Energy 76 (2014) 161–167

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

The impact of subsidies and carbon pricing on the wood biomass use for energy in the EU

Alexander Moiseyev [a,*], Birger Solberg [a], A. Maarit I. Kallio [b]

[a] Department of Ecology and Natural Resource Management, Norwegian University of Life Science, Ås, Norway
[b] METLA (Finnish Forest Research Institute), Vantaa, Finland

ARTICLE INFO

Article history:
Received 9 December 2013
Received in revised form
12 May 2014
Accepted 14 May 2014
Available online 16 June 2014

Keywords:
Bioenergy
Subsidies
Forest biomass
Partial equilibrium model
Forest sector model
Renewable energy

ABSTRACT

This study examines how subsidies for wood-fired heat and power plants and wood with coal co-fired power plants influence the use of wood biomass for energy in the short (2020) to medium (2030) term in the EU (European Union). Analysis shows that without subsidies wood-fired electricity will take only a marginal market share due to limited availability of low-cost wood from logging residues. A high CO_2 price of 100 €/t without subsidies results in 30 million m^3 of industrial wood used for energy production, which is sourced from the reduction of 12 million m^3 for wood products, 10 million m^3 additional imports and 8 million m^3 additional harvest. With a subsidy level of 30 €/MWh in the four EU member countries Denmark, Germany, Netherlands and UK, the total amount of industrial wood used for energy becomes 158 million m^3. In the latter case, reduction of wood for wood-based products is 35 million m^3, additional harvest in the EU is 21 million m^3, and import to the EU is 102 million m^3. Subsidies to wood-fired and especially coal with wood co-fired mills substantially increase the use of wood and especially industrial wood for energy. However, even with a high 100 €/tCO_2 price and subsidy, mostly gas-fired electricity is projected to be displaced in 2030 by the increasing use of industrial wood, which is not beneficial regarding reducing the high CO_2 emission from power production using coal. To a large extent, subsidies for wood co-firing maintain the coal power share, which will otherwise be reduced at high carbon emission price level. In addition, the model results show that the main sources of the growing use of industrial wood for energy are imports from regions outside of the EU, which thus creates considerable carbon leakages.

1. Introduction

The EU (European Union) has set strong targets for reducing the GHG (greenhouse gas) emissions by at least 80% below 1990 levels by 2050 in order to halt the global climatic warming to 2 °C [1]. Before that, the EU had put in place legislation to reduce its emissions to 20% below 1990 levels by 2020. Studies by the ECF (European Climate Foundation) [2] and the EC (European Commission) [3] address the feasibility and implications of the 80% emissions abatement objective. One of the consequences of achieving that objective would be high CO_2 prices after 2030; over100 €/t in 2040 and 200 €/t in 2050.

According to the ECF [2], RES (renewable energy sources) are going to play a key role in achieving EU energy sector decarbonisation targets in 2050 by supplying a major part of electric power and heat. By 2030, RES energy supplies are expected to provide 55–60% of the EU electricity production, while the remainder will be provided by nuclear power, coal and gas. The use of coal and gas is expected to gradually diminish as a result of reduced CO_2 emission allowances sold on the EU ETS (Emissions Trading System) and rising CO_2 prices. Since coal and gas are the two most important fuels used in Europe in power production, their prices and the CO_2 emission prices will affect how the new RES, including wood biomass, will compete for the share of the power market. However, carbon emission prices are very low in the EU at present, and the major drivers of RES supply are various subsidies. According to Badcock and Lenzen [4] subsidies for biomass are the second highest per unit of electricity produced after solar power. Coal with wood co-firing is often seen as a low cost and efficient way of achieving the 20% RES target set by the EU for 2020 [5]. Despite the "low cost" image of coal with wood co-firing it receives hefty subsidies in the UK, the Netherlands and some other EU member states, and the efficiency of such policies are questioned by non-scientific sources [6]. The EU target for reducing GHG emissions by 80% has caused strong debates among different industry groups. The CEPI (Confederation of the European Paper Industries) states in

* Corresponding author. Tel.: +358 452343788.
E-mail addresses: moiseyev17@gmail.com, alexander.moiseyev@efi.int (A. Moiseyev).

http://dx.doi.org/10.1016/j.energy.2014.05.051
0360-5442/

its report [7] that with the increasing CO_2 prices, the forest products industries will have to compete for the wood biomass with coal plants, which will find it increasingly cost-effective to substitute wood for coal. Also, the bioenergy producers are highly interested in how much wood biomass will be available and at which prices.

It is therefore of considerable interest to analyse the impacts of increased demand for wood biomass for bioenergy in the EU. These impacts depend rather strongly on the kind of subsidies used. Thus, in this article we examine how various kinds of subsidies for wood-fired heat and power plants and wood with coal co-fired plants influence the use and price of wood biomass for energy in the short (2020) to medium (2030) term in the EU, in competition with the forest industries.

Most of the previous studies deal only with the technical and economic potentials of using wood for energy [8], or look at the wood market implications taking either biomass prices [9] or biomass use [10] as given, or they look at the biomass scenarios without considering their market implications [11]. On the other hand, energy sector-related studies tend to take biomass price and supply as given [12,13]. IAMs (Integrated Assessment Models) such as REMIND, MERGE, POLES and IMAGE-TIMER have been used to assess the biomass use for climate mitigation scenarios [14,15]. However, the wood biomass was mostly limited to the wood energy plantations and logging residues. There is no forest sector as such within the IAM framework, which limits the possibilities for studying interactions between energy and the forest sector. Few studies have looked into the interaction between the energy sector and the forest sector. Lauri et al. [16,17] and Moiseyev et al. [18] provide an exception. In these studies, use of wood for energy is endogenous and the major driver of increased usage of energy wood is different levels of carbon emission prices. In Moiseyev et al. [18] subsidies for energy wood were also considered as an additional driver of increased use of wood for energy, but the main focus was on carbon emission prices.

