Belgium has been accepted as independent body by the authorities to check the data all over the world. Research Centre Laborelec has designed together with SGS a fast and cheap certification procedure with the aim of gathering the whole set of data required for the grant of the green certificates as well as obtaining guarantees with respect to traceability and a minimal set of sustainability criteria.

Keywords: biomass/coal, certificate trading, CO2 emission reduction, electricity generation, environmental aspects biomass production, forestry residues, life cycle assessment (LCA), pellets, sustainable use of biomass.

1 INTRODUCTION

Since 2002 the Belgian main utility Electrabel carries out co-firing of different biomass resources in its pulverized coal power plant In 2005, Electrabel has retrofitted two existing pulverized coal power plants of the year 1960's for firing wood pellets instead of coal. Rodenhuize power plant, located near Gent, generates electricity with hardcoal (70%), wood-pellets (25%) and olive cake (5%). Les Awirs power plan, located near Liège, has been converted for firing exclusively wood pellets (100%) without co-firing anymore. Today the Belgian capacity of Electrabel for generating green electricity with biomass reaches 287 MW (Table I).

Table I: Use of biomass in Belgian thermal power plants

Power plant	**Biomass and technique**	**Power capacity**
Ruien	separate injection of biomass dust (wood and exotic powder)	50 MW
Ruien	co-gasification of clean wood chips (Belgium, France)	22 MW
Langerlo	co-milling of sewage sludge of Belgian origin	4 MW
Langerlo	separate injection of wood dust of Belgian origin	28 MW
Langerlo, Rodenhuize, Ruien	co-milling of imported olive cake	30 MW
Langerlo	co-milling of imported coffee ground	2 MW
Les Awirs	firing imported wood pellets	85 MW
Rodenhuize	separate milling and injection of wood pellets	66 MW
Total	**biomass**	**287 MW**

Both retrofitted plants Rodenhuize (Unit 4) and Les Awirs (Unit 4) operate at nominal load since September 2005. The capacity of both plants together is about 2500 tons of wood pellets per day or 700 000 tons a year. Globally about 15% of the feedstock is expected to originate from Belgium, the rest being imported from the whole world.

The imported feedstock is shipped to the harbor of Antwerp and from there on by flat boats up to the sites of the power plants. For being granted green certificates for the green power that is generated, Electrabel is submitted by the Belgian authorities to an extensive analysis of the supply chain. The present paper describes how this analysis is being performed.

2 BELGIAN GREEN CERTIFICATE SYSTEMS

Belgium has committed itself to reduce the greenhouse gas emissions with 7,5% by 2012. In addition, electricity sales are submitted to a renewable obligation of 6% renewable electricity by 2010 in the frame of targeted green certificate systems in each of the three Belgian regions. The obligation is coupled with a penalty for the unrealized share of green power.

The system in Flanders is based upon the energy balance and the use of fossil energy along the supply chain that is then subtracted from the number of granted certificates. An example of calculation is given hereunder for wood pellets originating from Canada (British Columbia). The electricity used for the pellet plant and for the drying is directly subtracted. The primary energy used for the production, the local and overseas transportation is subtracted with a factor 55% being the efficiency of the reference combined cycle power plant firing natural gas.

Contributions for energy consumption:

1) Electricity consumption pelleting:	106 kW_e/ton
2) Primary energy for drying is biomass:	0 kW_p/ton
3) 700 km train transport x 55%	59 kWh_p/ton
4) Sea transport: 750 ton diesel x 55%	=128 kWh_p/ton
TOTAL	294 kWh/ton

Primary energy in 1 ton wood pellets is	4700 kWh_p
Gross electricity generation per ton	1786 kWh_e
Subtraction	- 294 kWh_e
Net result	1493 kWh_e

The number of certificates is then reduces with a factor:

- k = 1493/1786 = 0,84

(i.e. loss of 16% green certificates).

One sees that energy needed for drying is not considered if it is made from renewable sources, while electricity is always taken into consideration, even if from renewable origin.

