BeWhere description

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General overview

The BeWhere model minimizes the cost of the full supply chain described in 1 (Natarajan et al. 2011, Kraxner et al. 2014, Leduc et al. 2012). It is assumed that the existing plants (e.g., pulp and paper mills, combined heat and power plants) have to meet their biomass demand first. If there are enough feedstock remaining and if the cost of production from new production plants is competitive enough against the reference system (fossil fuel based), these new production plants can be setup. The feedstock comes from the country itself, residuals from saw mills (in the case of woody product) or imports. And the demand has to be met from both bioenergy production plants and/or the fossil fuel based reference system. The model will then identify the optimal location of the new production plants, their capacity as well as the technology. The intake of the biomass and the location of the new production plants are also controlled by the environmental constraints. The objective function that is minimizes is the sum of the cost plus the sum of emission times a carbon cost for the supply chain. The model minimizes the cost of the whole region, but does not maximize the profit of a plant or a country. Not only the cost are minimized, but the emissions also have an important role as each emission of the segments of the supply chain are tracked.

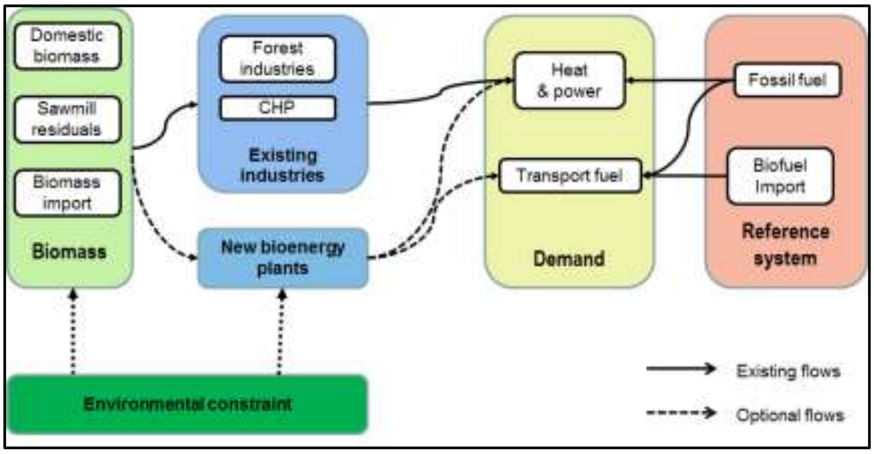

Figure 1: Overview of the full supply chain analyzed in BeWhere.

Feedstock

The model is applied at the European level which includes EU28, the Balkan countries, Turkey, Ukraine and Moldavia. All information of the supply chain is based at the grid size level. For the European model, the size of the grid is 40*40 km^2. The Figures below present some example of the input data for the availability of the feedstock (Figure 2) and its costs (Figure 3). The model used 10 types of forestry feedstock: logging residues from final fellings, loging residues from thinings, stemwood from final fellings, stemwood from thinnings, stumps from final fellings for both connifers and nonconnifers. 5 type of energy crops categories have also been considered for heat and power production, namely: Perennials grassy and woody, straw and pruning residues and grassland. For each feedstock type, the availability and the cost have been derived from the WP1 of the S2Biom project.

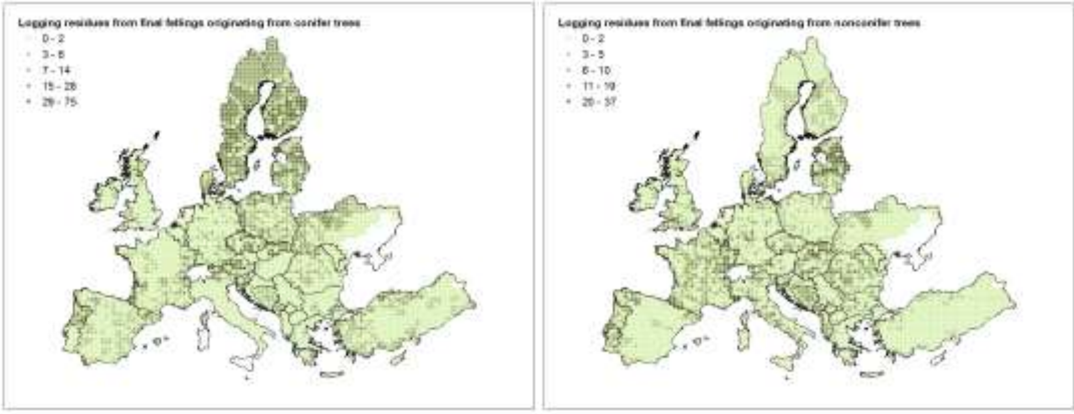

Figure 2: Availability of logging residues from final fellings from conifer (left) and nonconifer (right) trees in kt/year.

