Renewable and Sustainable Energy Reviews 58 (2016) 69–74

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Agricultural biogas plants in Poland – selected technological, market and environmental aspects

Arkadiusz Piwowar [a,*], Maciej Dzikuć [b,1], Janusz Adamczyk [b,2]

[a] Wrocław University of Economics, Department of Economics and Organization of Food Economy, Komandorska Street 118/120, 53-345 Wrocław, Poland
[b] University of Zielona Góra, Faculty of Economics and Management, Licealna Street 9, 65-001 Zielona Góra, Poland

ARTICLE INFO

Article history:
Received 9 October 2014
Received in revised form
16 December 2015
Accepted 17 December 2015

Keywords:
Agricultural biogas
Installations output
Poland

ABSTRACT

Renewable energy plays an increasingly crucial role in ensuring the energy security of Poland. Due to a large area of agricultural land, a relatively high cattle and pig population, and well-developed agri-food industry, the main source of renewable energy in Poland is agricultural biomass. The study focuses on the development of agricultural biogas production in Poland. The main purpose of the considerations was to present the current state of development of the agricultural biogas market in Poland, including technological aspects. As it appears from the analyses, the production of agricultural biogas increased in 2011–2014 by 137.29 million m^3. Also the structure of consumption of substrates from the agricultural biogas production changed towards a wider use of products from the agri-food industry. Currently, the total capacity of plants for the production of agricultural biogas in Poland is 244,156,466 m^3/year. The use of biogas from agricultural biogas plants is an increasingly important element of the distributed power generation in Poland.

Contents

1. Introduction

A characteristic trend in changes in agribusiness is an increase in the importance of non-food use of feedstocks from agriculture [1]. Apart from ensuring the food security, agriculture and agribusiness also perform other functions, including those associated with the energy security. In the literature of the subject, energy self-sufficiency is an indicator of the country's energy security [2,3]. It is the ratio of the amount of energy obtained in the country to the amount of energy consumed [4]. The energy sovereignty of Poland is limited by large-scale imports of crude oil, oil products and natural gas. The independence of Poland in terms of energy security can be improved through development of the renewable energy sector based on domestic energy resources. For energy purposes there can be used for example the biogas obtained from organic feedstock coming from three main sources: agricultural biomass, sludge from sewage treatment plants and organic waste from landfills [5,6].

In Poland, due to a large area of agricultural lands (14.6 million hectares) and well-developed cattle and pig raising, the opportunities for development of the renewable energy market are seen in agricultural biogas plants. In 2013 in Poland, the cattle stock density per 100 ha of agricultural land was at a level of 40.3 pcs, while the pig stock density per 100 ha of arable land was at a level of 105.7 pcs [7]. In the process of biogas production, generally any type of plant biomass can be used [8]. The utilization of the waste

* Corresponding author. Tel.: +48 71 36 80 430.
E-mail addresses: arkadiusz.piwowar@ue.wroc.pl (A. Piwowar), m.dzikuc@wez.uz.zgora.pl (M. Dzikuć), J.Adamczyk@wez.uz.zgora.pl (J. Adamczyk).
[1] Tel.: +48 68 32 82 815.
[2] Tel.: +48 68 32 82 237.

