ABSTRACT

The massive deployment of renewable and distributed energy resources is the current trend to increase the efficiency, sustainability and reliability of energy supply and the independence from external sources.

Biomass is a renewable resource, distributed and abundant in Spain, although its use for energy purposes is currently very limited and uncompetitive against other sources of renewable energy. The massive deployment of biomass heat, power and/or cogeneration applications requires optimization based on technical, economical and environmental issues.

The main objective of the thesis is to define an optimization methodology for the energy use of biomass in a given geographical area and apply it to the Valencia Community. Firstly, it was reviewed the state art of biomass energy use technologies and concerns, and previous methodologies that partially dealed with feasibility analysis of biomass energy use.

It has been developed a methodology, structured in different modules, that evaluates biomass resources, calculates and optimizes transport distances and costs, potential consumers and characterizes biomass energy use technologies. All these modules come into a module for optimization and evaluation of scenarios which allows comparing different energy alternatives from an economic and environmental point of view.

The methodology has been applied to the Valencia Community and it has been studied the feasibility of different bioenergy applications for each district. The energy potential of the residual biomass, mainly from agricultural crops and forestry, is one million tons which is equivalent to 260,000 tonnes of oil equivalent (toe). In most districts the low ash content allows both, applications of generation of electricity or cogeneration, and pellet production plants. Depending on selected technology, the installed power would be between 85 and 145 MW, equivalent to 1 - 1.5% of the total power installed in the Valencia Community, and 15 times more than present power fueled with biomass (8.9 MW in 2011 according to data from AVEN). The economic feasibility of biomass plants was acceptable in most cases, with payback periods below 10 years, especially in cogeneration and pellet production plants. This economic feasibility was largely due to the logistic structure with subcontracted transportation and previous compaction (which was shown as the best alternative in any case), and the fact that the plants had reasonable size with amounts of managed biomass in the range 10,000-80,000 t per year.

CO_2 balance was favorable in all cases being, again, the production of pellets and cogeneration applications the better ones, since emissions savings were between 3 and 5 times greater than those from electricity generation plants. Proposed logistic structure was the best one from both, economical and environmental, points of view.