Važni faktori pri oživljavanju industrije biodizela u Srbiji - prilika ili zamka?

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Apstrakt: Ukoliko Srbija nastavi sa evrointegracijama, politike Evropske unije vezane za korišćenje biogoriva će morati da se implementiraju. Direktiva 2009/28 / EZ podrazumeva udeo od 10% biogoriva u transportnom gorivu na tržištu, do kraja 2020. godine. Iako je proizvodnja i korišćenje biodizela u skladu sa praksom razvijenih zemalja, u Srbiji se još uvek ne proizvode niti troše značajne količine ovog goriva. Na osnovu sprovedene analize ustanovljeno je da Srbija ima potencijal da proizvede biodizel preradom domaćih sirovina. Logičan korak je dakle, uspostavljanje domaće proizvodnje biodizela. Ovaj rad predstavlja i diskutuje važne faktore za proizvođače biodizela i/ili investitore, u pokušaju da umanjí poslovne rizike ili da pruži polaznu tačku u traženju načina da se ovi faktori pretvore u dobitke. Za razvrstavanje tih faktora korišćen je PESTEL okvir, često korišćeni alat pri donošenju strateških odluka.

Ključne reči: industrija biodizela u Srbiji; podsticaji za biodizel, domaće sirovine za biodizel; PESTEL analiza.

Important factors in the revival of the biodiesel industry in Serbia - progress or pitfall?

Abstract: If Serbia is to continue with European integration, European policies related to the use of biofuels will have to be implemented. Directive 2009/28/EC implies 10% of biofuels in transport fuel by the end of 2020. Although the production and use of biodiesel is in line with the practice of developed countries, Serbia does not produce nor use significant quantities of this fuel. Based on the conducted analysis, it was established that Serbia has the potential to produce biodiesel by processing its domestic raw materials. The logical step, then, is to re-establish the domestic biodiesel industry. This paper presents and discuss important factors for biodiesel producers or / and investors, in an attempt to mitigate business risks or to provide a starting point in a search for ways to turn these factors into gains. The PESTLE framework was used for classification of these factors, on account of its common use in making strategic decisions.

Keywords: biodiesel industry in Serbia; biodiesel incentives; domestic biodiesel feedstock; PESTLE analysis.

1. Introduction

The fight against pollution makes diesel vehicles almost certainly futureless in major European cities. Over the next decade, according to Bloomberg (2019), 24 European cities with a total population of 62 million people will ban diesel vehicles, and 13 of those cities will ban all internal combustion cars by 2030. This trend leads to a decreased price of used diesel vehicles on the market. This, on the other hand, enables the citizens of Serbia, a country with a far lower economy than the European average and less strict regulations on pollution, to get used diesel vehicles cheaper. In addition to the fact that diesel has been already the most dominant fuel in transport sector in Serbia, the mentioned trend additionally contributes to the increase in the overall diesel consumption. In 2017, 2,466,000 tons of crude oil were imported in Serbia, while in 2018, this number increased by 7.3%, reaching a value of 2,660,100 t (Statistical Office of the Republic of Serbia, 2019). Although Serbia has the domestic petrol industry,

the amount of extracted and processed crude oil is insufficient in relation to existing needs, mostly because it is determined by the availability of this natural resource and operational and strategic decisions of the company that have access to it. In order to decrease foreign trade deficit of Serbia, it is necessary to find other ways to reduce imports. Many countries cope with crude oil demand, while simultaneously tackling other important state matters by inducing substitutes for petroleum derived fuels in the form of various biofuels, produced domestically by biomass processing. It results in several benefits. By domestic biofuel production, demand for crude oil is reduced which further reduces foreign trade deficit (Bomb, McCormick, Deurwaarder & Kåberger, 2007). At the same time, local agrarian industry is boosted by increasing employment opportunities. Silalertruksa, Gheewala, Hünecke, & Fritsche (2012) estimated that in Thailand, production of bioethanol could generate 17-20 times more workers than gasoline production. Furthermore, energy products supply is diversified, which contributes to the country's energy security (Uría-Martínez, Leiby & Brown, 2018). Finally, it reduces the overall pollution and is believed to help in coping with the climate emergency (Korać, Mićin, & Čupić, 2019; Fivga, Speranza, Branco, Ouadi & Hornung, 2019).

Since the diesel is predominant transport fuel in Serbia, biodiesel as its substitute is expected to be predominant among biofuels. It is considered to be a non-toxic, biodegradable substitute for petroleum diesel (Fivga *et al.*, 2019). Three basic raw materials used for the production of biodiesel are lipid materials (vegetable oils or animal fats), alcohols and catalysts which accelerate the reaction between lipid materials and alcohol (Stamenkovic, Stamenkovic-Ilic, Stamenkovic, Veljkovic & Skala, 2009; Knothe, Krah, Gerpen, 2015; Fivga *et al.*, 2019). Since the cultivation of different oilseed crops in the agrarian industry can provide significant yields of lipid raw materials, vegetable oils represent the most common feedstock for biodiesel production. According to statistical data (Statistical Office of the Republic of Serbia, 2019) and most importantly, several comprehensive studies by various authors, it has been shown (See heading 3.4.2.) that Serbia has the potential to domestically produce sufficient amounts of biodiesel feedstock that meet quality criteria (Babić, Đurišić, 2008; Đurišić-Mladenović, Kiss, Škrbić, Tomić, Mićić & Predojević, 2018; 2019a; Latinović, 2019, 2019a).

Numerous European countries have highly developed biodiesel industry, especially Germany and France. The majority of those countries also have a vibrant domestic biodiesel market. Almost or all of their supply is used to meet domestic mandate-driven demand. According to Rouhany and Montgomery (2018), "this dual role, as both producer and consumer, partially explains the limited international trade in biodiesel feedstock". On the other hand, various actions by the Government of Serbia have led to the almost complete shutdown of the domestic biodiesel industry (Tešić, Kiš & Janković, 2010; Latinović, 2019; 2019a) which goes against the policies of the European Union concerning the use of biofuels, specifically Directive 2009/28/EC (Directive 2009/28/EC) that implies 10 % of biofuels in transport fuel by the end of 2020.