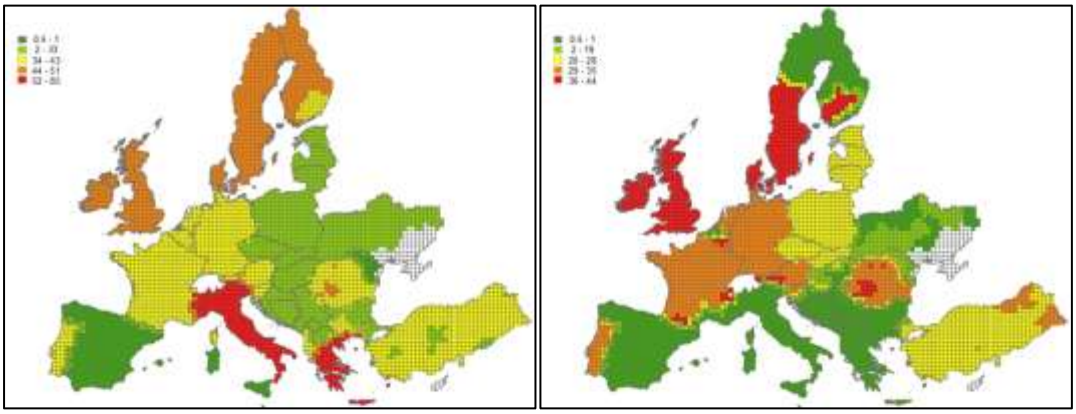

Figure 3: Cost of logging residues from final fellings from conifer (left) and nonconifer (right) trees in EUR/kt.

Demand

The demand is assessed at the grid level as well, for heat, power and transport fuel. Figure 4 presents the geographic explicit energy demand. The computations are based on projected data for transport fuel demand and population for the year 2020. The national demand is downscaled based on grid point population, with the demand per capita assumed equal in all grid points of each country. Data on district heating has been obtained from (Werner 2006) and (Egeskog et al. 2009), with the total national district heating demand downscaled under the assumption that the district heating demand is proportional to the population of each grid point. It is assumed that all existing fossil heat can be replaced with heat from the new biomass conversion facilities. For transport fuel, country-specific average petrol and diesel pump prices are used (Eurostat 2015). District heating prices are estimated from consumer price averages (Werner 2006), under the assumption that it is possible to sell heat at 50% of the consumer buying price. Electricity prices are average end-user prices (Eurostat 2015).

Figure 4: Demand of transport fuel (left), residential heat (middle) and electricity (right) in PJ/year.

Technology

The number and type of technologies under investigation have been screened from a database of over 70 technologies developed under WP2. The matching tool[1] provides the main techno-economic information of a given technology (e.g. capacity, operating hours, type of processing feedstocks and energy outputs). The selection process resulted in a list of 18 candidate technologies covering the spectrum of the main conversion processes adopted in Europe for both heat and power production as well as biofuel production (specifically Methanol, Ethanol, and Fischer-Tropsch Diesel). Figure 5 presents the costs of operation and investment for the technologies chosen for the woody biomass feedstock. It should be mentioned that for biofuel production, only forestry residues have been considered as input feedstock, since the lower bound size of the selected technologies required to adopt high energy content biomass (in terms of lower heating value in MJ/TON) in order to meet the energy requirement of the biofuel production processes.

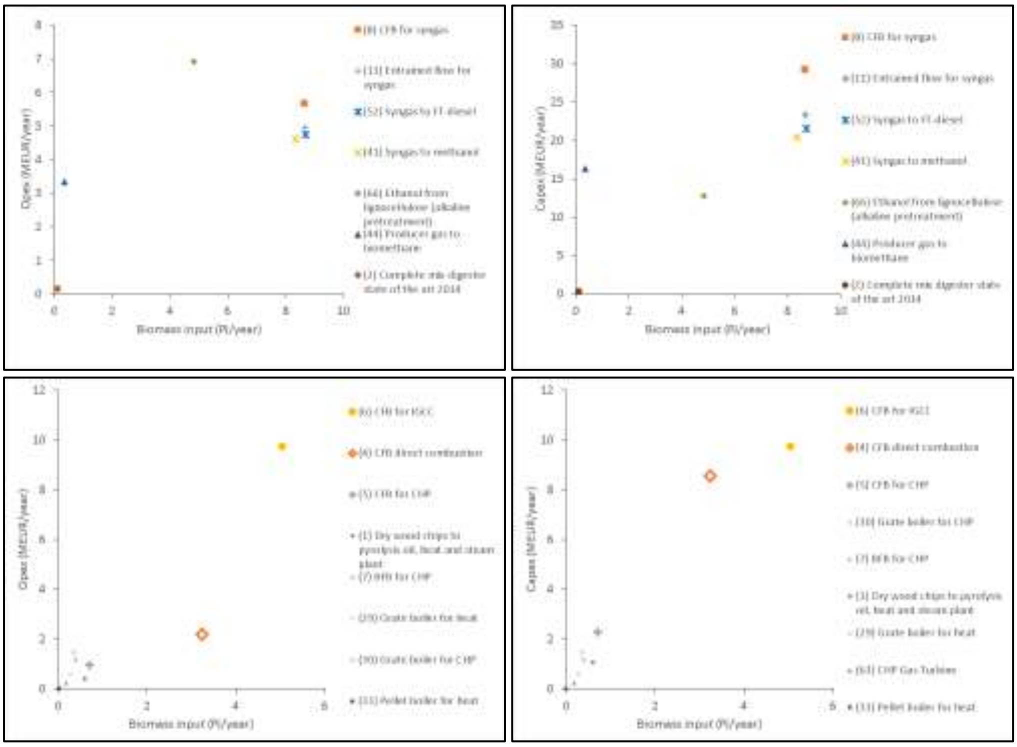

Figure 5: Operation cost (left) and capital cost (right) for the technologies considered for the forestry feedstock for the production of heat and power (top) and biofuel (bottom).

References

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[1] http://s2biom.alterra.wur.nl/home