

Technical and Economic Analysis for the bioenergy production from agricultural residues in the region of Central Macedonia

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Abstract. The aim of this paper is to analyze the bioenergy production from agricultural residues. The selected case study was the agricultural area of the Region of Central Macedonia in Northern Greece. In this context, a technical and economic analysis is conducted for the existent crop plans in each of the seven regional units of the region. The analysis included the calculation of six indicators (three economic and three environmental indicators). From the calculations derived the existent values for the bioenergy (thermal energy and electrical energy) production of the region. From the results we can conclude that the size of each regional unit is the most important factor for the results of the indicators. The second important factor is the variety of crops in the existent crop plans. On the other hand, the number of crops that participate in the crop plan seems not to play any role for the indicators calculations.

Keywords: bioenergy, agricultural residues, thermal energy, electrical energy

1 Introduction

Almost two thirds of renewable energy sources, in the European Union (EU), origin from biomass, including agri-food waste (Fischer and Schrattenholzer, 2001). As biomass sources are considered energy crops, agricultural crop residues, animals' waste and forest residues. The bioenergy production from agricultural residues enhances the role of agriculture in the creation of new sustainable energy sources and connects directly with rural development policy (Rosillo-Calle, 2003). This can be achieved by cultivating crops in agro-energy districts with high values of agricultural residues. The use of crop residues and waste is already at a high level in several European countries (van Dam et al., 2007), but the use of energy crops has still controversial aspects.

The aim of this paper is to analyze the bioenergy production from agricultural residues in the selected case study area of the Region of Central Macedonia in Northern Greece. For this reason a preliminary technical and economic analysis is

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conducted for the existent crop plans in each of the seven regional units (Chalkidiki, Kilkis, Imathia, Pella, Pieria, Serres, Thessaloniki) of the region. The analysis included the calculation of six indicators (three economic and three environmental indicators). From the calculations derived the existent values for the bioenergy (thermal energy and electrical energy) production of the region.

The paper is organized as follows. In the following section, the methodology approach is presented. The last two sections contain the results of the analysis and some concluding remarks.

2 Methodology

In order to calculate the bioenergy production in the region of Central Macedonia a technical and economic analysis is conducted for the existent crop plans in each of the seven regional units of the region. The collection of the data from the Hellenic Statistical Authority (statistics.gr) refers to the year of 2014.

We have selected three indicators. The three of them were economic indicators (gross margin, income and variable cost) and the rest were environmental indicators (bioenergy production, production of thermal energy, production of electrical energy). A short description of these indicators is presented below.

Gross Margin

Gross margin is calculated using the data from prices, yields, subsidies and variable costs. This parameter was used as the best estimator of the farmers profit.

Income

Income is an important attribute of the system as it defines total agricultural output. It was computed by the simple combination of yields and prices, plus subsidies where applicable.

Variable Cost

In order to calculate variable cost all the agricultural inputs are summarized (seeds, fertilizers, chemicals, machinery, labor and the cost of water).

Biomass production

Based on the literature and taking into account newer research efforts in the same direction (Tziolas et al., 2016) the agricultural residues from larger crops per area and yield in tons per acre are calculated. The total amount of biomass produced for the crops residues of the agricultural holdings in the Region of Central Macedonia.

Production of thermal and electrical energy

In order to calculate the production of thermal and electrical energy for crops, the Lower Heating Values (LHV) were considered (Di Blasi et al., 1997, Menconi et al., 2013).

3 Results

The following section shows the results as regards the potential biomass production, the electrical and thermal energy produced by crop residues and the results for the selected economic and environmental indicators. The Region of Central Macedonia (RCM) is divided into seven regional units, the regional unit of Chalkidiki, Imathia, Kilkis, Pella, Pieria, Serres and Thessaloniki. According to the biomass potential maps of the National Information System for Energy, the region of Central Macedonia has the largest reserves of biomass from agricultural residues throughout Greece. According to the existent crop plans, it is observed that the region of Central Macedonia presents a great variety of crops (cereals, fruit trees, energy crops).

With the use of the existent crop plans of each region we have calculated the existent values for the bioenergy (thermal energy and electrical energy) production of the region. The results are presented in the following table 1.

Table 1. Calculation of the bioenergy indicators for the Region of Central Macedonia

REGIONAL UNIT	INDICATORS					
	GROSS MARGIN (€)	INCOME (€)	VARIABLE COST (€)	BIOMASS PRODUCTION	THERMAL ENERGY (MJ)	ELECTRICAL ENERGY (MJ)
CHALKIDIKI	53.967.483,39	126.613.026,70	72.645.543,31	80.220,14	573.275.638,80	644.935.093,65
IMATHIA	57.976.363,58	134.136.928,00	76.160.564,42	78.911,43	594.520.307,40	668.835.345,83
KILKIS	48.289.926,37	87.248.535,34	38.958.608,97	156.070,53	1.022.178.722,60	1.149.951.062,93
PELLA	117.743.657,73	270.594.719,40	152.851.061,67	168.632,75	1.267.986.022,20	1.426.484.274,98
PIERIA	26.846.441,95	78.053.914,92	51.207.472,97	74.108,44	499.751.880,40	562.220.865,45
SERRES	90.211.726,82	190.760.941,64	100.549.214,82	304.851,61	2.050.609.074,80	2.306.935.209,15
THESSALONIKI	56.037.760,21	128.544.292,60	72.506.532,39	247.059,16	1.629.586.984,04	1.833.285.357,05

4 Conclusions

In this paper we have examined the existent crop plans from the seven regional units of the region of Central Macedonia in Greece. The crop plans included the main cultivations in each regional unit and the potential production of biomass (tn/acre) of the cultivations. From the results we concluded that the crops that can produce biomass from their residues are mainly cereals and energy crops because they have plenty of straws and stalks, which can produce high levels of biomass. From the crop plans we concluded that the main cultivations of Central Macedonia are cereals (hard and soft wheat), cotton and maize and in some regional units such as Pella and Imathia the main cultivations are fruit trees. From the results we can conclude that the size of each regional unit is the most important factor for the results of the indicators. So, regional units with big size of agricultural areas present the highest values. The second important factor is the variety of crops in the existent crop plans. Regions with crops with high agricultural residues have better results as regards the biomass. On the other hand, the number of crops that participate in the crop plan seems not to play any role for the indicators calculations.

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