As Serbia has the potential to produce biodiesel by processing domestic biodiesel feedstock, the logical step is to re-establish the domestic biodiesel industry. For this to happen, it is necessary to involve potential investors and/or producers. This paper identifies and discusses important factors and potential hindrances in biodiesel industry investment projects in order to minimize business risks and help future investors and/or producers to turn these factors into gains.

2. Methods

This manuscript is based on the identification, analysis and critical review of the main factors that may affect biodiesel production, as well as the risks that potential producers and/or investors in biodiesel investment projects in Serbia may face. On the account of its common use in strategic decisions making, as is the case with the initiation of biodiesel production, PESTLE framework was used for their convenient classification. Another reason for choosing this framework was that the biodiesel production was recognized as a complex system, linked to the sustainability assessment dimension (economic, social, environmental, political and technological) (Bautista, Espinoza, Narvaez, Camargo, Morel, 2019). Furthermore, an overview of the potential of Serbia for the production of domestic lipid biodiesel feedstock was provided (See heading 3.4). This potential was determined on the basis of the current and official data of the Statistical Office of the Republic of Serbia as well as on the comprehensive and thorough study conducted by Đurišić-Mladenović *et al.* (2018).

3. Results and discussion

A critical review of important factors for the development of the domestic biodiesel industry is given through the PESTLE analysis framework. It is a strategic tool that provides a framework for analyzing the external environment of an organization. It identifies six key areas that should be considered when attempting to identify external influences that could cause gains or represent threats (Cadle, Paul & Turner, 2018). These areas that constitute the PESTLE acronym, are: political, economic, socio-cultural, technological, legal and environmental.

3.1. Political factors

In Serbia, Biodiesel became an interesting fuel couple decades ago, specifically during the sanctions against Serbia and Montenegro, although this period was characterized by primitive production with small overall capacities (Babić, Đurišić, 2008). In the year 2008, European Union and the Republic of Serbia signed the Stabilization and Association Agreement. It entered into force September 1th, 2013 (Ministry of foreign affairs of the Republic of Serbia, 2019). This agreement was a confirmation of Serbia's perspective toward membership in European Union, but it was a two-way street. In addition to the assistance of the European Union, Serbia needed to accept certain ethical, economic, environmental, legal and other norms of the European Union before it would become its full member. Among other things, this included certain obligations regarding the increase in the share of renewable energy sources in the total energy balance. Even before signing this agreement, in 2006, Serbia accepted the obligation to submit a plan for the implementation of the Directive 2003/30/EC to the European Commission. This directive implied 5.75% share of biofuels, such as biodiesel and bioethanol, in petroleum fuels, by the end of 2010 (Directive 2003/30/EC). This should have been a step towards a more serious approach to biofuel production at the state level. Investors indeed believed that this was a reliable indicator for biofuel product placement, thus it has led to several significant investments in biodiesel production (Latinović, 2019b). The most significant one was Victoriaoil biodiesel plant in Šid with installed capacity of 100,000 tons of biodiesel per year.

Although such incentives might seem like a “green light” for potential biodiesel producers, they can also represent a trap, if they get omitted at some point. Olteanu (2009) examined trends and historical data on biodiesel industry in Germany and found out that there were numerous biodiesel investment closures and considerable reduction both in the number of producers and production capacities. This was due to volatility of crude oil and feedstock prices, as well as decline in government aids and gradual increase in the excise tax burden on German biofuels. Non-relatedly, but similar event has happened in Serbia, too. Contrary to the expectations, instead of the state incentives and aid, Serbian government has introduced high excise taxes on biofuels along with “Regulation on the quality monitoring of oil” and biofuels and “Regulation on the marking of oil derivatives” in 2015. These steps have led to the almost a complete shutdown of the Serbian biodiesel industry (Tešić, Kiss, Janković, 2010; Latinović, 2019). Victoriaoil stated that in 2007 it produced only 27,000 tons of biodiesel. Luckily, their technology allowed them to conserve the biodiesel plant and switch to the production of edible oil.

In 2013, a legal framework that would force oil companies to blend petroleum products with biofuels with the state control was announced once again, but the adequate decree has not been issued until today. However, in 2015, The Energy Development Strategy of the Republic of Serbia until 2025 was adopted, although it was not legally binding document.

Meanwhile, Directive 2003/30 has been replaced by Directive 2009/28/EC. New directive implies 10 % of biofuels in transport fuel by the end of 2020 (Directive 2009/28/EZ). Regarding the Serbia's path towards European integration, it is expected that mandatory use and production of biofuels will be a current topic in the near future.

3.1.1. The Energy Development Strategy of the Republic of Serbia

On December 4th, 2015, the National Assembly of the Republic of Serbia adopted the Energy Development Strategy of the Republic of Serbia until 2025 with projections until 2030. (The Energy Development Strategy, 2015). The strategy signalizes points listed below as priorities.

- Ensuring energy security, reducing import dependence, securing energy reserves of oil and natural gas and building new electricity capacities.

- The development of the energy market within the EU energy market in which the Republic of Serbia is integrated with the signing of the Treaty establishing the Energy Community, which contributes to the economic development and stability of the country and the construction of modernization of the electricity and gas infrastructure.
- Establishing a sustainable energy sector through the application of energy efficiency measures, the use of renewable energy sources and the application of environmental protection standards and the reduction of adverse impacts on climate.

Mitigation of import dependence on oil and encouragement of renewable energy source usage are key factors regarding the biodiesel industry.

While national biodiesel policy implementation in major producing countries such as USA, Brazil and Germany (Su, Zhang & Su, 2015) seems to address a wide range of interests across several objectives, according to Rouhany and Montgomery (2018), the situation is actually reversed. They stated that: „In reality, the support of specific sectors and interests, such as farm lobbies and energy groups, often determines policy design and implementation “.

It remains to be seen how the Republic of Serbia will behave in this field in the forthcoming period, given the historical data on its unpredictable behavior and will it be able to avoid the traps that intertwine other countries.

