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Modelling of biomass prices for bio-energy market in the Czech Republic

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ABSTRACT

The article combines theoretical approaches in economic modelling with practical application of created models for the bio-energy sector in the defined area. Design and application of economic models is discussed to predict future biomass prices from new energy crops on the developed and saturated bio-energy market. The models use minimum price methodology based on application of elementary principles of economic theory to commercial activity with undeveloped production and/or the demand side of the biomass market. The model is then tested on real economic and agronomic data from pilot and experimental biomass production and utilization projects in the Czech Republic with a case study of biomass from poplar and willow short rotation coppice (SRC) and reed canary grass plantations. Selected results of this modelling of biomass prices are presented and discussed. The economic model created proved to be a practical tool for analysis of the effectiveness and competitiveness of biomass from different energy crops on the energy market, which can be used for strategic planning on the part of state administration or decision-making of companies in the biomass sector.

1. Introduction

Biomass is the most important renewable energy source (RES) available in the Czech Republic, contributing about 82% to the total RES utilized as primary energy sources (76 PJ out of 94 PJ in 2008) [11]. In the long term (a time horizon until 2030) it is expected that biomass will contribute approximately 80–85% to the total amount of RES used both in electricity generation and the primary energy structure, and it is expected to reach approx. 276 PJ in 2050 [16]. Every long-term project, including action plans, state energy policy, investment decisions, etc., requires information on biomass cost curves and the expected future prices of different types of biomass for energy purposes.

Biomass utilization for power generation is not accompanied by problems of unstable power supply, which occurs with, for example, wind or solar energy dependant on uncontrollable natural conditions. The unregulated and unlimited development of photovoltaic power plants in particular has resulted in difficulties with ensuring the control and reliability of power supply in the Czech Republic [15,29]. The possibility of storage and controlling power generation in line with the needs of the power grid is one of the main advantages of biomass compared with other RES used for power generation.

The main and most difficult barrier to biomass utilization is the amount available on the market and its accessibility. Total biomass consumption for energy purposes in the Czech Republic was approx. 6.9 m tonnes in 2008. Residual and waste biomass from paper production made up a substantial share of this amount. Household consumption based on self-collection of wood in forests or non-trade firewood was a significant part of total biomass consumption – approx. 3.4 m tonnes. Only a smaller part (approx. 2 m tonnes) of biomass actually entered the domestic biomass market [11].

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With regard to the aims of the Kyoto protocol on reducing greenhouse gas emissions, the Czech Republic has already reached its goal. Current GHG (Greenhouse Gas) emissions are approx. 23% below those in the reference year of 1990 (emissions in 1990 were 190.3 m tonnes CO_{2e}, emissions in 2006 were 144.8 m tonnes CO_{2e}), while the goal for the Czech Republic is an 8% reduction by 2012. This was made possible mainly due to the high emissions in the reference year of 1990 and the changes in the structure of primary energy sources used (the reduction of the very high share of coal from 65% in 1990 to less than 50% in 2007), the absolute reduction of primary energy sources used (2076 PJ in 1990 and 1880 TJ in 2007) and, last but not least, the increase in RES utilization (the contribution to primary energy sources used increased from 2.2% in 1990 to 5% in 2008 – [11,17]).

The Czech Republic (unlike the majority of developed countries, e.g. see [7]) could sell part of the GHG emission reduction pursuant to the Kyoto protocol to Japan, Spain and Austria in 2009 (approx. 66 m AAU) and expected total revenue is EUR 0.6-0.8bn [18]. This money has been channelled into the recently launched Green Savings Programme aimed at energy savings and renewable energy sources utilization in the household sphere. Biomass utilization plays here a significant role and biomass is expected to become one of the substitutes to domestic brown coal, still widely used for individual space heating [19].

As mentioned above, Czech Energy Policy and other strategic studies (e.g. [16]) assume a continuous increase in the biomass contribution to the balance of primary energy sources. Since sources of waste and residual biomass are already exploited, the future development of biomass utilization requires fundamental development of intentionally grown biomass from energy crops. Longer time horizons (2030–2050) assume the utilization of up to 1 m hectares of agricultural land for "energy biomass" planting [16]. Extensive investments and financial support are needed both for the technologies for biomass utilization and establishment of energy crops plantation.

Biomass prices play a key role for stakeholders deciding to invest in biomass use (e.g. energy groups deciding to invest in equipment for electricity and/or heat production using biomass) or to invest in production (e.g. farmers considering the development strategy for their business and use of the agricultural soils to which they have access). The standard decision-making process for both groups is based on longer time horizons. Stakeholders investing in energy equipment need to ensure fuel supply and therefore require long-term contracts for biomass supply. Those investing in SRC or other perennial energy crops with a minimum production cycle of 10-years will, however, be looking for long-term use for their product. Yet in this type of decision-making process information on current biomass prices cannot be used. The main reasons for this are as follows: (1) There is a limited biomass market, in which the price of individual biomass forms are not of a predicative type (only about 2 m tonnes of biomass enter the domestic biomass market, and this biomass is almost exclusively waste originating in the wood processing industry and agriculture, only approx. 65,000 tonnes is intentionally planted biomass [11] – i.e. current prices on the biomass market do not reflect the situation in which the vast majority of used biomass comes from biomass planting on agriculture land; (2) Traded biomass is at the moment primarily used for power generation (approx. 1.2 m tonnes in 2008 – 580,000 tonnes of wood residuals from timber harvesting, 590,000 tonnes of wood chips and wood residuals, 65,000 tonnes of intentionally planted biomass [11]) and currently the biomass prices reflect green bonuses and feed-in tariffs for electricity produced from biomass burning [20]; (3) The assumed mass development of biomass use will lead to fundamental changes in the volume and the structure of the biomass market.

Biomass prices are generally market-driven, with a balance between the supply of and demand for biomass being attained. The factors that influence the price of biomass can be divided into those of supply and demand. Supply factors provide the investor deciding whether to implement a biomass plantation project with information on economic viability. From the analyzed supply factors we can derive a minimum price per unit of production (i.e. the unit price of biomass) that has the meaning of long-term marginal costs [21–23]. This price represents a limit under which a rationally thinking stakeholder would not go (i.e. the project will not be realized). The minimum price is a guideline that allows for the determination of the price level around which the given biomass form may fluctuate.

2. Methodology

2.1. Minimum price calculation

Models of the expected future biomass prices were created for poplar and willow short rotation coppice (SRC) and reed canary grass plantation using the minimum price methodology based on the Net Present Value criterion – see Section 2.2.

The basic criterion for the investor's decision to accept or reject a project is the Net Present Value (NPV) criterion – [1]. When NPV is greater than zero, investors realize a higher rate of return on capital invested compared with other investment opportunities. NPV equal to zero thus defines the limit to accepting the given project. NPV calculation can be also done in reverse logic. NPV is not the result of calculation, but NPV = 0 is used as the binding condition to calculate the so-called minimum price of production. Minimum price of production is needed specific price (at least) to assure (at least) the required rate of return on the capital invested for the investor [22]. This approach is generally applicable to a wide range of economic tasks, such as calculation of the required price from the investor's point of view (if the market price is lower than the calculated minimum price for the analyzed project, the investor refuses to invest in the project) or the calculation of the proper value of feed-in tariffs for electricity generated using RES (the state regulatory authority derives a proper feed-in tariff value for the given RES type based on the assumption of adequate value of the regulated rate of return) [24].