

## Role of Land Resources in the Development of the Market of Renewable Energy Sources of Agricultural Origin in Latvia

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**Abstract.** To comply with the requirements of the EU Directive 2009/28/EC for using renewable energy sources (RES) in Latvia, the agricultural industry has to become a significant supplier of resources to energy producers and consumers. An increase in the area sown with maize is forecasted by exploiting the unused agricultural land to expand biogas production. The agricultural area has decreased by 2% in Latvia over the recent decade, and 16% of its total agricultural area are not exploited anymore. Thus, agricultural land resources are available to produce intensively RES for biogas production in the future and to achieve the target set for renewables by 2020, so that the total capacity of biogas facilities reaches 61 MW. In 2011, totally 24 new biogas facilities with a total capacity of 29.38 MW started operating. Nevertheless, the Ministry of Economics of the Republic of Latvia has granted 59 licences to purchase electricity produced from biogas in compliance with the renewable power purchase obligation. It means that raw materials are needed for newly established biogas facilities.

**Key words:** RES (renewable energy sources), land resources, biogas, biomass, market.

**JEL code:** C88, D29, O38, Q28, Q42, R11

### Introduction

According to Latvia's economic development forecasts, the agricultural industry will gradually grow. The Ministry of Economics of the Republic of Latvia (2011) forecasts that positive growth rates are expected for almost all industries of the national economy, whereas export-oriented industries including agriculture, will grow faster than the national economy on average. The economic growth scenarios developed by the Ministry of Economics for a medium term (until 2016) indicate that Latvia's Gross Domestic Product might increase by 2.7-4.8% a year (depending on the scenario), while primary industries including agriculture are expected to grow at an average rate within a range of 3.5-4.1% a year.

In forecasting the economic growth, it is assumed that the agricultural sector would produce traditional agricultural products. Yet, the foundation of biogas facilities started in Latvian rural areas in 2009. It means that in the territories where biogas facilities were constructed or will be constructed, energy crops for biogas production would be grown on agricultural land, thus, competing with the production of traditional agricultural commodities for food. According to I.Pilvere, V.Tetere, I.Upite (2011), by developing biogas production, "stable income from selling electrical energy, beneficial effect in agriculture and diversification of income sources are gained from the results of implemented projects" as well they mentioned that "there is a possibility to use agricultural production waste". B.Kniuksta, J.Caplikas (2011) conclude that "agriculture based bioenergy development has direct and indirect effects in economic, social, and environmental fields". Yet, K.Naglis-Liepa, J.Leikucs, M.Pelse (2010) emphasise that "the EU energy policy is directed towards promotion of renewable energy proportion in total energy balance and Latvia's ambitious aim is to achieve 40% of renewable energy in the total primary energy balance in the year 2010". Therefore, the research on

how to balance the possible development of various industries in rural areas has to be conducted. Basically, it is necessary to analyse the use of agricultural land resources to determine the availability of these resources for growing non-food crops. Presently, agricultural land is a significant resource in Latvia, which is used not only "for agricultural production but it is also a work object and a work tool, and it is substantial to ensure efficient land use" (Pilvere, 2008). B.Vazonis (2010) emphasise that "beyond supplying food and fibre, agricultural activity can also be instrumental in forming the landscape, providing natural resources and preserving biodiversity". Similar ideas belong to scientists such as B.L. Turner, E.F.Lambin, A. Reenberg (2007), S.Wirsenius, C.Azar, G.Berndes (2010), and A. Nikolaou, M. Remrova, I.Jeliazkov (2003). Qualitative indicators of using agricultural land point at insufficiently intensive agricultural production in Latvia. A small share of agricultural area available in Latvia is used for growing energy crops. Growing energy crops in the territories around biogas development centres will improve quantitative indicators of using land resources and is a prerequisite for a market of RES of agricultural origin to arise there. Yet, Latvia's geographic situation and favourable climate are good prerequisites for the industries of agriculture and forestry to provide the necessary RES.