In Sjølie et al. [19], the Norwegian forest sector model was complemented by a district and household heating model in order to study the impact of various levels of carbon emission prices and investment subsidies on the substitution of fossil fuel by wood fuels. A tax of 60 €/CO_2 on fossil fuels was found to increase use of wood for district heating substantially. However, a 50% subsidy for district heating installation combined with much lower carbon emission tax helped to increase the use of wood for district heating to almost the same levels. Both carbon emission tax and investment subsidy were deemed to be effective policy measures to increase the use of wood biomass for energy.

A similar study [20] for Finland was carried out with the Finnish forest sector model SF-GTM (Finnish Global Trade Model) augmented with a heat and power energy model [21]. In order to reach 20% RES targets for Finland in 2020, a modest carbon emission tax and a small subsidy for wood-based electricity combined with a subsidy for small tree harvesting were assumed. A target of energy wood for 2020 can be reached with the proposed carbon tax and subsidies, but a reduced forest carbon stock due to increased harvesting will result in increased CO_2 emissions leading to an overall negative carbon emission balance within a 2035 time frame.

A model of the Finnish electricity and heat market [22] was used to study feed-in tariffs and a subsidy to renewable energy together with the CO_2 emission price. Subsidising forest biomass combustion in a co-firing power plant decreases the investment in pure renewable technology (wind power). However, the use of fossil fuels (coal and gas) increases modestly when the carbon emission price is set at low levels. The CO_2 intensity of electricity production is nearly equal whether biomass co-combustion is subsidised or not. Since subsidising wood with coal co-fired electricity production results in lower electricity marginal costs, the use of both coal and wood pellets can increase when the CO_2 emission price level is low. This could lead to the so-called Green Paradox, when subsidising biomass causes the increased use of fossil fuels [23].

We will focus on the large-scale power and heat sector in the EU and examine the potential demand for wood fuel by the coal and wood-fired power and heat plants and the question of how this demand depends upon different kinds of subsidies and different developments of the prices of CO_2. We model coal, gas and wood-based power and heat for the existing technologies in the aggregated form (one technology for each fuel type for each country). With such a level of technical details we do not regard this model as a "realistic" full scale energy model. However, it allows us to consider the competition between coal, gas and wood for the energy production taking interaction with the global forest sector into account. Our approach is similar to Moiseyev et al. [18], but in this paper we study different levels of subsidies and varying levels of adoption of wood for energy subsidies among EU member countries. Compared to Lauri et al. [16], the energy sector representation is expanded to cover the gas power sector, and we also take into consideration the wind and solar PV (photovoltaic) power production based on the projections of expected future capacity expansions by ECF [2,24]. For the analysis, we use the same version of the partial equilibrium model for the global forest sector, the EFI-GTM (European Forest Institute Global Trade Model) model, as used in Moiseyev et al. [18]. It covers the whole world, which allows us to fully account for the international trade of wood biomass and forest products. The EFI-GTM model does not take into account more local small-scale electricity and heat production including domestic boilers. However, the main growth in wood biomass use for energy is expected at large-scale industrial facilities [25], where various subsidies are given in order to reach the 20% EU RES target.

2. Methodology and main data assumptions

In the analysis, we use the EFI-GTM global forest sector model [9,26]. In Moiseyev et al. [18], the model was revised to include heat and power produced from coal, gas and wood into the modelled commodities, which previously consisted of the forest and forest industry products only. Four types of thermal power electricity generating plants (by type of fuel used – lignite, coal, gas and wood), four types of heat plants and four types of CHP (combined heat and power) plants were included, as described more in detail in Moiseyev et al. [18].

Electricity and heat production is described as a process with fixed fuel inputs and other non-fuel costs. Coal and gas prices are exogenous, but they can change over time according to the scenario assumptions. Wood used as fuel can be obtained from logging residues and from industrial wood (sawlogs, pulpwood and sawmill residues) converted to energy chips and wood pellets. Electricity and heat generation efficiencies for eight types of thermal power and CHP plants are based on data from the database of the GEMIS (Global Emission Model for Integrated Systems) [27]. Required fuel input corresponds to the electricity efficiency and is also based on GEMIS data. The average estimate for the LHV (low heat value) of hard coal and lignite is taken from Schuster and Peterson [28]. The LHV of wood is based on United States Forest Service – Forest Products Laboratory [29], and is assumed to be 13.76 MMBtu per tonne of air-dried wood (20% moisture content) and 12.04 MMBtu per tonne of semi-dried wood (30% moisture content). The average weight of wood is assumed to be 0.6 tonne/m^3 (air dry wood). Consequently, air-dried wood has an LHV of $13.76 \times 0.6 = 8.26$ MMBtu/m^3 (8.7 GJ/m^3) and semi-dried wood has an LHV of $12.04 \times 0.6 = 7.22$ MMBtu (7.6 GJ/m^3). The LHV of wood pellets is assumed to be 13.6 MMBtu per tonne [29]. For coal with wood pellets, co-firing 20% of energy input is assumed to be coming