GLOBAL POTENTIAL OF ENERGY WOOD

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Introduction

Woody biomass will be an important source of energy in the future when the reserves of fossil fuels shrink and the costs of using fossil fuels increase due to climate change mitigation. In 2000 approximately 2.5 Gm^3/yr (21 EJ/yr) woody biomass was used for energy, which consisted of 1.7 Gm^3/yr (15 EJ/yr) household fuelwood and 0.8 Gm^3/yr (6 EJ/yr) energy wood. This was about 5% of primary energy and 40% of renewable primary energy consumption in the world.

The maximum available woody biomass in 2050 is estimated to be 43 Gm^3/yr (310 EJ/yr). If all of this biomass were used for energy production then it could satisfy 31 % of the expected primary energy demand of 1000 EJ/yr in 2050. Given the increasing importance of woody biomass as an energy source, it would be interesting to know how much of woody biomass will actually be used for energy production in 2050 and at what price.

Method

The global potential of energy wood is estimated by using the Global Biomass Optimization Model (GLOBIOM) and the Global Forest Model (G4M). The advantage of using a market-based optimization model is that we can consider the actual wood use instead of some assumed potentials. In particular, we can analyze the substitution between material use of wood, household fuelwood and energy wood through market mechanism.

By energy wood we mean large scale woody biomass use for energy, i.e., energy wood excludes small scale woody biomass use for energy (=household fuelwood). We distinguish between energy wood and household fuelwood, because the trend in woody biomass consumption for energy is going towards large scale industrialized use.

