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Analysis of sustainable liquid fuel production and usage in Lithuania in compliance with the National Energy Strategy and EU policy

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ABSTRACT

The article provides the analysis of production and usage of sustainable liquid fuels (biodiesel and bioethanol) in Lithuania in compliance with the National Energy Strategy and European policy. With regard to the principles of economic, environmental and social sustainable development and evaluating biofuel supply sources, the national aim is to reduce greenhouse gas emissions and the consumption of fossil fuel, especially in transport sector. The use of alternative fuels in the EU-28 is regulated by Directives, and in many countries, liquid biofuels are blended with mineral fuels. In Lithuania, the share of liquid biofuels reached 5.75% of the total volume of transport fuel in 2010, and this share should increase to 10% until 2020.

In the Baltic States, as well as in other East European countries (Finland and others), biodiesel is produced mainly from the rapeseed oil and bioethanol – from the starch containing cereals (wheat, triticale, etc.), sugar beet or potatoes. Lithuania promotes production of liquid biofuel via economic and legal measures. Revised legislation provides favourable conditions for the development of biofuel production. Established biofuel production framework exceeds the capacities, which are required by Lithuania's obligations, related to liquid biofuel consumption in transport sector.

In the article, the liquid biofuel production and the tasks for reduction of GHG emissions in the EU and Lithuania were overviewed. The analysis of biofuel production and policy in Lithuania was carried out. Energy from RES and the share of liquid biofuels were investigated. The trends of the liquid biofuel production and consumption were reviewed. The selection of biofuel feedstock was disclosed. The legislations regulating production and consumption of biofuels in Lithuania were shown. The evaluation of biofuels impact on environmental pollution was performed. National policy regarding the increase of biofuels use in Lithuania was presented.

1. Introduction

There are obvious reasons for increasing the share of renewable energy sources in the European Union (EU). The objectives of the EU Member States are to change their policies in order to significantly increase the use of renewable energy sources (RES) in all fields: electricity production, heating and cooling and transportation [1–4]. Pacesila et al. [5] showed that national production of renewable energy could help each EU Member State to reduce energy dependence from other countries. Moreover, the energy dependence of EU countries is not determined solely by renewable energy production rate, but may also depend on economic and national energy policy, the amount of national energy consumption and other factors. In Europe, 31% of energy is consumed in the transport sector, which is 94% dependent on oil [6]. Also, in Lithuania, significant amount of energy (about 36%) is consumed in transport sector [7]. The EU Member States are called upon to ensure rapid, fair and simple authorization procedures for RES and improve the pre-planning mechanisms. The municipalities must assign suitable regions and locations for the deployment of RES technology implementation and integrate these into their regional and local action plans. Liquid biofuels are researched mainly to replace conventional liquid fuels (diesel and petrol). Liquid biofuels offer numerous benefits related to energy security, economy, and environment [8–10].

1.1. An overview of current status and prospect of liquid biofuels use in the European Union

The EU-28 is one of the leading producers of biofuels in the world. In the EU-28, the biodiesel production increased very quickly by 2009, and thereafter, the global growth of the production of biofuels decreases [11,12]. In 2015, in the EU-28, about 13.5 billion litres of biodiesel were produced. This comprised 55–60% of the total biodiesel

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world production [6,9]. The US took the second place in the world in biodiesel production and produced about 4.8 billion litres in 2015, Brazil was the third, producing 4.1 billion litres, Argentina – 2.1 billion litres and the rest amount was produced in other countries. Production of biodiesel is gaining speed in Thailand, Malaysia, China and other Asian countries, which have produced a total volume of 4.00 billion litres in 2015 [13]. Presently, biodiesel accounts for more than 20% of the global biofuel production [11]. The global biodiesel output rose fractionally, from 22.4 billion litres in 2011 to 30.00 billion litres in 2015. However, biodiesel production process is complicated and expensive if compared with the production of mineral fuels [11–13].

A review of liquid biofuel demand and supply in Northwest Europe towards 2030 was provided in [14]. The evolution of biodiesel production, consumption and environmental impact in Brazil were reviewed in [15]. Also, Biofuels are used in all parts of the world [16]. Recent developments on biofuels production from microalgae, quantitative and qualitative feasibility of microalgae biodiesel (current status and perspectives) were overviewed in [17,18]. Studies on biodiesel production as well as the application of various biodiesel additives were presented in [19]. Biodiesel production and its use in diesel engine and effects of alternative fuels on the combustion characteristics and emission products from diesel engines were reviewed in [20,21].

Bioethanol is another type of biofuel, which is widely used in transport. In 2013, the global annual production of bioethanol was 88.32 billion liters. 56% of this volume was produced in USA, and 27% – in Brazil. The input of other countries was: China – 2.98 billion liters per year, and the EU – 5.8 billion liters per year [13]. Thus, the EU Member States take the third place in the global annual production of bioethanol. Though lagging behind USA and Brazil, bioethanol production is constantly growing in the EU Member States because the ethanol improves fuel combustion in vehicles, thereby reducing the emission of carbon monoxide, unburned hydrocarbons and carcinogens [14]. In comparison to petrol, ethanol contains only a trace amount of sulphur. Therefore, mixing ethanol with petrol helps to reduce the fuel's sulphur content and thereby lowers the emissions of sulphur oxide, a major component of acid rain, and carcinogens [12].