Therefore, the **research aim** is to analyse agricultural land resources in Latvia to determine their availability for biogas production. The **research object** is agricultural land resources in the territories of biogas development centres in Latvia, while the **research subject**, which will assist in identifying causes of the problem researched, is the market of RES in Latvia.

**Research hypothesis:** participants of the energy market in Latvia are prepared to achieve a 40% share of the RES in gross domestic energy consumption by the year 2020.

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Table 1

Land uses in Latvia in 1935-2010, thou. ha

No.	Indicators of land use	1935	1980	1990	2000	2010	2010 against 2000, %	2010 against 1935, %
1.	Total area	6579	6459	6459	6459	6459	100	98
2.	Total agricultural area	3679	2581	2567	2485	2430	98	66
3.	Forests	1742	2729	2803	2852	2955	104	170
4.	Other land (occupied by waters, roads, buildings)	1158	1149	1089	1122	1074	96	93

Source: authors' calculations based on the RSS data, 2011 and SLS, 2011

#### Research tasks:

- 1) to characterise the agricultural land resources and their potential availability to produce RES of agricultural origin in Latvia;
- 2) to determine the necessary quantity of biomass to produce RES of agricultural origin according to the strategic target set;
- 3) to analyse the availability of agricultural land in the regions of biogas production;
- 4) to forecast the development of RES of agricultural origin.

The present research was performed in 2011, and to achieve the research aim, information available by the Ministry of Economics of the Republic of Latvia and the Ministry of Environmental Protection and Regional Development of the Republic of Latvia (before 2010, the Ministry of Regional Development and Local Government), legal enactments related to production and sales of RES, strategic planning documents, Central Statistical Bureau data, a database of the Rural Support Service (hereinafter RSS), and research papers of other authors were used in the research. The following methods were employed in the research: analysis and synthesis, the monographic, abstract, logical, and graphical methods, a method of sociological studies (documentary analysis), and statistical methods (full statistical observation and information summarisation).

## Research results and discussion

### 1. Availability of agricultural land to produce renewable energy sources of agricultural origin

The industries of agriculture and forestry manage 83% of land resources available in the territory of Latvia. Agricultural land occupies approximately 37.6%, while forestland – 45.75% of the country's rural areas. The economic growth has promoted changes in the area managed by the industries of agriculture and forestry in Latvia. Since 1930, the forest area has almost doubled in Latvia from 24% in 1930 to 45.7% in 2010. An especially significant increase in the forest area was observed during the Soviet period (Krastins, 2001). Its reasons were as follows: nationalisation of land, establishment of large collective and state farms, and due to inability to farm the entire agricultural area, part of it was transformed into fallow land and afforested. A factor promoting an increase in the forest area was the Soviet period's purposeful patriotic leaders of the forest

industry who were able to use their influence on political circles. The existing areas were effectively managed and new areas were afforested (Krastins, 2001). These processes continue nowadays as well. Latvia is presently one of the most wooded countries in Europe. An analysis of data showed that the forest area tended to increase. It is ensured by the fast growth of the forest industry and its significant role in supplying RES to energy producers and consumers on the Latvian and world market.

Changes in the agricultural area also characterise the development of agricultural industries. The exploitation of the entire agricultural area indicates on the development of the agricultural sector. Its development promotes the expansion of businesses and a more complete use of resources endowed by the nature. An unused agricultural area indicates that traditional agriculture is not able to produce sufficient income stimulating those engaged in agriculture to expand their business activities.

The previous trend in Latvia during the recent century, in general, indicated a decrease in the agricultural area and an increase in the unused agricultural area. However, the agricultural area (well-farmed area) has even slightly increased over the recent 10 years (2000-2010). The sown area rose in the period of 2003-2006 (by 26%), and afterwards a slight decrease was observed from 2006 to 2010. The areas of meadows and pastures were comparatively stable over the recent decade.

In the period of 2000-2010, 4% of agricultural land was transformed into land for construction.

Part of agricultural land is not presently used for agricultural production. In 2010, it accounted for 16% and totalled to 368.9 thou. ha.