3.1.2. Marking of oil derivatives

The Government of Serbia has adopted two regulations concerning the marking of oil derivatives. These are „Regulation on the quality monitoring of oil and biofuels “ (2015) and „Regulation on the marking of oil derivatives “ (2017). These regulations allow market inspection to control fuel in tanks of business entities vehicles, specifically in trucks, buses and agricultural machines. The goal is stated to be the determination of the origin of transport fuel and provision of quality products to consumers. This is an advanced technique in suppressing the black market, completely in accordance with European practice. However, the legislator did not properly approach to the protection of small agricultural producers who produce biodiesel for their own needs. Large scale producers who place their product on the fuel market would have no concerns regarding these regulations, but for small agricultural producers this represents a significant obstacle. Regulations impose that transport fuel in Serbian market must be marked with the appropriate marker at the appropriate concentration. Blending marked fuel with a self-made biodiesel would lead to diluted markers.

This means that in the case of market inspection, business entities such as small agricultural holdings, caught with “irregular” fuel would be faced to huge penalties, from 50,000 to 2,000,000 RSD. This however, is not in line with the European practice and the adopted strategy of energy development of Serbia. As long as the legislator does not pay attention and adopt regulations that support this kind of production and consumption of biodiesel, a part of agricultural waste biomass and waste frying oil remains unused on the account of inadequate legislation. Such waste represents the most suitable feedstock for biodiesel production from the environmental and economic aspect and it is believed to contribute to rural development even more (Heijman, Szabó & Veldhuizen, 2019; Rodrigues, Da Silva & Silva, 2019; Latinović, 2019a). Using those waste materials as feedstock would help solving the problem of their disposal as waste and reduce the share of the agriculture feedstock usable for food production being used for fuel production. Moreover, precisely in the area of waste recycling, the effect of a larger number of such small producers using biofuels for their own consumption is recognized as a potentially significant factor in sustainable waste management at the state level (Latinović, 2018).

3.1.3. Excise taxes

Biofuels in Serbia are subjected to the excise tax law (The law on excises, 2019). This law also prescribes the amount of the excise tax. At the time this paper was written, the excise tax on biofuels in Serbia amounted RSD 56.04 which was € 0.4571 at the middle exchange rate of the National Bank of Serbia on May 31, 2019. The imposition of taxes was justified by the frequent illegal mixing and participation of biodiesel in petroleum diesel, without the knowledge of customers. Since it was cheaper than petroleum diesel, according to state officials, the state has lost its balance.

3.2. Economic factors

3.2.1. Biodiesel and petroleum prices volatility

Between 2005 and 2015, global biodiesel production experienced an increase of more than 20% per year. It resulted in a sevenfold expansion in one decade. It all happened at the same time, together with the rise in the price of petrodiesel. However, petroleum price has been in decline since 2014 (Fig. 1) and this is considered to have stimulated petrodiesel use again. The widespread use of biodiesel on voluntary level could be expected only if it were cost-competitive to fossil diesel (See heading 3.3 - “Socio-cultural factors”).

Energy content of biodiesel, on the average, is lower by about 12.8% on a mass basis, and about 8.7% on the volume basis (Sinčić, 2014). In other words, for the same volume of fuel injected, engine power with biodiesel should be lower by 8.7%. This means that for the same engine performance level achieved by using one volume unit of diesel fuel, it would require 8.7 % larger volume of biodiesel fuel. Applied to the price of biodiesel, it should be about 9 % lower than the diesel price. Appreciation of this fact while forming the price of biodiesel was brought into question by the high excise tax on biofuels, imposed by the state (See heading 3.1.2.).

Figure 1: Global crude oil, rapeseed oil and sunflower oil prices per ton, from 2009-2019.

Data source: Index mundi 2019; 2019a; U.S. Energy information administration, 2019.

The sensitivity analysis of a biodiesel investment project, conducted by Kiš and Jovanović (2007) showed that such a project (Fig. 2) is most sensitive to changes in final prices of biodiesel, purchase price of lipid feedstock and petrodiesel prices (Kiš, Jovanović, 2007). Namely, it has been shown that the cost of feedstock makes up as much as 70 – 95 % of the total operating costs of a biodiesel plant (Banković-Ilić, Stamenković & Veljković, 2012). Considering pressure from rising prices of oilseeds and volatile crude oil prices, the government aid is necessary in order to make biodiesel production economically feasible (Naylor and Higgins, 2017). However, the current cost of biodiesel production depending on the current price of feedstock, used technology and operational production settings is not the part of this study.

Despite the downward pressure due to low global petrodiesel prices (Fig. 1) and policy uncertainty in some markets, biofuel production and demand continued to increase in 2016, and biodiesel further retained a dominant position in the transport bio fuel with about 4 % in the total world consumption of transport fuels (Naylor and Higgins 2017). This can be attributed to the compulsory mixing and use of biodiesel that ensures consistency in demand. Furthermore, future trend of international prices of biodiesel is expected to be in the inclination in nominal terms over the next 10 years, driven by the recovery of crude oil markets and prices of biofuel feedstock (Rouhany, Montgomery, 2018).

Figure 2: Production of biodiesel by phases (inputs, process, outputs).

Source: Kiš, Jovanović (2007).

3.2.2. Serbian biodiesel market size

In 2018, 228,900 freight vehicles, 9,980 buses, 8,979 work machines and 1,999,771 passenger cars were registered in Serbia (Statistical Office, 2019c), although the exact number of diesel passenger cars was not available. Still, the final energy consumption of transport diesel fuel in Serbia in 2017 was 1,571,130 t (Statistical Office, 2019b). If Serbia had reached the target of 10 % of biofuels in Petro fuel products, 157,113 tons of biodiesel would have been consumed that year, just in the form of transport fuel.

Although, there is a trend of ejecting diesel engines from urban areas in several European countries, it is not the case in Serbia where, on account of the economic situation, there is a significant demand for used diesel vehicles from European Union. There is no indication that this trend will be declining in the near future and diesel fuel still represents the most used fuel in transport sector.