http://dx.doi.org/10.1016/j.rser.2015.12.153
1364-0321/

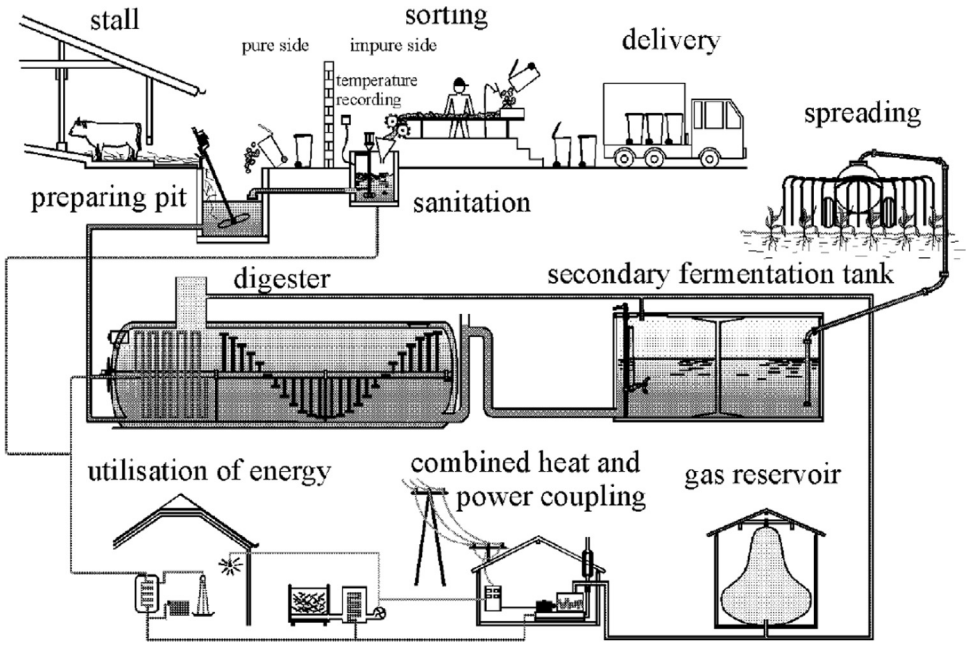

Fig. 1. Model of a typical agricultural biogas plant that is especially suited to digest farmyard manure and offers the possibility of co-digestion of organic wastes. *Source:* [21].

generated by the agricultural production and the development of uncultivated land and fallows for energy purposes contribute to the development of agribusiness and constitute a source of additional income for agricultural holdings in Poland [9]. Poland has very robust agriculture and food industry. Biogas plants supplied with food industry waste present the biggest growth opportunity available to the Polish renewable energy sector [10].

The development of the market of agricultural biogas plants is important in terms of the development opportunities for rural areas in Poland, which can be analysed in social, economic and environmental aspects [11]. This manifests itself, inter alia, in activation of the local community and establishment of specialized production, trade and service entities dealing with construction and maintenance of technical infrastructure of agricultural biogas plants as well as with collection and/or supply of biomass to biogas plants. It is also important that the digestion mass can be used for fertilizing purposes. The development of agricultural biogas plants in Poland may therefore reduce the use of mineral fertilizers in agriculture, which at high prices of mineral fertilizers on the domestic market may improve the profitability of plant production [9,12,13].

The development of the market of renewable energy sources, including those based on biomass, is an important element of the energy policies of EU countries. In Western Europe (e.g. in Germany) the number of biogas plants is steadily increasing. For example, in Germany there were approx. 140 biogas plants in 1992, while 7720 biogas plants operated at the end of 2013. Biogas production in Germany has developed rapidly over last 20 years. For 2013, the German Agency for Renewable Resources (FNR) states that 1.157 million hectares of cropland (10% of the available cropland) were dedicated to the production of biogas [14]. Rapid progress in this sector is associated with the relevant legal and financial solutions that have changed the energy system in Germany towards the support for renewable energy sources. It should be emphasized that there is a new energy policy in the European Union. The aim of this policy is to reduce the consumption of fossil fuels and promote the production of energy from renewable sources. The development of the agricultural biogas market is important in the context of the necessity to fulfil the National Indicative Targets imposed on Poland and the provisions of the Climate and Energy Package [15,16]. Poland has a great biogas potential, which is comparable to that of Germany [17].

The purpose of this paper is to present the current state of and the prospects for the development of the market of agricultural biogas producers in Poland. An additional objective of this study was a comparative assessment of technical potentials of the existing agricultural biogas plants in Poland, broken down by provinces. The numerical data presented in the study was taken from the information published by the Agricultural Market Agency. Pursuant to the Act of 10 April 1997 – Energy Law [18], the authority keeping the register of power companies dealing with the production of agricultural biogas is the President of the Agricultural Market Agency. The entities included in this register are obliged to submit reports that contain information concerning, inter alia, the amounts and types of resources used to produce agricultural biogas (or to generate electricity from agricultural biogas).

2. Technological and environmental aspects of the agricultural biogas production in Poland

As mentioned in the introduction, the production of energy from agricultural biogas is one of the options for production of energy from renewable sources. The most often method used to rewrite biogas in Poland for other useful forms of energy is cogeneration. Energy production from agricultural biogas enables Poland to meet the National Indicator Target mandate and the obligations resulting from the Climate and Energy Agreement [19,20]. The feedstocks used in agricultural biogas plants for the production of renewable energy are subjected to the methane digestion process, which consists of a group of biochemical reactions occurring under controlled anaerobic conditions (Fig. 1). Technologies for the production of agricultural biogas differ, inter alia, in the method of loading and storing the substrates, but the mechanism of biogas production is identical. This process consists of several stages: initially there takes place the hydrolysis of proteins, carbohydrates and fats into their monomers, which are then