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Short Communication

Toward a More Environmentally Friendly Use of Biomass for Energy Purposes in Poland

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Abstract

It is argued that in the Polish climate (typical also for many regions in Europe), the best energy use of the existing biomass potential is to provide heating for agricultural holdings based on the locally available biomass feedstock. The cost of heating then becomes significantly lower compared to heating by fossil fuels, especially when biomass is self-produced. This paper analyzes economic and environmental impacts of substituting coal with biomass in agricultural holdings in Poland. The results show that a reduction of CO_2 emissions could be achieved at much lower cost: up to about 8% of public subsidies paid for using the equivalent amount of biomass for power generation.

Keywords: biomass boilers, straw, heat, co-firing, green certificates

Introduction

Compared to fossil fuels, solid biomass as a fuel is characterized by relatively low heating value and low bulk density. Typically, the energy content of a given volume of biomass is about four times lower than for coal. Therefore, transportation of biomass is relatively energy and emissions intensive, which decreases the environmental benefit of conversion of energy production from fossil fuels to biomass. This effect is, however, minimized if biomass is used locally, where it was grown. Given a defined area, biomass is a limited resource determined by available land area, soil quality, etc. Therefore, decreasing the distance of biomass delivery to the location where it is used puts a limit on the output capacity of the energy production facility. In contrast, the overwhelming practice in Poland, the EU and, in fact, worldwide is currently using biomass mainly for power generation. This is driven by regulations designed for CO_2 emissions reduction. However, the economics of power generation favor units of large output capacity, of the order of tens to hundreds of MW. Obviously, such units require large amounts of biomass, which has to be transported from distant locations, often from overseas. In fact, the current structure of the biomass supply is: 70% domestic market, 15% regional import (Ukraine, Russia, Czech Republic, Slovakia), 15% overseas imports [1]. This practise is criticized by many experts, including power station managers [e.g. 2].

Long-distance transportation is only one of the factors that decrease the environmental benefits of using biomass for power generation, or – in general – for energy production (e.g. heat only) in large output capacity units. A number of environment-damaging factors appear at the subsequent stages, such as fires. Two biomass fires occurred recently in Poland: Dolna Odra, January 2010 [3], and Turów, August 2012 [4]. Biomass dust explosions and self-ignition of biomass stocks are a frequent phenomenon [5]. When biomass is added to coal in pulverized coal boilers the milling of biomass increases electricity consumption by 10-15% [6]. Increased slagging and fouling due to biomass additions to coal in co-firing technology decrease the overall efficiency of power generation [7] and lead to serious technological problems (e.g. more frequent slag removal) [8].

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Moreover, the content of chlorine in biomass increases corrosion of metal elements of the equipment, creating serious operational and maintenance problems [6]. Altogether, using solid biomass for power generation generates serious additional environmental and financial costs.

Cost of Green Electricity

First let us note that biomass is used in Poland mostly for power generation by co-firing it with coal. In 2011 97% of biomass was used for power generation or co-generation in large system units. Heat-only production constituted only ca. 3% [9]. The time development of using biomass for power generation is presented in Fig. 1. The columns present the total biomass used for power generation scaled by factor 0.70, which – according to [1] – is the fraction of biomass of domestic origin. Between 2004 and 2011 the amount of biomass used increased more than nine-fold. This increase has been driven by significant subsidies to "green electricity" generation, granted in the form of so-called "green certificates." Until the beginning of 2012 power companies received about 70 EUR for each "green" MWh on top of the market price of the traditional "black energy" derived from coal, which fluctuated around 120 PLN (30 EUR) [10].

Such a high level of subsidies compensate the power generators for all losses mentioned above, but still with a significant profit margin. Let us assume that this level of subsidies is granted to ca. 10 TWh planned for electricity derived from biomass in Poland in 2015 [11, 12]. The corresponding subsidy would then become 700 mln EUR annually. This perspective had led to an investment boom in biomass-based power generation. Consequently, due to oversupply of green certificates in the market, the price of green certificates dropped to about 60 EUR in 2012 [13] and 30 EUR in March 2013 [14]. Moreover, the Polish government plans [15] to reduce the subsidies by a factor of 0.30 and 0.95 to co-firing and dedicated biomass power generation, respectively. According to information given at a Polish Parliament hearing [16] "energy companies received 1.7 bln PLN (ca. 400 mln EUR) of subsidies for co-firing," which is quite below the amount that would be paid for 10 TWh. In an opinion voiced in [16] "… this should be the subject of investigation of a special parliamentary commission." The criticism of co-firing is more and more frequently shared by experts and academics [e.g. 17]. Despite this criticism and discouraging signals from the Polish government and the market, according to [13] "… support mechanisms in the green certificates formula is functioning well and we can observe a boost in investments." Therefore, one can expect that in the coming years huge amounts of money may be funneled to biomass-based power generation – to co-firing, in particular.

It should be noted that those subsidies are covered by the final energy consumers in their electricity bills, in which the surcharge for "green kWh" constitutes several per cent. According to [18] the energy provider has to add about 29 PLN (ca. 7.5 EUR) to the price paid for each MWh (about 200 PLN, ca. 50 EUR). This additional cost propagates through a tariff-setting mechanism to final energy consumers and constitutes a subsidy hidden in their energy bills.

Below we present an alternative to the use of this public money that would serve the same purpose, i.e. reduction of CO_2 emissions in a more cost-effective way.

The Alternative

The alternative is quite straightforward and is based on the principle that biomass should be used first of all locally, ergo in small or medium-sized units.