3.3. Socio-cultural factors

The experience from leading biodiesel producing countries such as Germany and the UK showed that most consumers purchase biodiesel only if it was price competitive with petrodiesel. In Germany, the availability and price of biodiesel has allowed pure biodiesel to find its way to customers and its sales continue to grow. However, in the UK, the experience indicates that only few consumers are willing to purchase B5 at a price premium. The environmental reasons for purchasing biofuels are simply overshadowed by price and availability (Bomb, McCormick, Deurwaarder & Kåberger, 2007). These authors concluded that biodiesel, on account of price sensitivity of the market, would face difficult survival without state aids. „Consumers purchase cheap rather than green “(Bomb *et al.*, 2007).

In this respect, media coverage as a key factor in forming customer behavior (Jagodič & Vukasović, 2019) would also need to influence biofuel market in order to make customers participate voluntarily. In 2014, a comprehensive overview on media coverage of environmental issues in Serbia was conducted by Jovanović and Aćimović. They stated that independence of media on environmental issues is necessary if the level of information, development of value systems and relations to the environment is to be raised. For the Republic of Serbia this fact is of particular importance given the process of European integration. They concluded that there was an increasing range of thematic coverage on environmental issues. However, it should be noted that the manuscript reviewed the coverage of all environmental issues, not just biofuels (Jovanović, Aćimović 2014). Still, the economic situation in Serbia does not play in favor of the voluntary purchase of biodiesel. It is highly likely that from the aspect of the social status of the average Serbian citizen, production and the compulsory use of biodiesel would be an additional economic burden, rather than a benefit (Latinović, 2019a). The aptitude of Serbian society is still at a level where significant purchases of biodiesel can be expected on voluntary basis only if it was price competitive with petrodiesel.

3.4. Technological factors

3.4.1. Technological innovations in the field of lipid feedstock for biodiesel production

The quality of biodiesel is determined by the quality of lipid feedstock, the processing technology used, and the process parameters (Knothe *et al.*, 2015; Rathore *et al.* 2016). When it comes to biofuels and

feedstock generally, the four-generation division is often mentioned. The first generation of biofuels most commonly refers to biofuels produced from cultivated crops such as corn, sunflower, rapeseed, soybean, palm, etc., otherwise intended for human food (Bezergianni & Dimitriadis, 2013). Second generation biofuels are made by processing non-edible biomass with few remaining limitations related to the cost-effectiveness involved in scaling the production to a commercial level. Third generation biofuels are made of feedstock produced by microorganisms, while fourth generation biofuels are made by genetically modified microorganisms to enhance production while simultaneously removing carbon from the atmosphere (Abdullah *et al.*, 2019; Alalwan, Alminshid & Aljaafari, 2019).

Biodiesel lipid feedstock can be divided into following groups: plant oils (edible), plant oils (non-edible), used or waste edible oils, microalgae oils and animal fats (Vignesh & Barik, 2019). Beside common oilseed plants used for the production of biodiesel such as rapeseed, soybean, palm, sunflower, etc., several others were tested. Efe, Ceviz & Temur (2018) conducted a comparative study on characteristics of biodiesels obtained from common oilseed plants – soybean and sunflower, but also from canola, hazelnut and corn. The study showed that it was possible to obtain biodiesel by processing these plants and that B20 hazelnut biodiesel showed the most superior performance among all other biodiesel samples. Bolonio, García-Martínez, Ortega, Lapuerta, Rodríguez-Fernández & Canoira (2019) tested grape seed oil, potential waste in Spain and other wine producing countries, and found that it represented a promising feedstock for biodiesel production. Also, several non-edible oils such as pyrolysis oil, *Calophyllum Inophyllum* Linn oil, *Jatropha Curcas*, *Madhuca Indica* and *Pongamia Pinnata* oil were successfully tested as a biodiesel feedstock (Suresh, Jawahar, Richard 2018).

In addition to lipid feedstock obtained from agriculture, waste edible oils (WEO) can also be used for biodiesel production (Maneerung, Kawi, Dai & Wang, 2016, Tran, Kaiprommarat, Kongparakul, Reubroycharoen, Guan, Nguyen & Samart, 2016; Vignesh & Barik, 2019). It is oil generated as a waste in food production, also referred to as “waste frying oil” (WFO) or “waste cooking oil” (WCO), or as a by-product of industrial production of edible oils. The use of this type of oil has double advantage – on the one side, it represents perspective and cheap raw material for industrial biodiesel production and on the other side, in this way the problem of appearance of oil as a waste and its disposal is solved (Đurišić-Mladenović, Predojević, Škrbić, 2015). However, high free fatty acids (FFA) in waste oils represent a serious disadvantage in the process of transesterification (Sahar, Sadaf, Iqbal *et al.*, 2018). Such oils require more complex and resource demanding preparation prior to biodiesel production. Since waste oils are scattered, generated in small quantities at a stochastic pace by a large number of generators, this capillary distribution represents another logistical problem to be solved (Latinović, Jovanović, 2019).

Another type of waste suitable for biodiesel production was found to be spent coffee grounds (SCG). Atabani, Shobana, Mohammed *et al.* (2019) presented the possibility of using extracted oil from SCG for biodiesel synthesis. The produced biodiesel was then blended with Euro diesel, butanol, pentanol and hexanol to improve its density, kinematic viscosity and cold flow properties in order to satisfy specifications - required by defined standards (See heading 3.5.1.). In a similar study conducted by Kamil, Ramadan, Awad, Ibrahim, Inayat & Ma (2019), beside technological feasibility of such a feedstock, profitability of a SCG biodiesel plant was estimated at over 10,000 t/y. What also gained attention in recent years was waste tallow biodiesel. It was tested in different blends with WCO biodiesel, and was observed that it had the proper characteristics, but it was concluded that further research was needed to ensure that its use for these purposes was economically justified (Hazrat, Rasul, Khan, Ashwath & Rufford, 2019).

