EMISSION PAYMENTS AND SUSTAINABILITY CRITERIA FOR SOLID WOOD BIOMASS: OPTIMAL ENERGY MIX AND COSTS OF TARGETS

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Overview

Wood based bioenergy has an important role in fulfilling the targets for renewables and emission reduction in the countries with large forest resources, like Finland. Commonly, energy and climate policies consider bioenergy as greenhouse gas emission free. This is typically justified through carbon neutrality argument (e.g. Sedjo, 2011). Carbon neutrality argument stems from the fact that the biomass is renewable and the carbon released by biomass use is only recycling of carbon already in circulation. The emission free biomass has been recently contested due to the carbon leakage and the importance of temporal aspect of uptakes and emissions. The latter argument refers to carbon debt generated by an instant release of carbon by biomass use and the following gradual absorption of carbon by slowly growing plants (e.g. Fargione et al., 2008; Searchinger et al., 2008). A similar carbon debt argument has been proposed for the use of harvest residues as there is an instant release of carbon that would otherwise be released only gradually (e.g. Repo et al., 2011). Thus, carbon neutrality may not justify emission free status of all bioenergy.

The European Commission prepared a draft of the proposal to introduce sustainability criteria for solid and gaseous biomass in heating and cooling and electricity (EC 2013), in addition to the liquid biofuels. In many Member States, the flue gas emissions from the use of solid biomass are significant as compared to the current emissions in the Emissions Trading sector. The treatment of emissions from solid biomass is also likely to have major implications in fulfilling the national targets under the Renewable Energy Directive. In this study, we implement the sustainability criteria and non-zero emission coefficients for solid wood biomass and evaluate their impacts on the optimal energy mix as well as on the costs of emission reduction and achieving renewable target, in the case of Finland.

Methods

The optimal forest carbon policy derived in Lintunen and Uusivuori (2014) is utilized in this study. They showed that emission payments for solid wood biomass have to be based on the effective emission factors and the social cost of carbon (i.e.CO_2 price) to fully reflect the impacts of using wood biomass on climate. The effective emission factors reflect both the nominal emission factor of a specific input and a temporal advancement or postponement of emissions due to the use of the input. Thus the effective emission factors for harvest residues depend on the discount rate and the decay rate. We begin our analysis with a partial carbon policy, where an emission factor is placed only on the forest residues. We compare the results with a comprehensive policy scenario, where the carbon policy is extended to the forest management also. The further effects of implementing a target for renewable energy with feed-in-tariff as policy instrument are assessed as well. We assume constant price of carbon to be 15 or 30 €/ton of CO_2 reflecting e.g. the price of emission permit allowance or a carbon tax.

Policy calculations are performed with an intertemporal partial equilibrium optimization model covering detailed description of energy and forest sectors. A multi-input, multi-output model with Leontief technology describes the optimal production of the forest industries. The optimization is performed with respect to input use. The model includes several energy wood types such as roundwood, harvest residue fractions and by-products of production processes. In the energy generation, the energy transformation into heat and power is linear but the non-linear transportation and co-firing costs enable interior solutions in fuel use optimization. The model includes several boiler types as well as wind power. Investment decisions are modeled through dynamic optimization with restricted foresight on the future. Wood supply is based on a detailed description of Finnish forest with forest owners optimizing thinning and clear-cut decisions under bounded rationality of expectations.

Results

Effective emission factors for all types of harvest residues are lower than emission factors for coal with discount rates up to 5 %. Sustainability criteria have been suggested to be fulfilled if the emission reduction is 60 % compared to fossil fuels (EC 2013). Residuals satisfy the sustainability criteria if the discount rate is 5 % or lower. Small-sized trees are accepted as renewables only if discount rate of 1 % is applied. Stumps are not fulfilling the criteria even with discount rate of 1 %.

When setting emission payments to harvest residues their competitiveness against other renewables and fossil fuels weakens. Thus the use of energywood was reduced by 10-65 % depending on the price of carbon and discount rate, compared to the current climate policy. Especially, the use of energy wood types with high decay rates, like stumps, decreases. On the other hand, the use of those energy wood types, like small-diameter branches, that would decay fast in the forest and have thus low effective emission factor, might increase. The higher the discount rate used when determining the effective emission rates, the lower is the use of energywood. The use of pulpwood in energy production increases if its emission-free status is continued.

In the case of comprehensive policy, the policy instruments are set also to carbon sequestration and carbon release from roundwood. Thus the policy increases the price of wood and decreases the fellings in the short and medium run (i.e. tens of years depending on length of rotation). Reduced harvests decrease the residue potential implying that the use of harvest residues is lower in the case of comprehensive policy than in the partial carbon policy. In the long run, timber stock and thus timber supply are at the higher and roundwood prices at the lower level with the comprehensive policy, due to the lower harvests in the adjustment path. In spite of the increased residue potential its use might decrease in the energy production as it loses competitiveness against pulpwood.

As the emission payments make the use of harvest residues more costly implying reduction in their use, other renewables are needed to achieve the possible target for renewables. The higher level for feed-in-tariff is needed to achieve the renewable target. The increase in FIT was evaluated to be 7-30 €/MWh in the cases calculated. In the comprehensive policy, the supply of by-products and black liquor is also reduced in the short and medium term due to the reduced harvests. Thus obtaining the target for renewables would be very costly.

Conclusions

Setting the emission payments and sustainability criteria for harvest residues does not cease their use in the production of heat and power. However, the emission payments weaken their competitiveness against wind power and fossil fuels and thus their use is at the lower level compared to current climate policy. Impacts on the optimal energy mix and costs differ to some extent in the different phases of adjustment path. In the case of implementing the comprehensive policy, achieving the target for renewables would be very costly. This would imply that the targets should be renegotiated for countries whose renewable energy generation is mainly based on the forest-based feedstock. Implementing the emission payments based on the effective emission factors in ETS might be challenging as the annual reporting of emissions cannot be based on the effective emission factors. However, effective emission factors reflect the full social cost of wood use that should be taken into account in the decisions of energy producers and forest owners. Policy should be implemented gradually in order to avoid the disturbances in the timber market.

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