The Basic Guidelines of Land Policy for 2008-2014 elaborated by the Ministry of Environmental Protection and Regional Development of the Republic of Latvia include medium-term and long-term scenarios for land use in Latvia. The scenarios were worked out by taking into account trends in land policy and economic development in Latvia as well as those in land use in Europe. According to an assessment of the development trends, demand for agricultural land will increase over the near ten years, which would be caused by the increasing demand for food products. Therefore, the unused agricultural area has to decline. Thus, certain areas of agricultural land are temporarily unused. Energy crops will be grown on a part of the agricultural area, a part of less fertile agricultural area will remain unused and

Table 2

**Unused agricultural land in Latvia in 2010**

No.	Land status	Area		Cadastral units	
		ha	%	number	%
1.	Surveyed land	2 352159	100	326 309	100.00
2.	Cultivated land	1 983260	84.3	259 696	79.6
3.	Unused land:	368 900	15.7	66 613	20.4
4.	Uncultivated land	316 341	13.5	56 571	17.4
5.	Overgrown land	49 710	2.1	9 300	2.8
6.	Land for construction	2 849	0.1	742	0.2

Source: authors' calculations based on the RSS data, 2011

overgrown to maintain natural landscapes (Zemkopības ministrija..., 2010). Therefore, a significant decrease in the agricultural area is not expected (RAPLM..., 2008).

According to a study of the Latvian State Institute of Agrarian Economics, the total arable area could change within a range +/- 4% compared with 2006 in the period until 2020. After comparing the forecast for the year 2020 and the real data for 2010 (CSB), an increase of 7% in the total arable area is expected (Eiropas Savienības Lauksaimniecības un Lauku Attīstības..., 2008).

Based on the analysis of agricultural land resources, one can assure that these resources are not fully and well exploited in Latvia. Both intensive and extensive development possibilities for producing RES of agricultural origin and satisfying this market's demand may be explicitly observed.

## 2. Necessary quantity of biomass of agricultural origin to produce renewable energy sources according to the target set

Until 2020, according to various information sources, an 11-13% increase in the gross domestic energy consumption compared with 2008 is forecasted for Latvia, and it might reach an amount within a range of 55 780 GWh (Latvijas Republikas Rīcība atjaunojamas..., 2010) – 56 944 GWh (Ekonomikas ministrija..., 2009). Increases in electricity consumption and fuel consumption by vehicles are mostly expected (Latvijas Republikas Rīcība atjaunojamas..., 2010). According to a report (Latvijas Republikas regulārais..., 2011), 5.06 GWh of electricity produced from RES was sold to the public company in 2010. In the same year, the following quantities were produced: 2139.7 thou. t of hay of perennial grasses, green forage, and silage; 209.0 thou. t of maize for silage and green forage; 7.7 thou. t of grains; and 1.27 thou. t of rape – biomass of agricultural origin that could be used for biogas production.

In accordance with the document Basic Guidelines for the Development of the Power Industry 2007-2016 (2006), which is in force, it was planned to construct biogas cogeneration plants with an electrical capacity of 61 MW in Latvia in 2010, while in 2020 their total capacity would have to reach 61 MW. A quantity of biomass needed for these biogas facilities was calculated according to the methodological instructions (Kalnins A. 2009), in which several models with a consumption of 300 (capacity

1 MW), 550 (capacity 2 MW), and 800 (capacity 3 MW) tons of biomass per day were available and it was based on a study *Possibilities of Biogas Production from Various Kinds of Biomass on a Farm* (Skudra A., Adamovics A., 2011) that was conducted on Latvian farms in 2011. Based on an assumption that on average an electrical capacity of biogas plant is up to 1 MW and electricity is produced for 330 days a year, the necessary quantity of biomass amounted to 550 thou. t a year. To provide a continuous operation of bioreactors with a capacity of 61 MW, approximately 1.5% of the available potential of biomass obtained from by-products in agricultural production has to be exploited. A total quantity of by-products in agricultural production, according to the calculations (Atjaunojamo enerģijas resursu..., 2006), consists of: 20 mln. m<sup>3</sup> of crop farming residues and green forage; 3.2 mln. m<sup>3</sup> of cattle manure; 20 mln. m<sup>3</sup> of pig manure; and 21.6 mln. m<sup>3</sup> of poultry manure a year.

