THE EVALUATION OF BIOMASS POWER PROJECTS

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ABSTRACT

Biomass is a renewable energy source attracting increasing attention. At the EU level in the last years a set of activities and programs were implemented in order to support and promote the use of this source of energy. This study addresses the issue of biomass costs for electricity production and the importance of incentives schemes such as feed-in tariff for the economic development of the sector. An economic evaluation of the electricity production from biomass is presented, based on a survey of both financial and social costs applied to the Portuguese case. Economic assessment was carried out by taking into account three types of biomass: energy crops (*miscanthus*), forestry residues and municipal solid waste. Four set of costs were considered and included: cost of capital, cost of maintenance and operation, fuel costs and external costs.

INTRODUCTION

One of the most relevant and worrying issues related to the energy sector concerns to the continuous increase of the energy dependence of most countries in recent years. The growth of the pollution levels along with the shortage of the fossil fuel reserves creates concerns that represent strong motivations for the development of new power plants assumed to be environmentally friend. The high efficiency of the biomass power plants along with the use of a fuel associated with renewed life cycles and their possible positive social impacts in particular at regional level, turn biomass an interesting alternative for the electricity generation (Carneiro and Ferreira, 2010).
The Biomass is seen as an energy source that can play a key role for the fulfillment of the goals of the renewable power plants, as it can contribute for the supply of energy in three sectors, electricity, heating/cooling as well as in the sector of biofuels (Council of the European Union, 2007). The increase use of biomass represents also an opportunity to reach a reduction of the greenhouse gases emissions, contributing to the concretization of the international environmental commitments, promoting also the forest management along with the regional development.
This study addresses the issue of biomass costs for electricity production and the importance of incentives schemes like feed-in tariff for the economic development of the sector.
Next section briefly presents a theoretical introduction addressing the topic of electricity generation from biomass and the types of biomass available. In Section 3 an economic evaluation of the electricity production from biomass is presented, based on a survey of both financial and social costs applied to the Portuguese case. The main conclusions are summarized at the end.

BIOMASS AS ENERGY SOURCE

The biomass is a heterogeneous energy because it can be provided by several sources like plants, animals and micro-organisms (Bhattacharva et al, 2003), and is used to meet a variety of energy needs, including generating electricity, heating homes, fuelling vehicles and providing process heat for industrial facilities.
To Berndes et al., (2003) biomass has the potential to become a major source of global primary energy over the next century, once it can contribute to many important elements of national or regional development: economic growth through business expansion and employment; import substitution, security of energy supply; and energy source diversification (Domac et al., 2005).
From the environmental point of view in general it is considered that biomass energy can play an important role in reducing greenhouse gas emissions, since when produced and utilized in a sustainable way, the use of biomass for energy offsets fossil fuel greenhouse gas emissions (Hoogwijk, 2009). This characteristic makes the biomass an energy source that can play a key role for the fulfillment of the goals of the renewable power plants.

Energy production – types of biomass

The biomass that can be used for energy production can be of two types according to their origin: (i) biomass produced by agricultural or forestry activity, in form of waste and subproducts, or (ii) biomass for energy purposes (dedicated production). Currently, forest residues, agricultural and urban, are the main raw materials for producing electricity and heat from biomass. In addition, a small share of dedicated crops is used as raw materials for production of liquid biofuels (IEA Bioenergy, 2010).

The availability of organic waste for energy use depends heavily on variables such as economic development, consumption pattern and the fraction of biomass material in total waste production. In what concerns agricultural waste, the potential depends on food production. For energy applications, which require the continued availability of biomass, it is necessary to take into account that agricultural residues are characterized by their seasonal availability and, therefore, needing storage for long periods. This storage may easily lead to change on the residues characteristics due the fermentation process. Biomass sources that are already concentrated in one place, often as a sub product of another process, tend to be cheaper since they require less intensive collecting and treatment procedures and have no production costs. Many agricultural and forest residues are not competitive with fossil fuels due to the dispersion over large areas in small volumes (IEA Bioenergy, 2005). In relation to forest residues, these are the most valued, since the areas of forests cover at present about 30% of the surface of the globe. However the energetic potential (sustainable) of forests in the world is uncertain.