In recent years, great efforts have been made in attempts to use algae for the production of lipid biodiesel raw materials. In the media and literature, micro-algal biodiesel production was considered to be a promising biodiesel production method for future applications with several benefits: renewability, sustainability, clean-burning, safety and cost-effectiveness issues. However, microalgae are grown in aquatic conditions. This implies that appropriate natural conditions for their cultivation, such as natural or artificial lakes and ponds, are required. Although they can be built on land that is not otherwise intended for agriculture, it would be necessary to provide enormous amounts of water, starch, sun and carbon dioxide to make algae give a more significant yield. The lipid yield of microalgae in relation to plants currently used to obtain biodiesel was indeed, up to 100 times higher (Ljupković, 2014; Danilović *et al.*, 2014), but recent research showed that their cultivation for the purpose of biodiesel production was still neither sustainable nor economically justified (Kenny, Flynn, 2017). Researchers

are still in the search for a higher productivity production method with higher stability to be used in industrial processes (Deniz, Aslanbay, Imamoglu, 2019).

Finally, all of these alternative raw materials come with new hurdles that need to be overcome. They are either in the testing phase, scattered in small quantities or derived from plants non-native to Serbian soil. Such feedstock should be seen only as a possible supplement, where significant amounts of domestic lipid feedstock should be expected only from domestic agriculture.

3.4.2. Domestic biodiesel feedstock potential of Serbia

The republic of Serbia covers the area of 88,499 km². Around 70% of its total area is used for agricultural purposes (Pocuca, Draskovic, 2015). Table 1 shows the actual yields and coverage area of the most important oil seed plants in Serbia in 2018, which are sunflower, rapeseed and soybean. Babić and Đurišić in 2008 roughly estimated arable land considered available for the production of oilseeds in Serbia on around 600,000 hectares (Babić, Đurišić, 2008). In year 2018., these plants reached covering area of around 481,248 hectares and they gave total yield of 1,514,735 tons of grains (Statistical Office of the Republic of Serbia, 2019a). With an average yield of 3 tons per hectare (Table 1) and with 36% of oil per ton of rapeseed grain (Enguidanos *et al.*, 2002) one hectare of rapeseed in Serbia would provide enough grain for production of 1.080 kg of biodiesel. Sunflower gives yield of 40 – 42% of oil per seed and with the yield of 3.1 tons per hectare, one hectare of sunflower would ideally be sufficient for up to 1,302 kg of biodiesel. Soybean on the other hand, has the lowest oil yield from those three plants with the average oil content of 15 - 25% of oil in the seed (Sharma, Kaur, Goyal & Gill, 2011).

Table 1: Rapeseed, Sunflower and Soybean area of coverage and yield in 2018.

	Area (ha)	Yield	
		Total (t)	t/ha
Rapeseed	45,628	135,422	3.0
Sunflower	239,148	733,706	3.1
Soybean	196,472	645,607	3.3

Source: Statistical Office of the Republic of Serbia. (2019a)

If the total yield from these three oilseeds in 2018 went for the production of biodiesel, it would have resulted with over 471,000 t of produced biodiesel. However, if this was the case, no livestock feed nor food products would have been made of these plants. Using edible vegetable oils as feedstock for biodiesel production is not regarded as long-term sustainable choice. This is the central issue of the “Food vs. Fuel” debate. It is an actual global debate on sustainability of biofuels given the food availability and price (Latinović, 2019; 2019a) but it is out of the scope of this paper.

Finally, in 2018, Đurišić-Mladenović, Kiss, Škrbić *et al.* (2018) thoroughly summarized the biodiesel production capacities and the indigenous oil-based feedstock potential. For the first time, it was done so comprehensive and fundamentally. They paid particular attention to the principal oilseed crops as biodiesel feedstock in Serbia. Also, the total 1st generation biodiesel production potential was discussed by balancing between available areas for cultivation of oilseed crops, and domestic edible oil and fodder requirements.

According to Đurišić-Mladenović *et al.* (2018), the annual theoretical biodiesel production in Serbia is estimated at 128,000 – 266,000 tons depending on the type of oilseed crop used as the feedstock. This number is in addition to the quantities of oilseed crops required by the domestic food and fodder industries. However, the real potential might be lower on account of several factors. The Autonomous Province of Vojvodina is the largest agriculture base in Serbia and it is almost completely plain. Such landscape along with moderate continental climate makes favorable climate conditions for development of agriculture. However, oil crops occupy around 19% of Vojvodina’s arable which is believed to be near of its biological maximum (Đurišić-Mladenović *et al.*, 2018). On the other hand, Central Serbia have trivial share of around 2% of oil crops of its total arable land area, which means that a substantial increase in areas under oil crops cannot be expected in Vojvodina, but Central Serbia. Still, there are many obstacles for substantial production of biodiesel feedstock in this region.

Agricultural holding in Central Serbia have relatively small average size of arable land, (around 2 ha) and they are scattered (Statistical office of the Republic of Serbia, 2018). This represents a significant logistical problem, which would likely cause increased transportation costs on account of organizing

production and collecting oilseeds and capital investments in new collection centers would likely be needed. In addition, this region has no tradition in the production of oil crops, which means that there is a lack of “know-how” and specialized machines for oil crop production (Đurišić-Mladenović *et al.*, 2018). These authors also noticed that rapeseed oil has more favorable properties than sunflower oil in respect to the compliance with the SRPS EN 14214 standard. They stated that the prevalence of polyunsaturated acids like in the case of several soybean and sunflower sorts (e.g. Zlata and Somborac, respectively) might make them unsuitable for the production of biodiesel in accordance to the same standard. This is due to high iodine number. Mixing with other vegetable oils of lower iodine number would be necessary if biodiesel is to meet requirements imposed by SRPS EN 14214:2019. As an alternative, they proposed increasing the production of high-oleic sunflower types (oleic acid > 70%) whose iodine number is less than 120 I₂ (100g)⁻¹. There are several domestically developed high-oleic types of sunflower (e.g. Oliva) but there are no data on areas under these crops, their potential yields and economic feasibility (Đurišić-Mladenović *et al.*, 2018).

3.4.3. Glycerol as the main by-product in biodiesel production

The main by-product in the production of biodiesel is glycerol, making about 10% of the weight of generated biodiesel (Quispe, Coronado, & Carvalho Jr., 2013). It is a virtually nontoxic organic compound with the molecular formula C₃H₅(OH)₃, with wide range of applications, especially in pharmaceuticals, personal care, foods and cosmetics (Tan, Abdul Aziz & Aroua, 2013).