The second system in Wallonia is compatible with the one in Brussels region. It is based upon avoided fossil CO_2 emissions with respect to a reference being the combined cycle power plant firing natural gas with an efficiency of η_E=55%. The regulatory body (Commission Wallonne pour l'Energie, CWaPE) has published a list of reference specific fossil CO_2 emissions of the whole supply chain for all fossil fuels as well as the major biomass resources [1]. Some elementary operations have even been quantified for woody products as well (see Table II).

Table II: Reference specific CO_2 emission factors in Wallonia (kg CO_2/MWh_p of primary energy)

	kgCO2/MWhp
◆ NON FOSSILE	
• wind/solar/hydraulics	0
• organic biodegradable matters	0
❖ milling	4
❖ transport < 200 km	5
❖ transport > 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
• gas-oil	306
• light fuel oil	310
• heavy fuel oil	320
• coal	385

Let us considered 'C' factors as CO2 emission rates with respect to primary energy. Then for natural gas one has:

- C_{NG} = 251 kgCO2/MWhp.

Let us considered 'G' factors as CO2 emission rates with respect to electricity generation. For the reference technology, a STAG power plant firing natural gas, one has:

- G_{NG} = 251/55% = 456 kgCO2/MWh_e.

The number of granted certificates is reduced with a 'k' factor corresponding to the relative avoidance of fossil CO_2 emissions with respect to the reference. This means that one green certificate is granted every time 456 kg of fossil CO2 emissions are saved with respect to the reference power plant.

If G_{PP} is the specific CO_2 emission rate of the considered power plant with respect to its fuel mix according to the official published emission factors, then, the 'k' factor is calculated according to the following formula (α_E, net electric efficiency of the power plant) :

$$k = \frac{G_{NG} - G_{PP}}{G_{NG}} = 1 - \frac{G_{PP}}{G_{NG}} = 1 - \frac{C_{PP} / \alpha_e}{C_{NG} / \eta_e}$$

Let us take the example of a thermal power plant firing wood pellets with a net efficiency of α_E=34%. For Belgian wood pellets, one has in Table II the contribution for wood pellets (30) and the one for the transportation on less than 200 km (5). With η_E=55%, α_E=34%, on has:

- C_{PP}= 30 + 5 =35 kgCO2/MWhp,
- k = 0,77 (loss of 23% green certificates).

For Canadian wood pellets, one has a higher contribution for transportation (25) such that:

- C_{PP}= 30 + 25 = 55 kgCO2/MWhp,
- k = 0,65 (i.e. loss of 35% of green certificates).

The development potential of wood pellets, as a new type of fuel for generating renewable electricity, appears to be attractive in both regions of Belgium. This is mainly due to the high penalty level related to the green obligation (12,5 c€/kWh in Flanders and 10 c€/kWh in Wallonia), and it remains true even if the Belgian systems reduce significantly the number of granted green certificates according to a rather detailed LCA analysis.

3 WOOD PELLET CERTIFICATION PROCESS

Belgian authorities impose that each supplier undergoes an audit within 6 months after the biomass has been first fired. The audit must examine the sustainability of the raw material sourcing as well as detail the energy balance of the whole supply chain. This includes the energy that is used for pelleting the wood and for transporting the final product up to the site of the power plant. If the product would appear in contradiction with the generic sustainability principle, the CWaPE would then have the right to cancel the granted green certificates.

For each producer, the global supply chain is analyzed by a local independent inspectorate, and approved by SGS Belgium, the latter being accepted as independent body by Belgian authorities for the grant of green certificates.

SGS checks first of all the sourcing of the wood (hardwood, softwood, saw dust, shavings, coppices) and the transportation between the sources and the pellet plant. If the biomass is not a secondary product but a

primary one, then the whole energy consumption needed for planting, fertilizing, harvesting etc. must be taken into consideration and energy used subtracted from the number of granted green certificates. SGS evaluates all energy consumptions for making the pellets (electricity for the densification and auxiliaries, fossil fuels or biomass for drying). Finally, SGS looks to the final transportation to the sea harbor (train, truck) and checks the global traceability.