Therefore several assessments of the potential supply of biomass show that the greatest opportunities for biomass production in Europe and in another places is in the dedicated energy crops (Ericsson and Nilsson, 2006).

According to Berndes and Hansson (2007) the adoption of land for the production of energy crops can be considered as an option for the various challenges in the agricultural sector arising from EU enlargement, such as the abandonment of land, the rising of unemployment and an exodus from rural areas. The contribution of energy crops will depend on many factors, including culture type, management, climate and soil.

ECONOMIC EVALUATION

A viable substitute of fossil fuel must have not only a better environmental performance, but must also be economically competitive in order to attract investors, and at the same time must give an important contribution to change the general balance of primary energy use (Domac et al., 2005). An important limitation of the use of the biomass as an energy resource can be the economic costs.

An economic evaluation of the electricity production from biomass is presented, based on a survey of both financial and social costs applied to the Portuguese case. Economic assessment was carried out by taking into account three types of biomass: energy crops (*miscanthus*), forestry residues and municipal solid waste. Four set of costs were considered and included: cost of capital, cost of maintenance and operation, fuel costs and external costs.

For the determination of Net Present Value (NPV) the present value of the estimated cash-flows is computed, based on a previously defined rate of return. As the economic analysis intends to go further than the financial analysis, the externalities were monetized and included in the economic study. Thus, besides the NPV (financial) the NPV (full cost) was also determined.

As a final note it should be underlined that being biomass a renewable resource is protected by law and benefits feed in tariff. Feed-in tariffs (FITs) are guaranteed minimum prices established by the government and paid by utilities to generators of electricity from renewable energy sources (RES) for a guaranteed minimum number of years and is by far the dominant model in EU (Ferreira and Vieira, 2010).

Table 1 and 2 presents the results of the proposed simulation. The conversion technology considered was the gasification and the values of external costs were taken from the ExternE study. These costs were updated to 2010 according to the Portuguese price growth.

Note that Social costs is the sum of Financial and External costs.

Table 1: Results of hypothetical scenario for miscanthus case

Costs	Present Value	Unit	Total Costs	Value	Unit
Investment	21.960.000,00	€	Financial	51.621.119,80	€
O&M	7.511.210,90	€	Social	58.733.701,67	€
Fuel	22.149.909,00	€	NPV (financial)	1.046.441,60	€
External	7.112.581,89	€	NPV (full cost)	- 6.066.140,27	€
Present value of sales	52. 667.561,40	€			

Table 2: Results for forest biomass and municipal solid waste for the case of Portugal

Forest biomass			Municipal solid waste		
Costs	Value	Unit	Total Costs	Value	Unit
Financial	51.401.858,06	€	Financial	49.905.061,18	€
Social	58.449.780,11	€	Social	59.426.221,93	€
NPV (financial)	786.907,33	€	NPV (financial)	- 14.983.156,67	€
NPV (full cost)	- 6.261.014,72	€	NPV (full cost)	- 24.504.317,42	€

The results show that the investment costs along with the fuel cost represent the highest share of the total financial cost for all cases. Higher values for the financial and social costs are obtained for energy crops and forest biomass, with the municipal solid waste (MSW) presenting the lowest value. For this different result contributes mainly the value obtained for fuel costs reported to moment zero: 45.0 €/MWh for the forest biomass and for dedicated energy crops and 30.0 €/MWh, for MSW. The costs of O&M are also approximately the same for both forest biomass and for dedicated energy crops with the municipal solid waste, presenting once more lower costs.

However, the negative values obtained for the financial and Social NPV in the case of municipal solid waste are-mainly due to the reduced feed-in tariff. In fact, the present feed-in tariff is 54 €/MWh for municipal solid waste, a clearly lower value than the price for the forest biomass and