At the very beginning of the development of the biodiesel industry, due to its widespread use, this by-product was a significant additional revenue for producers. Nevertheless, the availability of glycerol has increased multiple times due to remarkable growth of the biodiesel production worldwide. More than a decade ago, it became apparent that the existing glycerol demand market could not accommodate the excess amounts of glycerol generated from biodiesel production, which has become its bottleneck. Johnson and Taconi (2007) stated: “The flood of glycerol has created a glut in the glycerol market”. Before year 2003, the cost of crude glycerol was in the range of € 250 – 300 per ton, falling to even 0 € about a decade ago (Mizuno, 2009). In 2016 more than 30.8 million m³ (Mm³) was generated, which is 7.5% more than in 2015, while future growth was estimated by around 4.5% annually, reaching 41 Mm³ in 2022 (Monteiro, Kugelmeier, Pinheiro, Batalha & da Silva César, 2018). In 2011, it was estimated that 2 million tons (or just 40%) of a total of 5.1 million tons of glycerol was used, while the remaining 3 million tons were excess. Predictions on the global production of glycerol are to reach 7.66 million tons in 2020 (Anuar & Abdullah, 2016) making an even bigger gap between its supply and the demand.

However, there are various efforts and recent studies aimed at finding a novel use for glycerol, such as production of lactic acid by *Enterococcus faecalis* on waste glycerol from biodiesel production (Ciric *et al.*, 2020). Another one was thermochemical conversion of glycerol to medium methane content biological synthetic natural gas (bio-SNG). Researchers estimated that the bio-SNG made of glycerol containing only 80 wt% of free glycerol, could substitute up to 24% of the natural gas used at a pilot soybean biodiesel plant. They conducted a discounted cash flow analysis showing that it was possible to generate positive net present value and achieve internal rates of return within the hurdle rate (12%) for biomass gasification technologies (White *et al.*, 2019).

Perhaps the most promising one was the substitution of metalworking fluids (MWF) based on mineral oils and biocide additives by sustainable biodegradable glycerol-based MWFs (Winter *et al.*, 2012; Umamaheswara *et al.*, 2020). Around 2011, consumption of MWF in Germany alone was approximately 740 kt *per annum*, comprising about 70 kt of mineral oil components (Wichmann *et al.*, 2013). Moreover, glycerol-based MWF with 40% glycerol showed both good biostatic and technical properties, while at the same time being regarded as a sustainable and less hazardous substitute (Winter *et al.*, 2012; Wichmann *et al.*, 2013).

Finally, there were a few recent technological steps towards a glycerol-free production process. It is a relatively new alcohol-based reaction, although discovered decades ago. It is an interesterification reaction involving methyl acetate, but more research and development is required in order to make biodiesel production sustainable and economically feasible (Tan & Ang, 2019).

Nevertheless, it is still not realistic to expect that this will significantly affect the demand for glycerol in the near future, but efforts in these directions should be taken into consideration, especially in relation to mineral oil MWF substitution by glycerol-based MWF.

3.5. Legal factors

3.5.1. Biodiesel as a subject of standardization

Standards are, in their essence, documents that are accepted on a voluntary basis. However, governments are often referring to them in different technical regulations, which are legally binding documents, so it is essential to keep in mind that biodiesel as a final product have to meet different standards in order to find its place in the market. Since the technology of compression-ignition (diesel) engine is well established and widespread, biodiesel and its blends with petrodiesel have to adapt to it through a comprehensive standardization aimed at providing the appropriate characteristics of such products on the market (Latinović, 2019a).

Serbian standard that prescribes biodiesel characteristics is SRPS EN 14214:2019 and it fully corresponds to the European Standard EN 14214:2019 (ISS, 2019). As Sinčić (2014) stated, some of these characteristics partially coincide with characteristics of petrodiesel fuel. However, some characteristics are non-existing on account of their substantially different chemical composition. Due to the high total diesel fuel consumption levels, well established and relatively secure crude oil and diesel supply channels and its importance for the overall economic activity, biodiesel cannot completely replace diesel fuel. Therefore, it is most commonly used as a component for fuel blend with petrodiesel, in various proportions. In this case, its characteristics are specified by the standard SRPS B.H2.133:2015, which is identical to the standard ASTM D6751-15a (ISS, 2015). Blends are designated as "B" followed by a number that indicates the percentage of biodiesel. For example, the designation B100 represents pure biodiesel while B20 refers to the blend consists of 20 % of biodiesel and 80% of petrodiesel.

Following the adoption of the Directive 2009/28/EC, B10 is becoming more and more common in the European Union (Latinović, 2019a), which eurointegrations expect to be realized in Serbia as well. In step with the gradual increase in biodiesel share in petroleum products, new standards have been adopted. Blends containing up to 10% (v/v) of FAME are covered by EN 16734:2019, or in Serbia, its equivalent SRPS EN 16734:2019. It specifies requirements and test methods for marketed and delivered automotive B10 diesel fuel, containing up to 10.0% (V/V) FAME (ISS, 2019a).

Furthermore, Serbian standard SRPS EN 16709:2019, identical to EN 16709:2015+A1:2018 CEN/TC 19 specifies requirements and test methods for marketed and delivered high FAME (B20 and B30) diesel fuel for use in diesel engine vehicles designed or subsequently adapted to run on high FAME (B20 and B30) fuel (ISS, 2019b). Such blends are intended to be used on the voluntarily basis, and is expected to be mostly by agricultural sector and for working machines. Its price is the primary factor for choosing such a fuel type. In addition, further biodiesel share increase in the fuel blend, demands additional changes in petroleum diesel standards so that the quality of final blend can pass the environmental and technological requirements (Hart Energy, 2014).