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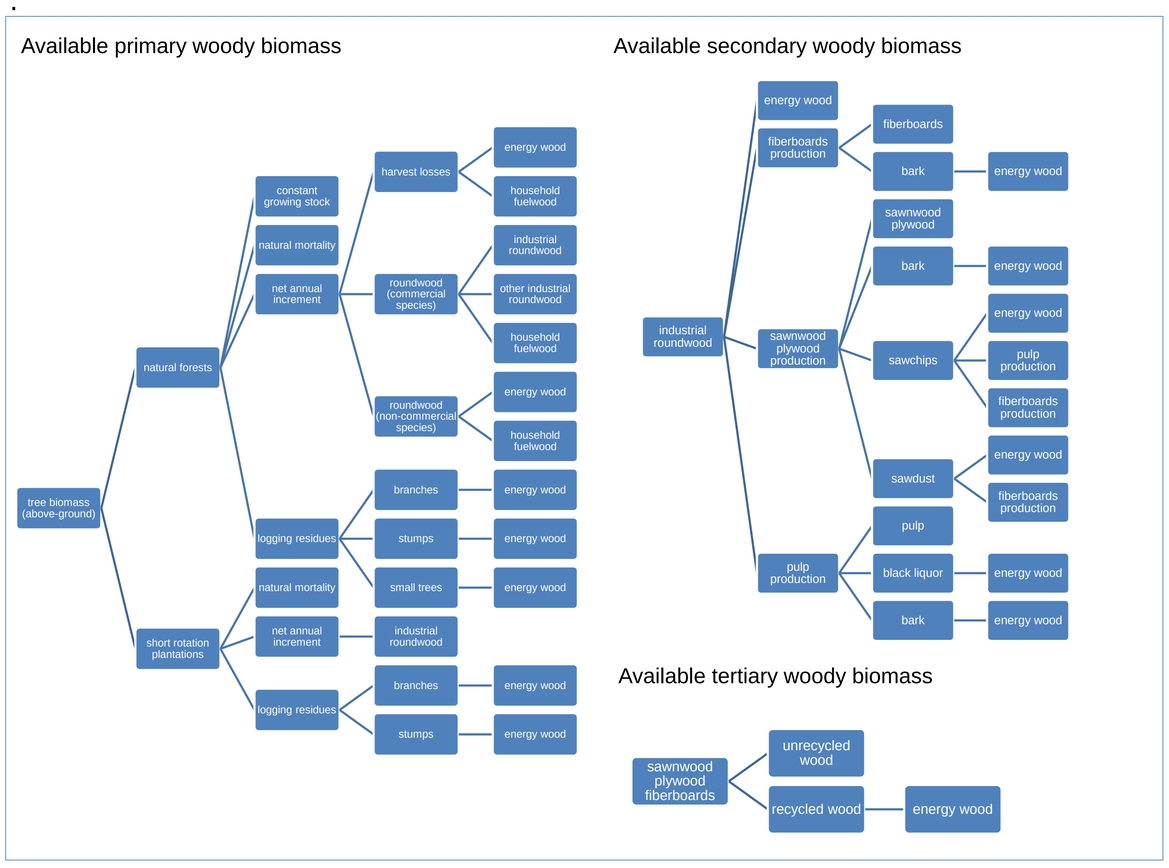
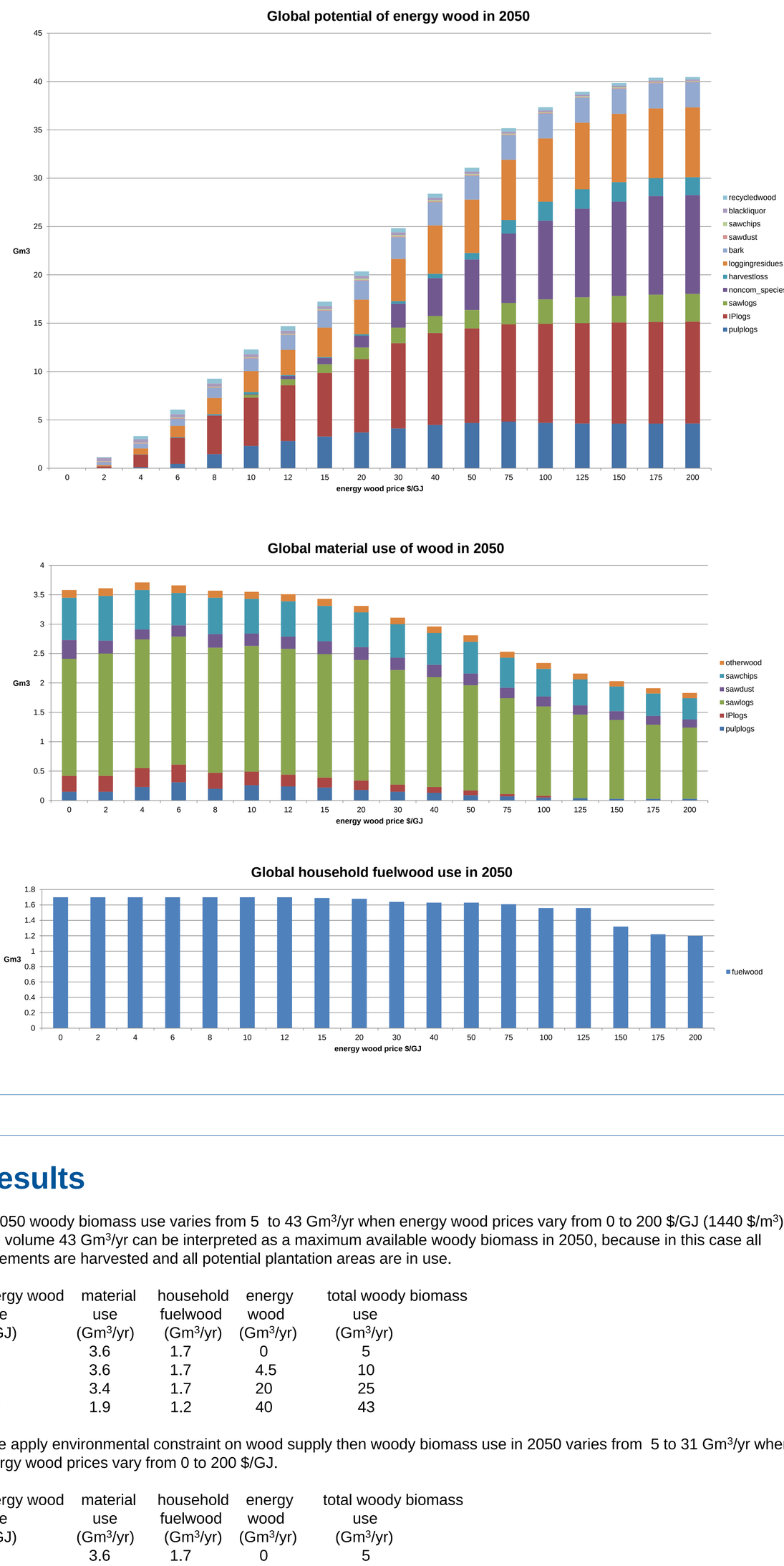




