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CONVENTIONAL BIOFUELS IN RESPECTS OF SUSTAINABLE DEVELOPMENT

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ABSTRACT: The aim of this paper was to discuss the issues related to conventional biofuels in the context of the sustainable development concept. The most important legal regulations which aim is ensuring their sustainable production was presented. The literature review was conducted in three dimensions – ecological, economic and social. Theoretically, conventional biofuels are in line with discussed idea, but in reality they are controversial. As a consequence, the current EU directives aim is to reduce their use and support the transition to advanced biofuels.

KEY WORDS: conventional biofuels, advanced biofuels, sustainable development

Introduction

Dynamic economic development, despite its numerous benefits (including improving the standard of living and the safety of societies) is connected with many negative phenomena as well as threats that are a major challenge for the 21st century. Degradation and pollution of the natural environment together with overexploitation of non-renewable natural resources (e.g. hard coal, crude oil and natural gas) are among the most serious ones. Faced with that problems, a lot of attention is paid to the sustainable development concept which emphasizes the need for the economic development to be harmonious with the natural environment and social sphere. In nowadays scientific discourse, for many decades, the term has most often been defined as the development that meets the needs of modern societies in a way that does not deprive future generations of the same possibility (Komorowska, 2014). In the concept of sustainable development, the pursuit of economic growth is not the aim in itself. It also involves social development and ecological approach towards life (Poskrobko, 2011). The idea is based on taking into consideration the relationship between the environmental, economic and social spheres as well as between the present and the future (Sobal, 2013).

The functioning of civilization and further economic development are inseparably connected with transport (Olejnik, 2016) – a major energy consumer and a significant pollution emittent. In the European Union, the transport sector accounts for about a third of the total energy demand (which is mostly covered by crude oil (petroleum)) (EU, 2016) and about a quarter of total greenhouse gas emissions, the most of which is generated by road transport (Kupczyk et al., 2017a). In an attempt to minimize its negative impact on the environment, the EU promotes the use of fuels based on renewable energy (in accordance with the concept of sustainable development) for transport. Member States are obliged to ensure that by 2020 the minimum share of renewable energy in final transport energy consumption is 10%. In this context, biofuel energy¹, which can be stored and, without significant technical impediments, used in the existing transport infrastructure, seems to be of greatest importance (ECA, 2016).

In Poland, conventional biofuels, such as methyl esters of higher fatty acids and bioethanol² (mainly made from rapeseed oil and maize) constitute the largest share in achieving the sector goal. Theoretically, the production and use of conventional biofuels support the idea of sustainable develop-

¹ According to Directive 2009/28/EC 'biofuels' means liquid or gaseous fuel for transport produced from biomass.

² In practice they are biocomponents – additives for petroleum fuels – bioethanol is blended with petrol, methyl esters with diesel.

ment. However, in practice these issues, due to their complexity and interdisciplinary, are a source of controversy.

Objectives, scope and methodology of the paper

The aim of the paper is to present the aspects connected with the production and the use of conventional biofuels in transport in relation to the sustainable development concept. The most important EU legal regulations highlighting the need to ensure the sustainable production of biofuels are presented in the paper. On the basis of the available literature, the issues related to biofuels based on agricultural raw materials in three dimensions – ecological, economic and social are also discussed. Both the aspects that form the basis of the claims in the paper and the ones that contradict it, are presented. The source materials are national publications, materials posted on biofuels websites and EU directives on the use of renewable energy in transport.

The complementary purpose of the paper is to present the results of research on attractiveness of conventional biofuels sectors in Poland in 2016. The scoring, multicriterial M.E. Porter method was used in the assessment of this sectors.

Biofuels and sustainable development – EU legislation

EU legislation clearly states that biofuels production should be sustainable. Consequently, in order to avoid its potential adverse environmental effects, biofuels must meet the so-called Sustainability Criteria (SC). Sustainability Criteria are a set of requirements introduced in 2009 by Directive 2009/28/EC (EU, 2009), which must be fulfilled in order for biofuel to be classified as renewable. Sustainability Criteria cover two types of issues:

- the biofuels capacity to reduce greenhouse gas emissions in relation to conventional fuels (by setting the required minimum reduction of greenhouse gas emissions from the use of biofuels in comparison to the fossil fuels emissions³),
- the problem of the biomass cultivation place, as a result of the establishment that biofuels cannot be produced from raw materials from high biodiversity areas (e.g. primary forests), carbon-rich areas (e.g. wetlands) and peatlands (Rogowska, 2014).