However, the EU itself has had contradictions in attitudes towards biofuels in the transport sector. Official European strategy is to promote an increase in the share of biofuels in transport fuel, and it is being covered by appropriate policies, directives, standards, etc. At the same time, the European Union is beginning to question the sustainability of biodiesel and its impact on reducing GHG emissions in general. Questioning of the viability of using biodiesel as well as its impact on the environment is not without reason. There are many well documented adverse effects that follow biodiesel industry (Latinović, 2019; 2019a). Some of them are: increased NO_x emissions (Chauhan & Shukla, 2011; Nestorović, Jovanović, Manić & Stojiljković, 2012; Jovanović, Joldžić, Jovanović, 2015), jeopardized food and water procurement referred to as „food or fuel“ and „drink or drive“ issues (Taheripour, Hertel & Tyner, 2010; Koizumi, 2015; Tomei & Helliwell, 2016) and various issues with engine operation, performance and durability, most specifically crankcase oil dilution and fuel system clogging (Fraer, Dinh, Proc *et al.*, 2005; Yüsek, Kaleli, Özener & Özoğuz, 2009; Thornton, Alleman, Luecke *et al.* 2009; Gili, Igartua, Luther & Woydt, 2011; Kurre, Garg & Pandey, 2016). However,

these fluctuations in EU courses concerning biofuels make the future of the entire biodiesel industry uncertain and this should be taken into consideration while making projections on return of investment period of a biodiesel investment project.

3.5.2. Political situation in the country concerning the rule of law

Eurointegrations of the Republic of Serbia also imply entering the reform process according to the model offered by this regional integration (Jovanović, 2012). The process itself involves the introduction of EU standards into national legislation, which further requires an enhanced form of enforcement control, but also of all other standards as well as the creation of new special institutions that will oversee the correct implementation of the newly adopted rules. It is being overseen both at the national level, at the local level and at the level of the organizations themselves (Jovanović, Stokić, Matavulj & Igić, 2012). In the end, all this implies the acceptance of a value system that applies in the EU countries. Since the Republic of Serbia is a candidate country, that is, in the process of negotiations with the EU, it should be underlined that by the date of accession, it is obliged to adopt EU legislation in various fields, including in the field of environment and energy. In this way, a completely new business environment is created. All this may be considered as a positive signal for potential investors in biodiesel industry.

Though, at the same time with European integration, Serbia is going through a difficult political period of various fluctuations and contradictions. Although political and legal factors are often intertwined, the political situation in the country has found its place in this section because it does not talk about government policies, but rather speaks of investor protection and security in conducting business within the envisaged legal frameworks and Serbian business environment. This is a particularly important topic for potential investors because the biodiesel industry is closely related to government policies, standardization and various legal regulations.

However, it is very ungrateful to talk about the political situation, especially in the native land of the authors. Therefore, in order to avoid any coloring of the text by the bias of the authors, Freedom House was chosen as a partially independent entity that has some credibility regarding to the subject. Their annual 2019 report on the Freedom and state of Democracy in the World stated that Serbia's status of Free country has declined to Partly Free country (Freedom House, 2019). According to the same report, Serbia was the fourth country with the largest decline in political rights and civil liberties in the World. It ranked just below Venezuela, Tanzania and Nicaragua. As democratic standards in Serbia continued to fall, while Russian and Chinese influence started to raise, Freedom House's latest "Nations in Transit report" classified its regime as "Hybrid". This means that Serbia has lost its status as a democratic country (Freedom House, 2020).

Concerning the rule of law this report stated: "The independence of the judiciary is compromised by political influence over judicial appointments, and many judges have reported facing external pressure regarding their rulings. Politicians regularly comment on judicial matters, including by discussing ongoing cases or investigations with the media, etc. Due process guarantees are upheld in some cases, but corruption, lack of capacity, and political influence often undermine these protections. Among other problems, rules on the random assignment of cases to judges and prosecutors are not consistently observed, and mechanisms for obtaining restitution in civil matters are ineffective. High-profile, politically sensitive cases are especially vulnerable to interference" (Freedom House, 2020). However, concerning rights to own property and establish private business without undue interference from state or nonstate actors, the same report stated: "In general, property rights are respected, but adjudication of disputes is slow, and problems such as illegal construction and fraud persist. An estimated two million buildings in Serbia are not registered..." (Freedom house, 2020).

Although it is not certain that these factors will have negative consequences on biodiesel industry investment projects in Serbia, it should be taken into consideration in order to prevent the possibility that the future success of the investment depends on one's goodwill.

3.6. Environmental factors

3.6.1. Disappearance of agricultural land

Annually between 6,000 and 30,000 hectares of agricultural land get obliterated and become unsuitable for agriculture. This reduction of agricultural land is due to urbanization, Greenfield investments, infrastructure construction and various excavation sites (Pocuca, Draskovic, 2015). Agricultural land in Serbia has experienced an alarming disappearance. For less than one human lifetime, the size of arable land in Serbia has reduced from 3.6 million ha in 1960 (Ševarlić, 2012) to around 2.5 million ha in 2018 (Statistical office of the Republic of Serbia, 2018). This means that Serbia has left without virtually one third of the cultivable land in only 60 years. Regarding the Serbia's potential for biodiesel feedstock production, this represents a significant risk. Given that the earnings and prices of agricultural products cannot compete with prices and earnings from other industrial branches, agricultural production is the weakest link in that chain. By its vulnerability, biodiesel industry is jeopardized as well.

3.6.2. Water consumption and waste water treatment

Feedstock cultivation, usually row-crop agriculture, is the most water-intensive of biofuel production stages. More intensive agriculture would require more irrigation, which would create pressure on water resources in many areas (Diamantopoulos, 2015). This issue often referred to as "Drink or drive issue". In addition, the largest biodiesel production facilities in Serbia, such as Victoriaoil plant in Šid, use Lurgi technology, where the process itself requires large quantities of water. The primary uses of water for biodiesel refining are to wash plants and seeds for processing and for removing catalyst that lags in the ester fraction from which it is eliminated by multiple rinsing with hot water (Stamenkovic *et al.*, 2009; Sincic, 2014; Efe, Ceviz & Temur, 2018). This water becomes wastewater, containing residues from the production process such as: oil, soap, methanol, glycerol etc. (Daud *et al.*, 2015). It is required to be processed, bringing new technological challenges and additionally increasing the production cost. Wastewater treatment processes vary from simple reservoirs, relying solely on sedimentation, to refined processing processes with advanced biological processing as we know it today. Processing aims to reduce the pollution contained in wastewater such as bacteria and viruses, components that consume oxygen, nutrients, pharmaceuticals, chemicals and heavy metals from wastewater before they are discharged into the receiving water. Rattanapan *et al.* (2011) found that efficiency of dissolved air flotation for biodiesel wastewater treatment can be enhanced by acidification and coagulation processes. Furthermore, Nikhom *et al.* (2019) demonstrated that oil recovered from biodiesel wastewater can be used as an alternative feedstock for biodiesel production. They recovered 33 g of oil from wastewater generated during the production of one liter of biodiesel.