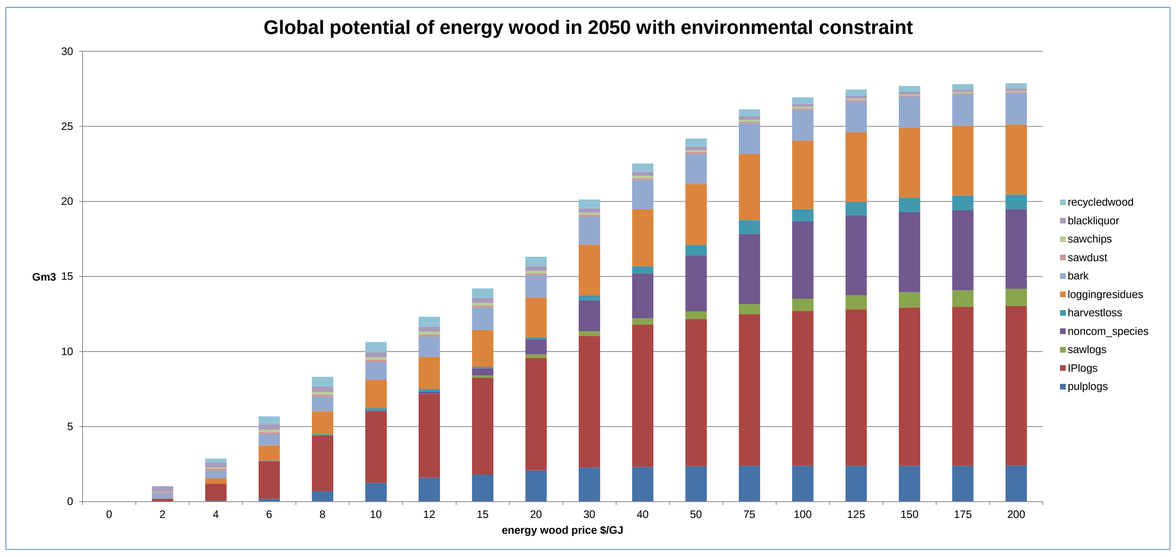
How to calculate the maximum available woody biomass in 2050 by using primary school level math ?

The maximum available woody biomass depends on the forest area and the yield of woody biomass per area. The global forest area in 2000 was approximately 4050 Mha and average increment 6.2 m^3/ha/yr. Increment measures only stemwood biomass, so we need to add logging residues (branches, stumps and small trees) into increment. This can be done by using so called biomass expansion factors. For simplicity suppose that the biomass expansion factor is 1.25 based on the logging residues generation rate 0.5 and recover ratio 0.5 Adding these figures together implies that the maximum available woody biomass in 2000 was 4050x6.2x1.25≈31 Gm^3/yr.

To calculate the maximum available woody biomass in 2050 we just need to know what happens for the forest area and increments between 2000 and 2050. For simplicity assume that increments stay constant over time (all forest are normal forests) and afforestation happens in the form of short rotation plantations with average increment 25 Gm^3/yr and biomass expansion factor 1.15. Moreover, assume that the accumulated deforestation is in its minimum level 50 Mha and the accumulated afforestation in its maximum level 425 Mha (GLOBIOM simulations imply that the accumulated deforestation in 2050 will be 250-50 Mha and the accumulated afforestation 0-425 Mha depending on the energy wood price). Adding these figures together implies that the maximum available woody biomass in 2050 will be 4000x6.2x1.25+425x25x1.15≈43 Gm^3/yr.

Simple environmental constraint on wood supply

It is unlikely that all forests will be converted into managed forest in 2050 even with a very high energy wood price. Hence, the available forest areas for wood supply are usually constraint with some type of environmental constraint. A simple environmental constraint on wood supply would be to sets aside primary forests. The primary forest areas are estimated by G4M model using the human activity impact index. Excluding primary forests decreases the initial forest area from 4050 Mha into 2300 Mha and the potential of energy wood by 0-30% depending on the energy wood price. The effect is smaller for the low energy wood prices, because then the environmental constraint is not binding in the most of the regions.



Results

In 2050 woody biomass use varies from 5 to 43 Gm^3/yr when energy wood prices vary from 0 to 200 $/GJ (1440 $/$m^3$). The volume 43 Gm^3/yr can be interpreted as a maximum available woody biomass in 2050, because in this case all increments are harvested and all potential plantation areas are in use.

Energy wood price ($/GJ)	material use (Gm^3/yr)	household fuelwood (Gm^3/yr)	energy wood (Gm^3/yr)	total woody biomass use (Gm^3/yr)
0	3.6	1.7	0	5
5	3.6	1.7	4.5	10
20	3.4	1.7	20	25
200	1.9	1.2	40	43

If we apply environmental constraint on wood supply then woody biomass use in 2050 varies from 5 to 31 Gm^3/yr when energy wood prices vary from 0 to 200 $/GJ.

Energy wood price ($/GJ)	material use (Gm^3/yr)	household fuelwood (Gm^3/yr)	energy wood (Gm^3/yr)	total woody biomass use (Gm^3/yr)
0	3.6	1.7	0	5
5	3.6	1.7	4	9
20	3.4	1.7	16	21
200	1.9	1.2	28	31

Based on the estimates of future carbon prices we could expect energy wood prices to be 5-20 $/GJ in 2050. Hence, it is unlikely that the global potential of energy wood will be more than half of the maximum available woody biomass in 2050.