

Feasibility assessment of poplar bioenergy systems in the Southern Europe

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Abstract

A detailed reliability assessment of bioenergy production systems based on poplar cultivation was made. The aim of this assessment was to demonstrate the Economic feasibility of implementing poplar biomass production for power generation in Spain. The assessment considers the following chain of energy generation: cultivation and harvesting, and transportation and electricity generation in biomass power plants (10, 25 and 50 MW). Twelve scenarios were analysed in accordance with the following: two harvesting methods (high density packed stems and chip production in the field), two crop distributions around the power plant and three power plant sizes. The results show that the cost of biomass delivered at power plant ranges from 18.65 to 23.96 € Mg⁻¹ dry basis. According to power plant size, net profits range from 3 to 22 million - € per yr.

Sensibility analyses applied to capital cost at the power plant and to biomass production in the field demonstrate that they do not affect the feasibility of these systems. Reliability is improved if benefits through selling CO₂ emission credits are taken into account.

This study clears up the Economic uncertainty of poplar biomass energy systems that already has been accepted as environmentally friendlier and as offering better energetic performance.

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Keywords: Energy crops; Supply chain; Power plant; Final biomass cost

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1. Introduction

Interest in the production of biomass by means of energy crops has increased over the last 40 years in Europe. Northern and Central European countries began to promote energy crops after the oil crises of the mid-1970s mainly in an attempt to counteract escalating prices [1,2]. Southern European countries such as Spain did not pay appropriate attention to the endeavour to produce additional renewable sources [2]. Currently, the promotion of biomass as a renewable energy is an important target for European policies, being incorporated within national policies [3–5]. Biomass-based electricity is promoted in the Renewable Electricity Directive, which aims to increase the use of renewable energy sources to 22% by 2010 [4]. Spain, in common with many other countries in the European Union, does not have great reserves of petroleum or natural gas, and therefore needs to import around 75% of the total energy demand [6]. Biomass produced as energy crops on a national scale can be an opportunity to reduce external energy dependency.

The biomass from energy crops as a renewable energy source is seen as a significant contributor to the carbon dioxide abatement strategy aiming at an 8% reduction in Europe, as required by the Kyoto protocol. Within the European objective, Spain has been requested not to increase more than 15% over the 1990 emission levels by 2012 [7–10].

Some of the energy crops analysed in experimental and demonstration parcels for their implementation in Mediterranean areas are annual species such as Ethiopian mustard (*Brassica carinata*) [11,12], cardoon (*Cynara cardunculus*) [13,14], sweet sorghum (*Sorghum bicolor* L.) [14,15] as well as short rotation coppices (SRC) such as poplar (*Populus* sp.) [16] or eucalyptus (*Eucalyptus globulus*) [17].

In accordance with the national Renewable Energy Plan, biomass must contribute 29.67% to the total renewable energy production for the year 2010 [5]. Energy crops are seen in the Spanish plan as a significant part of the strategy to achieve the expected energy objectives (3.35 Mtep) [5,18].

The poplar crop has been selected in this study because of its friendlier overall environmental performance and its high biomass production yields per hectare in Mediterranean areas [3]. An environmental disadvantage of this crop is its high consumption of water, which is a limited resource in Spain and other Mediterranean countries [19]. Given this limitation, the implementation of poplars as an energy crop competes with other crops in areas having sufficient water and land availability [20]. Currently in Spain, these areas are extensively occupied by woody crops aiming to produce wood for the paper and packaging industries. Additionally the implementation of this crop in unexploited marginal areas is also under consideration [21].

In this context, the main aim of this study is to examine the economic viability of the production of energy by means of biomass produced in poplar energy crops. The feasibility study also takes into account the marginal benefit of CO₂ emission reduction when substituting fossil fuel.

2. Methodology

2.1. The poplar bioenergy system analysed

The feasibility study analyses the three main subsystems of energy production with poplar biomass in Spain: (a) poplar cultivation and harvesting, (b) transport and (c) energy conversion. Poplar cultivation stages cover a 16-year period, including three 5-year rotations. The best period considered for

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