³ At least 60% for biofuels produced in installations starting operation after 5 October 2015, 35% for installations that were in operation on or before 5 October 2015 and at least 50% for them from 1 January 2018.

The second area of the Sustainability Criteria refers directly to the place where biomass is cultivated but does not take into account the so-called Indirect Land Use Change (ILUC). In many scientific circles, it has been recognized that the obligation to use biofuels can lead to diverted pasture or agricultural land to biofuels production. Such situation means that the demand for the food and feed products must be satisfied by the intensification of current production or by the production on other, non-agricultural land. The last scenario is an Indirect Land Use Change (ILUC) and when it involves the conversion of carbon-rich areas, it can lead to significant emissions of greenhouse gases. Identifying this phenomenon has led to a modification of legislation and the introduction of 2015/1513/EC (EU, 2015) in 2015. In this document, in order to reduce the effects of ILUC, the raw materials used for biofuel production have been diversified and it has been stressed that it is necessary to support the development of biofuels that do not compete with food crops. The directive introduced the division of biofuels into two types that is conventional ones (raw materials: cereal crops and other high-starch plants, sugar and oil and crops primarily grown for energy purposes on arable land as main crops) and advanced ones (raw materials: waste and algae and other listed in the Annex, including straw, manure and lignocellulosic materials). The Directive indicates that the second group of fuels leads to significant reductions in greenhouse gas emissions, low ILUC risk and does not compete with food and feed markets for agricultural land. Consequently, Member States should strive to promote the use of advanced biofuels and, in order to achieve the goal, set a minimum level of use (a reference value of 0.5% in 2020). Moreover, in order to prepare for the transition to these biofuels, it was established that conventional biofuels should not exceed 7% of final energy consumption in the Member States' transport sectors by 2020.

At present, the biofuels production in Poland is based primarily on the use of food raw materials (production of conventional biofuels). In 2016, methyl esters in nearly 100% were made from rapeseed oil, while bioethanol in about 70% from maize (table 1). In addition, the operation of technologies in the country that allow economically efficient production of biofuels from raw materials which do not compete with food production (advanced biofuels) is limited. As a result, EU legislation (Directive 2015/1513/EC) represents a significant challenge for the Polish transport biofuels sector in the coming years and raises many doubts.

Table 1. The raw materials used in Poland to produce methyl esters and bioethanol in 2016 (as for 13.03.17) [Mg]

	Raw material	Amount of used raw material (Mg)	Amount of produced biocomponent (Mg)
Methyl esters	Rapeseed oil	865 736	867 410
	Used vegetable oil	1 653	
	Rendered fat cat. III	1 985	
	Other	901	
Bioethanol	Maize	416 978	201 585
	Starch slurry	57 124	
	Strach C	39 042	
	Other	83 109	

Source: author's own work based on www.arr.gov.pl [20-03-17].

The impact of conventional biofuels on the environment

The unquestionable advantage of conventional biofuels is their renewable nature. The use of such energy in transport affects the reduction of the exploitation and use of non-renewable resources, which is crude oil. What is more, according to the SC (Sustainability Criteria), biofuels must meet the limits of greenhouse gas emissions and cannot directly contribute to the valuable natural areas degradation. Moreover, in the process of producing energy from biomass, valuable by-products are created, including rape meal, which is a protein-rich ingredient and is used in farm animals feed. Furthermore, conventional biofuels are easily degraded so that they do not pose a threat to soil and groundwater, e.g. in case of uncontrolled leakage. In addition, because of a higher ignition temperature, compared to diesel, they are considered safe (Żołądkiewicz, 2016).