Wastewater treatment in Serbia falls under the Regulation on limit values for emission of pollutants into water (2016). This Regulation establishes the emission limit values for certain groups or categories of pollutants for: technological wastewater before their discharge into the public sewage system; technological and other waste water directly discharged into the recipient; the waters that are discharged from the public sewage system to the recipient and the wastewater discharged from the septic and collecting pit into the recipient after the treatment, as well as the deadlines for their reach.

3.7. PESTLE analysis summary

Although all factors have been previously discussed individually in the respective headings, Table 2 and Table 3 present an abbreviated systematic overview of respectively, positive and negative key findings of the PESTLE analysis, for ease of review.

Table 2. Positive key findings of the PESTLE analysis.

Political	Economic	Social
<ul style="list-style-type: none"> - The Energy Development Strategy of the Republic of Serbia is basically in favor of biofuel producers. 	<ul style="list-style-type: none"> - Diesel fuel is the most dominant transport fuel in Serbia. - If Directive 2009/28/EC is implemented, Serbia will have a notable domestic biodiesel demand. 	<ul style="list-style-type: none"> - There is some media coverage on the topic.
Technological	Legal	Environmental
<ul style="list-style-type: none"> - Serbia has the potential to produce sufficient amounts of domestic biodiesel feedstock; - Domestic oilseeds are adequate as biodiesel feedstock 	<ul style="list-style-type: none"> - Biodiesel on the market must be in accordance with the SRPS EN 14214:2019 standard; - In general, property rights are respected <p>Adjudication of disputes is slow.</p>	<ul style="list-style-type: none"> - The disappearance of agricultural land should not significantly affect the potential for biodiesel feedstock production.

Overall, based on the positive findings, it can be concluded that all the basic technological preconditions for the production of biodiesel in significant quantities for the Serbian market have been met. Serbia has the potential to produce sufficient amount of domestic biodiesel along with the feedstock for its production. The production technology has been well developed, tested in practice and it has already been confirmed that it meets the criteria imposed by regulations and standards.

Table 3. Negative key findings of the PESTLE analysis

Political	Economic	Social
<ul style="list-style-type: none"> - Unstable political situation in the country; - Lack of democracy; - Uncertainty in government incentives and aid; - Uncertainty in EU attitudes toward biofuels in the future. 	<ul style="list-style-type: none"> - Volatile crude oil prices with a tendency to fall; - Rising prices of biodiesel feedstock; - Government aid is still necessary; - High excise taxes on biofuels. 	<ul style="list-style-type: none"> - Voluntary purchase of biodiesel can be expected only if its price is competitive to the price of Petrodiesel.
Technological	Legal	
<ul style="list-style-type: none"> - No major breakthroughs in production technology have been reached; - Momentous revenue from glycerol by-product should not be expected. 	<ul style="list-style-type: none"> - Possibility of interference in the work of courts; - Adjudication of disputes is slow; - Directive 2009/28/EC is still not implemented. 	

However, there are several factors that represent significant biodiesel industry investment project risks. Political situation is unstable with not entirely clear progress on the path towards the European integration as well as the full implementation of European Union directives concerning the mandatory use of biofuels. The latter is essential prerequisite for the stability of biodiesel demand. Also, the state of the art of the biodiesel production technology is such that state aid is still necessary in order to make profits, and the recent history of measures of the Government of Serbia has shown that reliance on the state support can be a double-edged sword.

5. Conclusion

This paper presented and discussed several factors that authors assessed as important for the establishment of the biodiesel industry in Serbia. Given the importance of the topic for both economy and European integration of the Republic of Serbia, the factors were classified based on the PESTLE analysis framework in order to make the manuscript findings more receptive to strategic decision makers. Although, some factors may belong to multiple areas of PESTLE framework, or may have some overlap, their classification was not as important as their identification and understanding.

Most importantly, Serbia was found to have the potential to produce sufficient quantities of the domestic biodiesel feedstock as well as to have notable biodiesel demand. That is, if the Directive 2009/28/EC is finally implemented. If that is the case, and if the biodiesel production in Serbia is established, such a model of production for the local consumption will not be unique to Serbia alone. The majority of countries that produce biodiesel also have a vibrant domestic biodiesel market.

However, a final assessment of whether or not to invest in biodiesel production is not be made in this manuscript. Considering pressure from rising prices of oilseeds and volatile crude oil prices, as well as the traditional biodiesel production technologies, the government aid is still necessary in order to make biodiesel production economically justified. Numerous factors concerning not only the external environment but also the internal environment of potential investors and / or producers, impose on each individual investor or / and producer to create their own economic study and assessment. It is necessary to choose between several options and choose the one which would be the most desirable for the company according to its own capabilities and capacities to cope with such uncertain business environment. Furthermore, the conduction of an unbiased objective economic study is questionable given the unstable political situation, history of unpredicted and contradictory moves of the Government of the Republic of Serbia as well as uncertainty in attitudes of European Union on biofuels in general.

Nevertheless, if all these factors were adequately anticipated in the planning phase, hopefully, potential investors and / or producers could take steps to prevent or mitigate negative outcomes.

6. Conflict of interest

We declare that we have no financial and personal relationships with other organizations or persons that can inappropriately influence our work. There is no professional or other personal interest of any nature in any product, service or company that could be interpreted as influencing this manuscript entitled.

7. Literature

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