In many European regions, notably in Poland, there is a significant demand for heating. This could be largely satisfied by biomass, primarily in rural areas, where biomass is locally available, in particular as agricultural residues. In Poland the main agricultural residue is straw, which is often burnt uselessly in the fields. At the same time, it could become an environmentally friendly fuel for heating the

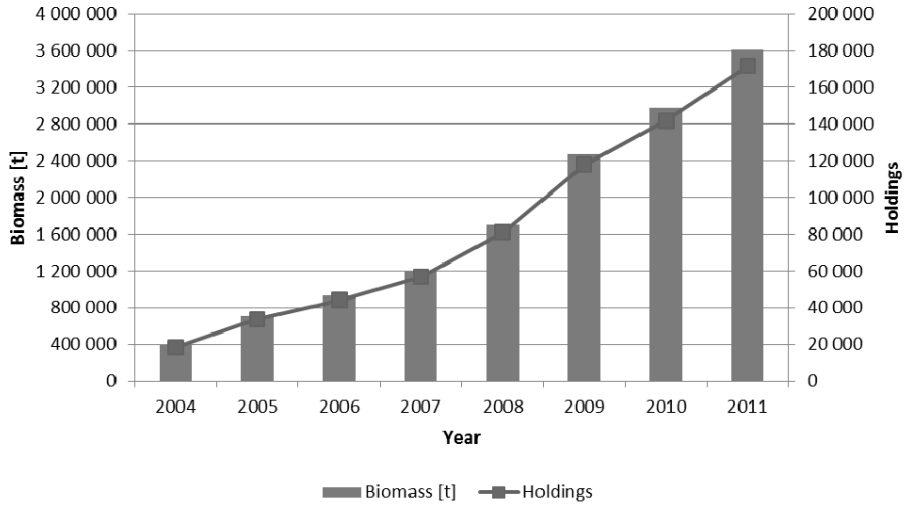

Fig. 1. Columns and left-hand side (LHS) scale – domestic biomass use for power generation; solid line and right-hand side (RHS) – the number of average agricultural holdings.

rural holdings, if burnt in dedicated biomass boilers. However, most farmers in Poland heat their holdings by coal, while good and efficient solid biomass boilers, produced in Poland, are available on the Polish market [19]. Unfortunately, farmers usually do not have sufficient resources to buy and install such modern boilers. At present, there exists practically no financial support scheme that would help them to overcome this barrier.

The solid line and the right-hand-side scale in Fig. 1 represent the number of the Polish holdings (average ones) that could be supplied with heat from biomass which is (was) used for power generation in Poland. The data show that the number for 2011 is above 170,000 holdings. The assumptions behind this figure are:

(i) The average farmer's holding in Poland uses about 240 GJ/y of heat [20]
(ii) Only domestic biomass is considered
(iii) The primary energy content of this biomass is the same as if used in power stations
(iv) The efficiency of power generation is 37% (average for Poland [21])
(v) The efficiency of the solid biomass boilers is 82% [22].

The CO_2 emission reduction effect would be at least the same as in the case of using the same amount of biomass for power generation. In fact, it would be much higher if energy losses in transportation, equipment damage, fires, etc. were taken into account. Moreover, local jobs would be created and a significant amount of money would stay in agricultural communes.

Most importantly, much less public money would be needed to achieve a given level of CO_2 emission reduction.

The calculations made using the Invert model [23] of the EU Altener Program show that, if farmers were supported by grants of 40% of the investment costs, the market for small-scale biomass boilers (20-50 kW) would grow significantly [24].

Let us note that the 40% corresponds to ca. 2,000 EUR per investment [25]. For 170,000 installations this would make in total 340 mln EUR, which is less than half of the 700 mln EUR of the "hidden" subsidy mentioned above. In fact, taking the real number for 2011 (400 mln EUR), it would be still only 85%. Assuming that the service life of the boilers under consideration is (at least) 10 years, the subsidy accumulated over that time would become 4 billion EUR. Hence, the 340 mln EUR paid once per boiler service life (for 170,000 units) constitutes merely ca. 8.5% of that sum. In other words, the same public money would give an environmental effect about 12 times higher (at least). This should be a convincing argument for the decision-makers that support using biomass for (local) heating rather than for large-scale "green electricity" generation.

Conclusions

The presented analysis shows that the local use of biomass for heating purposes is a simple and cost-effective solution to reduce emissions of greenhouse gases in Poland. However, this paper does not address the general question of how Poland can reach the target of 15% of renewable energy in the country's energy balance by a year 2020. The local use of biomass for heating constitutes only a contribution to that effort which, nevertheless, is both important and achievable at a cost lower than its equivalent obtainable by co-firing biomass with coal. Even if the search for the solution how to achieve that 15% renewable energy target is limited to the energy use of biomass alone, this would require an extensive, multidisciplinary study, which is far beyond the scope of this paper (e.g. [12]).

Finally, it should be noted that the main conclusion of this paper is supported by the results of the EU 4Biomass Project [26]. The opinion survey was there performed among 1221 experts/stakeholders from 8 countries (AT, CZ, DE, HU, IT, PL, SI, SK). They were asked the question: "which use of biomass for energy purposes is most important for achieving the targets of your national Biomass Action Plan?" The majority of respondents indicated "small scale heating systems using biomass" followed by "district heating using biomass," while "electricity from biomass" was ranked 4th out of 8 [27].

It should be noted that, recently, the small-scale use of biomass has been given increased attention in EU Programs (i.e. IEE ALTENER or ERA-NET Bioenergy 2013 calls for proposals) [28, 29].

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