Effectiveness of biomass development: life-cycle costs analysis

Tomáš Králík, Czech Technical University in Prague, Czech Republic, +420 2 2435 3308, tomas.kralik@fel.cvut.cz
Michaela Valentová, Czech Technical University in Prague, Czech Republic, +420 2 2435 3308, michaela.valentova@fel.cvut.cz
Jaroslav Knápek, Czech Technical University in Prague, Czech Republic, +420 22435 3315, knapek@fel.cvut.cz

Overview

In the Czech Republic, the expected development of renewable energy sources (RES) is mostly connected to biomass. It is estimated that 80 – 95 % of the long-term growth of RES is to be covered by biomass (Pačes et al.). In the same time such development presumes large-scale governmental support schemes, which currently are often not systemic and therefore ineffective.

Biomass is a very heterogeneous category and the support schemes to be effective need to acknowledge that. Assessing economic effectiveness of various types of biomass and their uses one cannot use aggregated data. On the contrary one has to respect the specific characteristics of individual biomass types and their production when optimizing the national strategies from economic point of view, but also as to long-term sustainability and ecology of biomass production.

The paper will therefore present systemic point of view on selected types of biomass for energy purposes. It assesses the whole fuel cycle of the final useful product (including production and processing of biomass) and evaluates the economic and the environmental effectiveness (i.e. compares "full cost" of 1 kWh or GJ of final useful product and "full cost" of one saved tone of CO_2) on the basis of identified fuel cycle, lifetime of individual technologies in given fuel cycle, effectiveness of energy transformations and energy losses.

Application of developed methodology is demonstrated on the representatives of the three most typical kinds of energy crop in the conditions of the Czech Republic. Three main types of biomass are evaluated that way (short rotation coppices, corn and reed canary grass) and compared among themselves and to conventional energy products.

Methods

The paper defines the production and processing cycles of selected types of energy biomass and selected types of final products (electricity, heat, solid, liquid and gaseous biofuels). The process analysis is used enabling to identify the key components of the given cycles. For each component, the technologies and their basic economic and energy characteristics are identified.

The process analysis focuses primarily on crops for agricultural land, i.e. short rotation coppices, corn and reed canary grass, and processing technologies connected to these crops. These crops have been selected because agricultural land represents the largest potential in terms of availability of land. The three crops also represent different production cycle in terms of length – from short term, one-year crops to perennial crops.

Evaluation of the effectiveness of the production and processing cycles is based on identification of energy, economic and ecological parameters of individual parts of the analysed cycles. The main energy characteristics are energy consumption and energy output of the given part of the cycle; economic characteristics are investment and operational costs and subsidies, if relevant. Ecologic parameters are related to CO_2 emissions.

Results

Biomass is a substitute of classic fossil fuels. The outcome of the evaluation of effectiveness of biomass cycles are specific costs for 1 GJ or 1 kWh of energy in final product, or in other words shadow price of one tonne of

saved CO2. This enables to compare the effectiveness of individual final products from biomass to each other and to conventional energy products. This in turn allows to identify economically and ecologically most effective ways of production and use of biomass for energy purposes, respecting all processes connected to its production and use.
The results therefore cover entail:

- Process analysis of production and processing cycles of three selected biomass crops to compare economic effectiveness of the given energy biomass uses, and
- Comparative analysis of the economic and ecologic effectiveness of the final products obtained from biomass with conventional energy products.

Conclusions

Biomass will play a key role in renewable energy sources development in the Czech Republic in the coming years. In the same time it is clear that the massive development will require system approach in preparation of the national strategy of the further RES development (revision of National action plane for RES and the State Energy Policy including reduction of barriers of biomass development and definition of cost effective support scheme for biomass production, processing and the utilization.

Current estimation of cost increase resulting from RES development (only!) for power generation approaches 2 bil. EUR in 2020 and biomass is estimated to contribute to these extra costs by app. 600 mil. EUR in 2020. Further development of biomass utilization would inevitably lead to the significant increase of extra cost resulting from biomass utilization for energy purposes.

The primary aim of biomass utilization for energy purposes is contribution to assurance of energy needs of final energy consumer. Different ways (i.e. fuel chains) of biomass utilization significantly differ in both in economic and energetic effectiveness. Assuming the economic scope of the task it is clear that systemic approach to biomass development and subsequently to development of coherent support scheme for biomass utilization are highly needed. Evaluation of economic and environmental effectiveness based on the whole fuel chain approach is one of the critical parts of this coherent system approach.

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