On the other hand, in the 2015 directive, the ecological character of conventional biofuels was challenged (which was described in the previous subsection). Moreover, the necessity to allocate land for conventional biofuel crops may also result in the emergence of crop monocultures, which in turn leads to soil depletion, reduction of its fertility and biological activity (Komorowska, 2014). Furthermore, due to the lower biofuel calorific value compared to fossil fuels (table 2), it is necessary to provide a greater amount of fuel in the combustion process. Such situation contradicts the idea of sustainable development and the postulates of reducing energy consumption (Borychowski, 2014a).

Table 2. Energy content of transport fuels

Fuel	Energy content by weight * (MJ/kg)	Energy content by volume * (MJ/l)
Bioethanol	27	21
Petrol	43	32
Methyl-ester	37	33
Diesel	43	36

* lower calorific value

Source: author's own work based on Directive 2009/28/EC.

Economic aspects of conventional biofuels

The possibility to increase the energy security of states by reducing their dependence on imported petroleum is among the most positive economic factors associated with the production and use of biofuels. This is of great importance due to the precarious political situation of countries that are the main suppliers of traditional fuels and because of the finite resource reserves. Limiting demand for fossil fuels may also indirectly affect oil prices. In addition, biofuel production is an indirect stimulus for rural development and the economy as a whole, which is part of the concept of sustainable development. The additional demand for agricultural raw materials used in the production of conventional biofuels leads to an increase in farmers' incomes and thus reduces income disparities between those working in agriculture and those in other sectors (Żołądkiewicz, 2016). In 2016 the Polish oil industry in nearly 70% worked for the biofuel production industry. It is an economically viable alternative to the development of national processing potential (Portal Spożywczy, 2016). Moreover, among the economic advantages of biofuel production, price stabilization can be identified in the markets for agricultural commodities used for their production by the possibility of developing surplus raw materials (Borychowski, 2014b).

Despite the discussed economic reasons for the production and use of conventional biofuels, there are also some negative factors associated with them. The direct costs of producing biofuels, especially methyl esters, outweigh the costs of producing petroleum fuels, which reduces their competitiveness (Wójcik-Czerniewska, 2015). The analysis indicate that the cost of producing one thousand liters of methyl esters is € 250-300 higher than the cost of producing diesel. However, the economic account of bioethanol production is more favourable. In Brazil, using sugar cane requires lower inputs than gasoline, which is due to a favourable climate and cheap labour. In the

USA, when using corn, these costs are similar, but the production of sugar beet or cereal biofuels is more expensive (Berny et al., 2015).

Conventional biofuels in relation to the social sphere

The advantages associated with conventional biofuels relating to the social area can be attributed to the creation of additional jobs in sectors related to their production. Analysis conducted in the European Union indicates that it is necessary to employ 12-14 people to produce one thousand tons of biofuels (Berny et al., 2014). It is estimated that in Poland 60-65 thousand people work in such sectors (Kupczyk et al., 2017b). What is more, increasing demand for agricultural raw materials used in the production of biofuels (as mentioned in the previous subsection) increases farm incomes, thus reducing poverty in rural areas, thereby increasing the access of local people to goods and services (Borychowski, 2014a).

However, the issue of food security raises the most controversy surrounding conventional biofuels, in relation to the social sphere. The raw materials used for their production are included in edible agricultural raw materials, which should primarily be used for food purposes. The increasing demand for raw materials used in biofuel production can lead to competition for these raw materials between the food and feed sectors and the biofuels industry. There is therefore a risk of the so-called „the hunger for land” that is the insufficient amount of land under cultivation for the agro-food industry. A lot of scientists point to the relationship between the intensification of conventional biofuels production and the rise in prices of raw materials. In addition, the use of foodstuffs for energy purposes is considered unethical (Żołądkiewicz, 2016).

The attractiveness of the conventional biofuels sectors in Poland

Each sector, at different stages of its development, is characterized by certainty features which have influence on its attractiveness (value). The value of a given sector can be determined using the scoring, multicriterial M.E. Porter method, in which researches are based on an expert method. This means that sheets prepared by the research team (so-called assessment grids), containing the criteria which determine the attractiveness of the analyzed sector, are given to persons with extensive knowledge of it, and they evaluate this sector (Kupczyk et al., 2017a).

