

Centralised electricity production from winter cereals biomass grown under central-northern Spain conditions: Global warming and energy yield assessments

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Abstract— The goal of this paper is to assess the sustainability of electricity production from winter cereals grown in one of the most important Spanish agricultural areas, Castilla y León Region, situated in central-northern Spain. This study analyses greenhouse gases (GHG) emissions and energy balances of electricity production in a 25 MWe power plant that was powered using straw biomass from three annual winter cereals (rye, triticale and oat) grown as dedicated energy crops. The results of these analyses were compared with those of electricity produced from natural gas in Spanish power plants. Assessments were performed using a wide range of scenarios, mainly based on the biomass yield variability obtained in demonstration plots of twelve different winter cereal genotypes. Demonstration plots were established in two different locations (provinces of Soria and León) of the Castilla y León Region during two crop seasons (2009/2010 and 2010/2011) using common management practices and input rates for rain-fed agriculture in these regions. Our results suggest that production of electricity from winter cereals biomass combustion yielded considerable reductions in terms of GHG emissions when compared to electricity from natural gas. Nevertheless, the results show that low biomass yields that are relatively frequent for Spanish farmers on low productivity lands may produce no significant reductions in GHG in comparison with electricity from natural gas. Consequently, the agronomic management of winter cereals should be re-examined in order to find potential improvements that achieve better energy balances and greater reductions in GHG emissions on land which is relatively uncompetitive in terms of crop yields and on existing low productivity scenarios.

Index Terms— Biomass, Electricity, Greenhouse gases, Global warming potential, Energy balance, Winter cereals

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