4 FORESTRY

In addition to the energetic audit of the supply chain including greenhouse gas emissions, Walloon authorities impose that the sustainable character of the forestry resources be proven as well. Evidence of sustainability can be delivered according to:

- a traceable chain management system at the supplier's end,
- forest certificates pertaining sustainability of sources, of the type "Forest Stewarship Council" or equivalent,
- or in the absence of such forest certification, all public documents originating from independent bodies like FAO, or NGO's like WWF, GreenPeace, … making a review of the forest management and control in the considered country.

It is the first time in our knowledge that such an extensive check is performed by an independent body for analyzing the sustainability of the wood pellets supply chain in many different regions of the world with a accent put on the fossil energy use, CO_2 equivalent greenhouse gas emissions and the management of the forestry resources.

5. PROCEDURE OF CERTIFICATION

To protect the environment a certification program with a quality mark is necessary in order to replace in a sustainable fashion fossil fuels by biomass and generating traceable green power.

In order for biomass to be accepted according to the Laborelec's standards, it must in a nutshell be a by-product (preferably not a primary one such that additional certificates are not lost) from agriculture and forestry. The biomass (solid recovered fuels) shall consist of organic material that comes from well-managed woods, (public) zones of vegetation or agricultural grounds. Energy consumption must be reasonable with respect to other references and heat for drying must be generated from renewable sources (biomass).

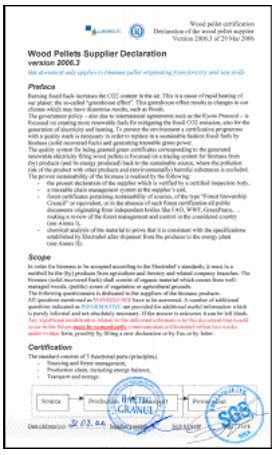
The quality system for being granted green certificates corresponding to the generated renewable electricity firing wood pellets is focused on a tracing system for biomass from (by) products (and its energy produced) back to the sustainable source.

Both Flanders and Wallonia authorities request at least an inspection report of each biomass fuel producing facility. Both regions have different legislations and different methodologies for calculating the number of granted certificates but Laborelec applies the same certification procedure.

This procedure allows as well to inform a potential supplier of all requirements made by the utility concerning:

- the technical specifications of the product for firing it in a thermal power plant (chemical composition, physical properties),
- the sustainability criteria for being accepted within the Belgian green certificate systems.

All this is concentrated in one single document called "Biomass Supplier Declaration" (6 pages). This document is signed by a representative of the producer and is verified and stamped by a certified inspection body (local SGS representative) before being delivered to the Belgian authority (Fig1).


Wood pellet certification
Declaration of the wood pellet supplier
Version 2006.3 of 29 Mar 2006

Wood Pellets Supplier Declaration
version 2006.3

Preface

Scope

Certification

Source
Production
Transport
Power plant

Figure 1: Laborelec certificate for imported biomass

For calculating the number of granted certificates Flemish authorities require the knowledge of a few parameters related to the plant producing the biomass fuel. Therefore, the supplier must fill in an informative questionnaire that consists of three functional parts (Fig.2):

- sourcing and forest management: wood origin;
- production chain, including energy consumptions;
- transport and storage, including rail and sea transport.

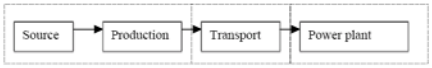


Figure 2: Functional parts of supply chain

6 CO_2 FOR WOOD PELLETS SUPPLY CHAIN

Laborelec is using the certification procedure since the beginning of 2006, and more than 30 suppliers have already been screened by SGS for the delivery of feedstock to Les Awirs and Rodenhuize power plants. The data collection gives already a unique view on fossil CO_2 emissions related to pellet plants located everywhere in the world. The results are presented in Table III and IV. The total value calculated takes electricity consumption, transportation to the harbor, sea transport and the transport in flat boats to the power plant into consideration.

The final result (last column) shows that the total

emissions range between 18 and 32 $kgCO_2/MWh_p$. If the real factor were used (instead of the imposed value for imported pellets of 55 $kgCO_2/MWh_p$ in Wallonia), the k reduction factor for the number of granted green certificates would have range between 0,75 and 0,85. Electrabel still negotiates with the Walloon Region to obtain that each supplier be considered separately for the calculation, as it is already the case in Flanders.

