LIFE CYCLE ASSESSMENT OF A BIO-ELECTRICITY SYSTEM IN GREECE

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ABSTRACT

Energy production from biomass presents environmental benefits, since it is a renewable source and a CO_2 neutral fuel that can be used in a variety of applications (power production, transportation, etc.). However biomass production and handling may be accompanied by possible ecological drawbacks.

In this paper a hypothetical power production system using biomass from a cardoon energy plantation, was analysed using the method of Life Cycle Assessment (LCA), in order to assess its environmental impacts. Fossil energy consumption, greenhouse gas emissions (CO_2, N_2O and CH_4) as well as SO_2 and NO_x emissions were assessed for the whole system on the basis of 1 kWh of electricity produced.

The methodology of LCA has been developed to evaluate the environmental burdens over the whole life cycle of a product or service taking into account all processes from raw material extraction until waste disposal. According to ISO standards for LCA (14040 – 14043) an LCA comprises of 4 interconnected phases: (1) goal and scope definition; (2) inventory analysis; (3) impact assessment and (4) interpretation.

The system analysed was divided into three subsystems: (a) biomass production; (b) tnansportation and storage; (c) power production. The nominal capacity of the power plant was set to 20 MWe, and the biomass required is produced from the cultivation of a total area of 1.270 ha. All data refer to Europe in the period between 1990 and 2000 and when possible to Greece in the same period.

According to the results the energy balance of the system is positive and 1 unit of fossil energy is required to produced 2,3 units of electricity. Life cycle efficiency of the system was estimated to 10%. Biomass production contributes significantly to the total energy consumption and to CO_2 and SO_2 emissions, biomass combustion in the power plant to the total CH_4, N_2O and NO_x emissions, while the contribution of biomass transportation and storage is relatively small to all parameters considered in the study. According to sensitivity analysis, the efficiency of the power plant has the largest influence on the results, followed by fertilisation and the yield of the energy crop. Transportation distances had a minor influence.