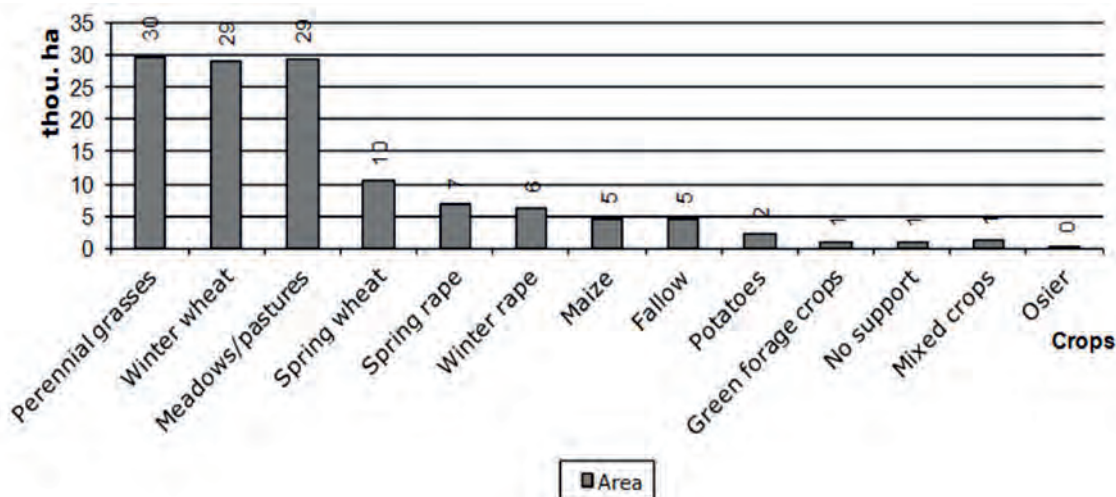
By developing a cooperation model, based on demand and supply, for the market of RES of agricultural origin in Latvia, it is possible to achieve a higher share of RES in the gross domestic energy consumption. The target set by Latvia may be achieved from the viewpoint of availability of resources. The achievement of the target does not contradict with the uses of agricultural land: food production or growing energy crops.

## 3. Availability of agricultural land in the territory of biogas thermoelectric power plants

The present development of agricultural industries is assessed based on qualitative indicators of land resources. In Zemgale, agricultural land is mostly used for growing grains and energy crops, while in Vidzeme, it is used for meadows and pastures, which are a feed basis for dairy farming. Owing to active production, funds are accumulated in these regions. These funds provide the implementation of new business projects based on available agricultural resources.

The growth potential of Latvia's agricultural industry is related to:

- increasing the agricultural sector's competitiveness by modernising obsolete equipment and buildings (special attention has to be paid to longer-term investments), promoting the engagement of young age farmers in agricultural business, developing



Source: authors' calculations based on the RSS data, 2011

Fig. 1. Sown areas in agricultural territories near biogas TEPPs in 2011

professional skills of those employed in agriculture, promoting cooperation among agricultural producers, and by fostering the introduction of modern technologies for processing agricultural commodities and for logistics and sales chains;

- developing market-oriented production units contributing to an increase in value added in the agricultural sector along with an increase in the overall efficiency in the agricultural industry;
- engagement of unused agricultural land in agricultural business.

The number of biogas facilities sharply increased in 2011, and 24 biogas thermoelectric power plants (hereinafter TEPP) with a total capacity of 29.38 MW were operating at the end of the year. The Ministry of Economics of the Republic of Latvia has granted licences to purchase electricity, in compliance with the renewable power purchase obligation, to 59 biogas TEPPs. The construction of biogas TEPP develops in agriculturally the most active regions of Latvia. In terms of territorial distribution, the biogas TEPP are located in the municipalities of Jelgava, Dobele, Ilukste, Burtnieki, Madona, Auce, Nica, Limbazi, Vilani, Vainode, and Iecava. In terms of regional distribution, 9 such facilities are in Zemgale (7.9 MW), 5 - in Vidzeme (6.87 MW), 4 - in Kurzeme (4.65 MW), 3 - in Latgale (2.2 MW), and 3 - in Riga (7.76 MW) planning region.