The overview of bioethanol processing was carried out in [22,23]. Bioethanol production from grass biomass was studied in [24]. An overview on the first and second generation bioethanol production with a particular attention to the potential of various biomass sources and technological approaches was presented in [25]. The second generation bioethanol production and fuel ethanol production from lignocelluloses biomass (feedstock and technological approaches) were overviewed in [26]. A review on the third generation bioethanol feedstock from algae (microalgae and microalgae) was made in [27]. Algal bioethanol production technology by using various cultivation, harvesting, extraction and commercialization techniques and its environmental perspectives (a trend towards sustainable development) was analysed in [28]. Policy makers and governments of all countries must recognize a significant contribution of biofuels to reducing the world's oil consumption [29,30].

1.2. The tasks for reduction of GHG emissions

Constant growth of biofuel consumption globally reduces the use of fossil fuel in transport sector, improves environmental conditions and reduces the volumes of harmful emissions into the atmosphere. The United Nations Framework Convention on Climate Change [31], which regulates GHG emissions, was adopted in 1992. The International Conference on Climate Change in Kyoto [32] took place five years later, during which the treaty was signed committing industrialized nations to reduce emission of GHG by 5.2% below their 1990 levels by year 2010. The EU Member States, including Lithuania, committed to reduce GHG emissions by 8% below to 1990 level [33]. More intensive use of biofuels in transport sector can significantly add to solving this problem, since transport sector is a massive source of pollution globally [34–36].

In 1990, transport sector of Lithuania accounted for 22.9% of the total GHG emission from energy sector, and in 2012 – 38.2%. In 2012, transport accounted for the largest share of the GHG emissions from energy sector [33]. To make energy from renewable energy sources competitive to that from fossil fuel is the global goal due to depletion of fossil fuel resources and growing environment pollution. The European Parliament and the Council had adopted Directive 2003/30/EC in 2003 [37], and later, the Law on Biofuel, biofuels for Transport and bio-oils of the Republic of Lithuania followed in 2004 [38], in which the respective requirements of the above Directive were enclosed. In this law it was defined that the share of biofuel up to 2% in total transport fuel should be introduced by December 31, 2005, and this share should increase up to 5.75%, by December 31, 2010. For realization of this task, new respective biofuel production technologies were created, a new production basis was implemented, also the raw material supply was ensured. Thus a new Directive 2009/28/EC was adopted in 2009 [1], which set a new goal to replace 10% of all transport mineral fuel with biofuel by 2020; the government of Lithuania also adopted this suggestion.

On April 28, 2015, the European Parliament approved the reform of the Renewable Energy Directive, which includes a 7% cap on food crop based biofuels for the transport sector [9,12]. The other 3% will come from a variety of multiple counted alternatives as well as biofuels from used cooking oil and animal fats, advanced biofuels, etc. Further growth in the use of conventional biofuels will mainly depend on the successful introduction of higher blends, such as E10 and E85 [2–4].

A comprehensive discussion on the global status of liquid biofuels use in European Union (EU) and Lithuania is presented in this study. The aim of this paper is to review and analyse the policy and pathways of the possibilities to increase the use of sustainable fuels in the transport sector of Lithuania and reduce greenhouse gas (GHG) emissions, so as to meet the requirements indicated in the EU-28 directives. The findings of this study can also be applied in other countries which have the similar climate conditions.

The paper is organised as follows: Section 1 presents the analysis of current status on the use of liquid biofuels in transport sector of EU-28 and worldwide. Also, the tasks to reduce GHG emissions are analysed. Section 2 discusses measures which were used for the evaluation of information about sustainable fuel production, consumption and policy of Lithuanian government and EU-28 for decrease of global warming. Section 3 examines problems of possibility of liquid biofuels use in Lithuania, sources of feedstocks for biofuel production and trends to increase biofuels use. The assessment of biofuels' impact on the pollution of environment is presented in the paper as well. Section 4 concludes the paper.

2. Material and methods

The article was prepared in close cooperation with the specialists from the Statistics Lithuania, Lithuanian Association of the Heat Suppliers and specialists of energy companies and associations. The information invoked in the preparation of the publication was taken from the publications of the Statistics Lithuania, Energy Balance 2005–2009 and 2010–2016, and annual reports of energy companies as well as from publications and databases prepared by international organizations (International Energy Agency, Eurostat). Over a hundred research works and publications were overviewed and analysed.

The analysis was based on the European and Lithuanian statistical data evaluation methods. Comparative indicators were prepared following the methodology, which was applied in the statistics of the International Energy Agency. According to this methodology, indicators of the total final consumption include non-energy use, whereas electricity consumption does not include transmission and distribution losses.

This work focuses on currently most important biofuels: bioethanol