By all producers, heat for drying is generated mainly from local biomass resources such that drying does not contribute to the fossil CO_2 emissions.

Local transport of the wood residues to the pellet plant in not included but has been estimated to be always less than 2 $kgCO_2/MWh_p$.

The global results are shown in Table III for the energy balance and in Table IV for the CO_2 balance, where GC stand for green certificates. Within both systems, one sees that the final result is lower in Wallonia than in Flanders due to the higher rate of fossil CO_2 generation of gasoil than natural gas.
Detailed analysis has lead to the conclusion that no trivial conclusion can be drawn according to the yearly capacity of the pellet plant or the distance from Belgian harbor. In some sense, a pellet plant located far away from its customers is not necessarily always less efficient than the closer ones.

Table III: Net energy balance of wood pellet suppliers according to region of origin

LABORELEC

Energy balance in MWh eqv electricity

Phase	Germany NL	Baltic	Sweden	Russia	Canada
Pelletising	150	130	170	200	120
Local transport	2	5	3	17	17
Sea-River transport	6	50	60	60	125
TOTAL	158	185	233	277	262
GROSS (38%)	1800	1800	1800	1800	1800
Granted GC	91%	90%	87%	85%	85%

Table IV: Specific fossil CO2 emissions of wood pellet suppliers according to region of origin

LABORELEC

CO_2 balance in $kgCO_2/MWh$ primary energy

Phase	Germany	Baltic	Sweden	Russia	Canada
Pelletising	11	13	15	20	13
Local transport	1	1	2	2	2
Sea/River transport	4	6	5	7	15
River transport	2	2	2	2	2
TOTAL	18	22	24	31	32
Granted GC	89%	86%	84%	80%	79%

7 CONCLUSIONS

Systems of green certificates have been developed in Belgium that makes the level of the green support mechanism proportional to the energetic efficiency of the whole supply chain.

Within that frame Laborelec has developed together with SGS Belgium a global biomass certification scheme that adds up the wishes of all regional authorities in Belgium. This certification procedure focuses on energy consumptions of the pellet plant and of the needed transportation. The procedure is fast: acceptance of a new supplier by the authorities is obtained within 2 weeks. The procedure is cheap as well: it costs less than 0,1% of the biomass fuel cost. The procedure delivers as well minimal guarantees on the traceability and the sustainability for the raw material sourcing.

From the data that haven gathered for the suppliers with whom Electrabel has contracted wood pellets, it appears that all of them are much more efficient than Belgian authorities thought at the beginning. Even suppliers located overseas can compete very well with European ones if they put the accent on efficiency, scale effect and transportation along rivers and sea.

8. REFERENCES

[1] CWAPE (2003). Le régime des Certificats verts dans le cadre de l'ouverture du Marché de l'Électricité en Wallonie. Namur, Commission Wallonne pour l'Énergie, version 2.3. (juin 2003), 12 p.

[2] FORSBERG G. (1999). Bioenergy Transport Systems. Life Cycle Assessment of Selected Bioenergy Systems. Report No 5. Uppsala, The Swedish University Agricultural Sciences, Department of Forest Management and Products, 89 p.

[3] THEK G., OBERNBERGER I. (2002). Wood pellet production costs under Austrian and in comparison to Swedish framework conditions. Proceedings of the 1st World Conference on Pellets, Sept. 2002, Sweden, 123 – 128.

[4] FOCK M.W., CHRISTIANSEN H.F. (2002). Life cycle assessment of procurement and conversion of biomass and fossil fuels used for energy production in Denmark 1997. Proceedings of the 12th European Conference on Biomass for Energy, Industry and Climate Protection, 17 – 21 June, Amsterdam, The Netherlands, 276 – 278.

[5] R. Torfs, D. Huybrechts, G. Wouters (VITO), Broeikasgasemissies, verzurende emissies en energiegebruik voor levering van energiedragers vanaf de ontginning tot aan de eindgebruiker; Projet Electrabel/SPE, Eindrapport Phase 1bis, 1999