Agricultural land available in municipalities is exploited to provide the operation of biogas TEPPs. To determine the area of agricultural land used for biogas TEPP, the authors performed calculations based on RSS information on sown areas of crops in the territories located next to biogas TEPPs in 2011.

Maize is mostly grown for biogas production. Yields of maize green mass are high, and it provides good parameters for biogas production. Experiments are conducted on the training and research farm "Vecauce" of Latvia University of Agriculture to determine the most suitable varieties of hybrid maize for Latvian conditions. The research results (Bartusevics, Gaile,

2009) showed that yields of maize green mass ranged within 43-61 t ha<sup>-1</sup>.

In 2010, totally 405 thou. t of maize green mass were produced for biogas TEPPs in the territories of municipalities located near these facilities. In the future, increasing the sown area of maize will be needed to provide the necessary quantity of maize green mass to biogas TEPP. It is useful to engage unused agricultural land in the sown area.

After analysing data on exploiting agricultural land, significant differences are observed among municipalities even within one planning region. In Jelgava municipality, which belongs to Zemgale planning region, 4% of agricultural land was not farmed, while in Iecava municipality, it reached 32%, amounting to a total of 7.4 thou. ha of unused agricultural land. Constructing biogas TEPP will improve the qualitative indicators of using agricultural land. In these regions, farmers have a possibility to diversify the structure of crops grown, thus, becoming resource suppliers to biogas facilities.

The purchase obligation at a certain price is based on a long-term contract to diversify agricultural production risks related to price fluctuations, especially for grain crops. The cooperation model established in such a way is a stable prerequisite for the market of RES of agricultural origin based on supply and demand. In the beginning of 2011, additionally approximately 800 thou. t of maize green mass may be produced by farming unutilised agricultural area in the analysed municipalities.

#### 4. Use of land resources for more efficient production of energy sources of agricultural origin

Latvia will integrate into the common EU energy market in the near future. To be able to compete with other EU Member States on the energy market and, at the same time, to solve energy security problems of the national level, the country's action plan is simple: the share and output of domestic energy resources have to exceed their consumption. An efficient use of land resources is a significant factor in implementing this

