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Sequester or substitute—Consequences of increased production of wood based energy on the carbon balance in Finland

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ABSTRACT

Forests play an important role in mitigating climate change. Forests can sequester carbon from the atmosphere and provide biomass, which can be used to substitute for fossil fuels or energy-intensive materials. International climate policies favor the use of wood to substitute for fossil fuels rather than using forests as carbon sink. We examine the trade off between sequestering carbon in forests and substituting wood for fossil fuels in Finland. For Finland to meet its EU targets for the use of renewable energy by 2020, a considerable increase in the use of wood for energy is necessary. We compare scenarios in which the wood energy targets are fully or partially met to a reference case where policies favoring wood based energy production are removed. Three models are used to project fossil fuel substitution and changes in forest carbon sinks in the scenarios through 2035.

Finnish forests are a growing carbon sink in all scenarios. However, net greenhouse gas (GHG) emissions will be higher in the medium term if Finland achieves its current wood energy targets than if the use of energy wood stagnates or decreases. The volume of GHG emissions avoided by replacing coal, peat and fossil diesel with wood is outweighed by the loss in carbon sequestered in forests due to increased biomass removals. Therefore, the current wood

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energy targets seem excessive and harmful to the climate. In particular, biodiesel production has a significant, negative impact on net emissions in the period considered. However, we did not consider risks such as forest fires, wind damage and diseases, which might weaken the sequestration policy. The potential albedo impacts of harvesting the forests were not considered either.

Introduction

Forests play an important role in climate change mitigation. Growing forests can sequester carbon from the atmosphere. Forests also provide woody biomass, which can be used to substitute for fossil fuels or displace more energy-intensive materials. Currently, the EU and international climate and energy policies favor the use of wood to substitute for fossil fuels to using forests as carbon sink. Under the Kyoto Protocol, the greenhouse gas credit that can be obtained via forest management sinks is capped and the benefits countries can obtain from forest sinks tend to be rather modest. For instance, Finland qualifies for the maximum credit of[3] 2.5 Mt CO_2 eq per year from this sink under the second commitment period of the Kyoto protocol starting in 2013 (UNFCCC, 2011), whereas Finland's forest management sink was as high as 30.8 Mt CO_2 eq in 2010 (Statistics Finland, 2012). The use of wood as a fuel feedstock in energy production provides much more options for fulfilling international commitments related to climate policies. In EU member states, increasing the use of wood energy helps to comply with the EU directive (European Parliament of the Council, 2008) on the promotion of the use of energy from renewable sources (RES) and reduce greenhouse gas emissions from energy production under the Kyoto protocol and the EU Emission Trading System. This is possible because wood is a renewable fuel, the carbon dioxide emissions of which are not counted in the greenhouse gas accounts (Statistics Finland, 2011). It is assumed that the greenhouse gases released into the atmosphere will eventually be recaptured by the regrown biomass.

Nevertheless, harvesting forest chips or roundwood and burning them as fuels causes immediate greenhouse gas emissions. In forests, this is observed as a reduction in forest carbon stocks. Such a reduction may be temporary, provided that the forests are managed in a sustainable manner. Several dynamic mechanisms contribute to determine the extend to which and when, the same amount of carbon will be recaptured in the forests. The decline in a forest's carbon stock from the use of forest chips or small trees collected from first thinnings, which would remain on the forest floor if they were not harvested for bioenergy, is due to the following: (i) it takes several years for them to gradually decay, (ii) part of their carbon content would eventually be trapped in the forest's soil (Repo et al., 2010) and (iii) the nutrients they contain may be lost, which hampers the growth of remaining biomass (Helmisaari et al., 2011). Harvesting roundwood, which is still growing, produces indirect emissions because if left standing, the trees would not only store their existing carbon content, but they would also continue growing and absorbing more carbon from the atmosphere. They would also continue to produce litter, part of which would increase the carbon stock in the forest's soil (Liski et al., 2006). The concept of carbon debt refers to the amount of time between when the biomass is harvested until the amount harvested has regrown (Fargione et al., 2008).

The scientific literature contests the carbon or climate neutrality of wood biomass fuels and recognizes that the emission benefits of bioenergy over the use of fossil fuels are time-dependent (e.g., Schlamadinger et al., 1997). Substituting forest residues (Repo et al., 2010; Pingoud et al., 2012; Wibe, 2012) or roundwood (Lecocq et al., 2011; Holstmark, 2012; Zanchi et al., 2012) for fossil fuels may not reduce greenhouse gas emissions in the time period necessary to slow global warming. The type of

[3] The credit can only be obtained from the part of the sink that exceeds the reference level, which is approximately 20.5 Mt CO_2 eq for harvested wood products in Finland.