In order to assess the attractiveness of sectors related to the conventional production of bioethanol and methyl esters in Poland in 2016, a set of 15 selected criteria was used. These included among others: the size of the sector, the projected growth rate and the competitive intensity. It also includes the entry barriers, the raw materials availability and the profit margin as well as the favorability of EU policies and the social perception of the sector. The developed assessment grids were given to experts, who evaluated every factors in a 0-3 scale. The final value of a sectors (expressed as a percentage) are the quotient of experts grade point average and the maximum possible value.

The polish biofuels sectors attractiveness has been studied by the WULS Production Engineering Faculty research team since 2007. The results of the research were presented in numerous publications (e.g. Antczak et al., 2016) and for the purpose of this article have been compiled with the values obtained for 2016 (figure 1).

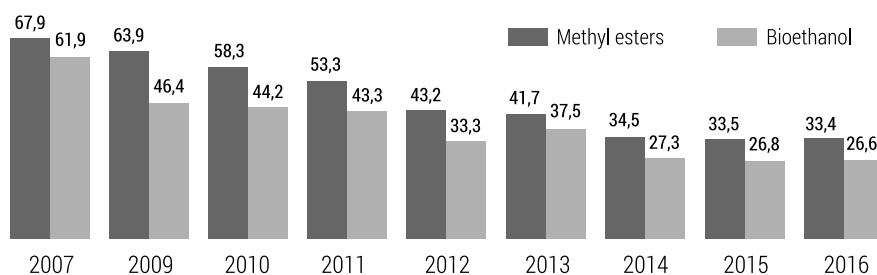


Figure 1. The attractiveness of the conventional biofuels sectors in Poland [%] [2007-2016]

Source: author's own work.

At the beginning of the analyzed period, the obtained results were very promising. However, because of the factors that undermine the conventional biofuels sustainability, the EU's legal regulations that limit the use of such fuels and, as a result, increase the interest in advanced biofuels, the attractiveness of the discussed sectors is systematically decreasing. The value of the methyl ester sector was more than twice lower in 2016 than it was in 2007, and shaped at a level of 33.4%. A similar situation occurred in the conventional bioethanol sector case, which attractiveness was assessed at 26.6%. Both of the analyzed sectors, related to the biofuels produced from food materials, are in the advanced stages of their life cycles and probably will go into the decline phase in the coming years. The current phase of their life cycle is characterized by a small and stable growth rate of the sector and also for the number of competitors as well as mature technologies.

Conclusions

The production and use of conventional biofuels in transport area are, in principle, part of the concept of sustainable development. Their use is reflected in ecological, economic and social aspects. Sectors related to the production of these biofuels are based on natural resources, limit the use of conventional fuels and greenhouse gas emissions and stimulate rural development. What is more, the production of biofuels reduces the dependence on imported mineral fuels and thus increases energy security. On the other hand, there are some aspects connected with conventional biofuels that are not in line with the postulates of the discussed issue. The main problem in this context is disputable, positive impact on the natural environment – its dubious protection due to the insignificant reduction of greenhouse gas emissions (with regard to ILUC emissions). Moreover, the demand for agricultural raw materials used in the production of biofuels can lead to competition for them between the food and feed sectors and the biofuel industry.

Initially, biofuels produced from agricultural raw materials had high hopes, but today they are a source of controversy because they do not deliver the expected environmental, economic and social effects. As a consequence, their production and use are currently undergoing a redevelopment phase, as indicated by EU legislation in order to reduce their use and support the transition to advanced biofuels (Directive 2015/1513/EC). This situation is also reflected in studies on the attractiveness of the biofuels sectors in Poland. Before 2010, the sectors related to the conventional production of bioethanol and methyl esters, were evaluated as attractive elements of the domestic economy. Since then, their attractiveness has been systematically decreasing and was more than twice lower in 2016 than it was in 2007.

National experts in the biofuels industry are of the opinion that advanced biofuels should be an important part of the energy mix of transport fuels in Poland. However, in their view, the sector ought to evolve in such a way that the current market and economic role of conventional biofuels is preserved, and that measures to support advanced biofuels include all accompanying circumstances, including their actual domestic production capacities on an industrial scale (Czubiński, 2016).

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The contribution of the authors

Joanna Mączyńska – 70%

Adam Kupczyk – 30%

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