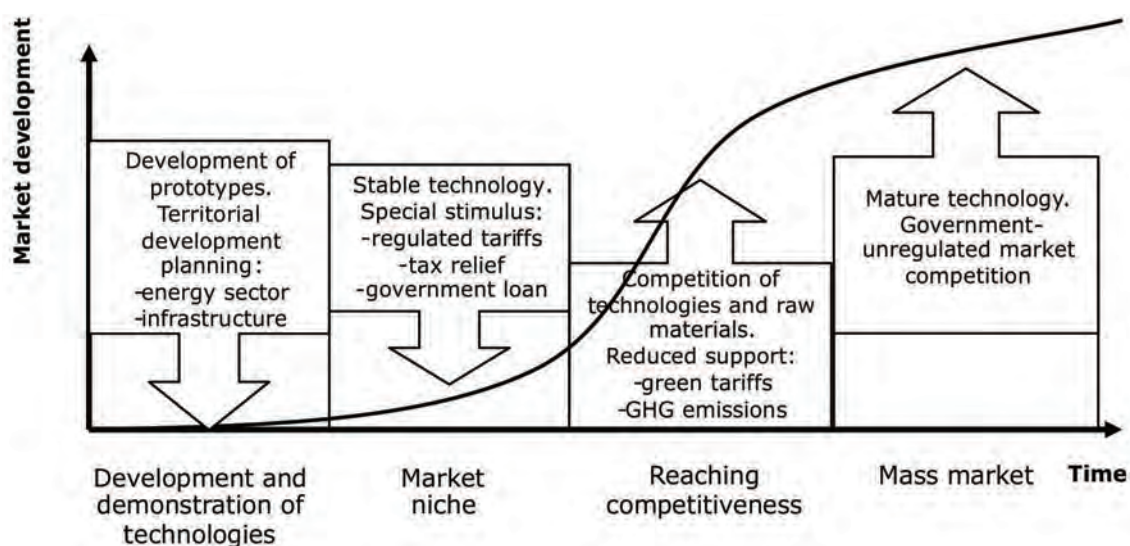


Table 3

## Low quality use of agricultural land in the municipalities of biogas development centres in Latvia in 2010

No.	Municipality	Agricultural area, ha	Farmed agricultural land		Unutilised agricultural area				
			ha	%	ha	%	uncultivated ha	overgrown ha	buildings ha
1.	Jelgava	76979	73879	96	3100	4	2837	254	10
2.	Vilani	15096	14469	96	627	4	527	95	5
3.	Dobele	51018	48053	94	2966	6	2593	370	3
4.	Ilukste	29577	27443	93	2134	7	2099	21	14
5.	Burtnieki	28408	25307	89	3101	11	2519	561	21
6.	Madona	81426	71755	88	9671	12	9127	496	47
7.	Auce	26221	23042	88	3179	12	2680	443	56
8.	Nica	11316	9610	85	1707	15	1588	115	3
9.	Limbazi	39790	31355	79	8435	21	7954	459	22
10.	Vainode	11094	8625	78	2469	22	1603	846	19
11.	Iecava	13629	9330	68	4299	32	3591	693	15
12.	Total	292479	342868	86	41688	14	36591	4258	211

Source: authors' calculations based on the RSS data, 2011



Source: authors' construction

Fig. 2. Development stages of RES market of agricultural origin

action plan. Large energy consumption by households and in the public and service sectors, and comparatively small energy consumption in the sectors of agriculture and manufacturing are specific to the structure of energy consumers in Latvia.

Long-term development planning and the elaboration of a strategy ensure RES of agricultural origin are produced according to the territorial location of energy consumers.

Constructing biogas TEPP in municipalities provides an opportunity to design a regional energy supply development plan and integrate it in the territorial plan of a municipality or town. It is possible to forecast the development of the country's entire

energy sector based on the principle of integration. A supply network of RES of agricultural origin has to be established in the same way as a network of natural gas. It is possible to plan and forecast the quantities of resources produced based on the available resources of agricultural land.

A research was conducted and scenarios were worked out (ES lauksaimniecības un lauku..., 2008) for using agricultural land resources. Possibilities for promoting the development of the market of RES by using government support and market regulation were presented in a research paper of Denina and Zvanitajs (2010). Other authors point to a need to establish a regional energy supply system by integrating RES of agricultural origin in

it. In general, the market of RES of agricultural origin in Latvia is at an early stage of development.

The present research will be extended by a long-term development forecast based on system dynamics and its analysis. Possibilities to optimise the process of production will be determined by modelling a necessary composition of substrates and supply channels for biogas TEPP. It is important to integrate the production of RES of agricultural origin with territorial development planning, as exploiting RES is related to constructing various infrastructure objects. Interactions of environmental, social, and economic processes will be modelled for biogas development centres in further research, which would ensure sustainable territorial development.

### Conclusions, proposals, recommendations

1. Structural changes in Latvia's national economy promoted a change in the area of land exploited in the industries of agriculture and forestry. The share of forest area has almost doubled in Latvia since 1930 – from 24 to 45.7% in 2010.
2. The total of utilised agricultural area 369 thou. ha or 16% were not exploited in 2010.
3. In 2011, totally 24 biogas thermoelectric power plants with a total capacity of 31.35 MW operated in Latvia, establishing territorial biogas development centres.
4. The areas sown with maize are still small in the municipalities of biogas development, occupying 3% of the total agricultural area in 2011.
5. Various kinds of biomass of agricultural origin are needed for qualitative and economically feasible biogas development. Growing various energy crops for biogas TEPP in their nearest territories will shape the regional market of RES of agricultural origin based on demand and supply.

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