energy crops (107 €/MWh). The differences in the obtained NPV values are largely explained by the different feed-in tariffs. Therefore, the increase on the applied tariffs contributes deeply to increase the interest over these projects and is a key factor for its financial viability. The external costs, despite representing a smaller value than any other financial cost components, lead to a negative value of NPV (full cost) for energy crops and for the forest biomass, also reducing significantly the values of NPV for municipal solid waste. In a first approach cost values related to gasification technology were used, in order to allow a comparison between the three types of biomass. However other simulations were made for the particular case of direct combustion, so that it would be possible to investigate how the chosen technology affects the viability of these projects. In the analysis for the forest biomass, gasification technology presents the best financial results, with a positive NPV (financial). The reason for this is the assumed conversion efficiency for the gasification higher than the combustion technology efficiency, reducing the cost of fuel. As for the municipal solid waste, the second alternative (combustion technology) presents as more favorable result, with total financial costs slightly below the gasification technology. In the particular case of energy crops, gasification technology presents total financial costs well below the obtained with combustion technology (steam cycle). This is once more due to a significantly higher value of fuel costs for the combustion technology (126 €/MWh) against 45 €/MWh for the gasification technology. The results indicate a negative financial and social NPV for the steam cycle (combustion technology), while for gasification, when the external costs were not included, the NPV was positive.

Sensitivity analysis

A sensitivity analysis is presented focusing on the most relevant variables for the evaluation and subject to a higher uncertainty. The sensitivity analysis allows to draw various scenarios, and to verify to what extent the viability of the project changes when the assumed values change. The results demonstrated that the discount rate, efficiency and feed-in tariff are the most important parameters influencing the viability of biomass plant. Due to high capital costs of biomass power plants, the financial results of the project will be highly favored by a reduction of the considered discount rate. As for the efficiency, the rate of the impact depends of the type of biomass used and of the selected technology. The efficiency of the process influences the fuel costs, and as demonstrated the fuel cost is one of the most important parameters influencing the economic viability of biomass plant. For the sensitivity analysis of the feed-in tariff, obviously as the value of the feed-in tariff increases, the project becomes more attractive.

Feed-in tariff

FIT prices are usually established in law. FIT prices can be as low as four and as high as thirteen times regular prices. Those values are determined by politics, not by market economics (Richard and Barclay, 2009).

In the most countries feed-in tariffs have been suffering adjustments over the years, in order to create conditions to attract investors to a sector that is expected to contribute to emissions reduction of the external energy dependency. The feed-in tariffs attract much capacity, since a fixed tariff is guaranteed, but only if the feed-in tariff is set at level sufficient to meet investor needs. The level and importance of feed-in tariffs may vary significantly among countries, depending on national characteristics such as the potential and costs of renewable resources or the political preferences regarding policy instruments to promote renewable electricity (Richard and Barclay, 2009).

The results of the Commission of the European Communities study (2005) demonstrate that for biomass forestry, the feed-in tariffs defined for half of the EU Member States hardly allow to cover generation costs. Denmark, Finland and Netherlands present the smaller gap between feed-in tariffs and generation costs. As for France, Greece, Ireland, Luxembourg, Portugal and Spain, the feed-in tariff support does not seem to be enough to bring about a real take-off in the biomass sector.

It has been shown that feed-in tariff is as expected a key factor for the project viability. The required feed-in tariff to make the project financially interesting from the point of view of a private investor, for the Portuguese case was estimated. According to the simulation conducted and to the assumed conditions, the feed-in tariff that would be required to make the project financially interesting from the standpoint of a private investor would be equal to or greater than 120 €/MWh for dedicated energy crops.

CONCLUSION

This study addresses the issue of biomass costs for electricity production and the importance of incentives schemes like feed-in tariff for the economic development of the sector.

Bioenergy may be able to offer socio benefits in Portugal compared to other energy sources, like the possibility to create direct and indirect jobs but economically, while the value of feed in tariff continues the same, the viability of this type of energy is uncertain. It can be concluded that a higher value of feed in tariff for biomass could lead to greater interest in these kinds of projects. Lower tariffs turn the project not interesting under the financial point of view of a private investor.. According to the literature reviewed, in nearly half of European countries, the support for biomass forestry it insufficient to develop this high-potential sector further.

Future works should approach more in detail the question of choosing the appropriate energy cultures, a parameter that influences significantly the financial viability of the project. Although the external costs continue to represent a considerable part of the social total cost, it is important to notice that is difficult to determine the externalities of biomass with precision, due to the heterogeneity of this spring of energy. Once again, the future works should contemplate the determination of these external costs for the Portuguese case, having in consideration the economic characteristics of the regions with bigger agricultural potential for energy crops, in order to select the relevant variables for analysis and then proceed to its monetary values translation.

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