22-osios jaunųjų mokslininkų konferencijos „Mokslas – Lietuvos ateitis“ teminės konferencijos
TRANSPORTO INŽINERIJA IR VADYBA,
vykusios 2019 m. lapkričio 22-23 d. Vilniuje, straipsnių rinkinys

Proceedings of the 22th Conference for Junior Researchers 'Science – Future of Lithuania'
TRANSPORT ENGINEERING AND MANAGEMENT, 22-23 November 2019, Vilnius, Lithuania

Сборник статей 22-й конференции молодых ученых «Наука – будущее Литвы»
ИНЖЕНЕРИЯ ТРАНСПОРТА И ОРГАНИЗАЦИЯ ПЕРЕВОЗОК, 22-23 ноябрь 2019 г., Вильнюс, Литва

ASSESSMENT OF MICROALGAE BIOFUEL PRODUCTION BY SWOT AND RISKS ANALYSIS

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Abstract. This manuscript is devoted to the biofuels based on microalgae and their efficiency assessment. Methods, that were used: risk-analysis and SWOT-analysis. Also here are the results of conducted risk-analysis and SWOT-analysis of production and use of the biofuels, that contain a microalgae components in their composition. Based on the results, can say about the efficiency of these fuels. Defined indicators are calculated for the introduction and development of this type of biofuels in the countries of Eastern Europe.

Keywords: biofuel, efficiency assessment, microalgae, biomass, risk-analysis, SWOT-analysis.

Introduction

To date, the introduction of alternative motor fuels and the expansion of the raw material base for their production is relevant for the following reasons:

- dependence on imports of oil and petroleum products;
- shortage of cheap energy resources;
- deterioration of the environment due to the processing and use of traditional energy resources;
- the need to ensure sufficient volumes of biofuels, including environmentally friendly and low cost;
- the need to ensure sustainable development, particularly in the transport sector, in line with global trends.

Before the start we define the main objective, object of study and tasks, which we need to perform to get results.

Objective: to evaluate the efficiency of using microalgae for biofuel production.

Object of study: production of biofuels based on microalgae.

Main tasks:

- learn about microalgae as a raw material for production of biofuels;
- to evaluate the life cycle of biofuels based on algae feedstock and make a risk-analysis;
- to evaluate the efficiency of using biofuels from algae raw materials by SWOT-analysis.

In this article were made the risks and SWOT-analysis for the efficiency assessment of production and use of biofuels that contain a microalgae, which is necessary when planning enterprises for the production of biofuels for a comprehensive assessment (economic, environmental, social, etc.). The analysis was done for Eastern European countries.

Microalgae as a biofuel feedstock

Microalgae are aquatic organisms that can consist of even one cell. The content of the chlorophyll makes it possible to produce products by absorbing oxygen in the air and converting it to organic carbon (Brennan and Owende 2010).

Due to the high lipid content, many microalgae species have become raw materials for biofuel production. The fatty acid composition of the lipids of these plants may vary depending on the growing conditions.

Today, use of algae raw materials leads to the production of different types of third-generation biofuels. According to scientists algae processing will allow to obtain different types of fuel from the accumulated biomass, because algae contain more plant matter than biofuels of the first and second generations, which allows to obtain more final products (Fig. 1).

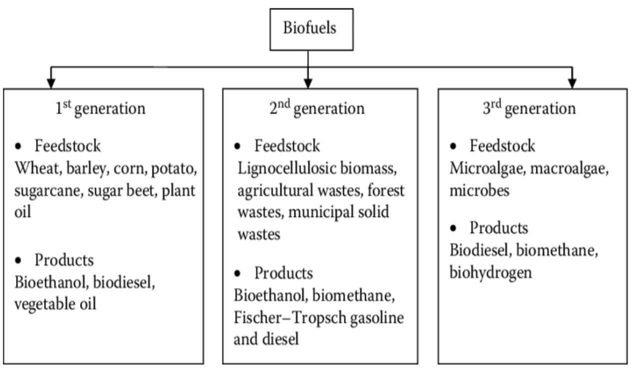

Fig. 1. Generations of biofuels.

One of the key reasons for considering microalgae as biofuel feedstocks is that their cultivation is unlikely to compete with food production, because they can be grown on untreated land, combined with the use of wastewater. Compared to traditional crops, microalgae can produce more energy per unit of land. Compared to higher order plants, where a large proportion of biomass performs structural functions, algae produce mainly organelles responsible for photosynthesis, growth and reproduction (Putt 2007).

Table 1. The main conditions required for the cultivation of microalgae.

Condition of growth of algae	**Impact on the cultivation process**	**Source of receiving**
Proteins, amino acids, fats	Necessary for high performance	Filed in photobioreactors from the outside
CO_2	Affect on the productivity and economic viability of algae	CO_2 supplied from the atmosphere, the excess can be taken in the form of flue gases from power plants
N	Affects the sustainability of biofuels from algae	N also available in the atmosphere, but algae need it in the form of ammonia for nutrient biosynthesis
The intensity of light	Affects the number of cells that have access to radiation	Light is naturally transmitted
Intensity of mixing	In the absence of mixing, cultures that are in the upper layer absorb too much light, and those in the lower layer absorb too little.	Mixing is ensured by technical equipment
pH	pH should be neutral, but it can also pollute the culture	pH is provided through chemical processes

So, microalgae are more efficient converters of solar energy than other plants. As with higher-order plants, microalgae require sunlight, water, CO_2 and nutrients to grow and reproduce. Growing them in a liquid medium where the cell grows in an aqueous suspension allows them to gain better access to nutrients (Pienkos 2007).

Assessment of microalgae biofuel production by SWOT and risks analysis

In general, the introduction of any new technology requires its detailed comprehensive analysis, determination of its profitability, competitiveness, assessment of potential risks that can be identified in the stages of technology implementation and realization (Roebuck 2011). In order to evaluate the efficiency of production and use of biofuels from microalgae, we conducted risk-analysis and SWOT-analysis.

Risk assessment at the biofuel life cycle stages

One of the key steps in the risk analysis process is the identification and classification of risks (Roebuck 2011).

An example of the scheme of life cycle of biodiesel from microalgae is shown in Fig. 2. The main environmental aspects related to the technological cycle of using biofuels from algae feedstock and the potential risks of using this biofuels are listed in the table below (Table 2).

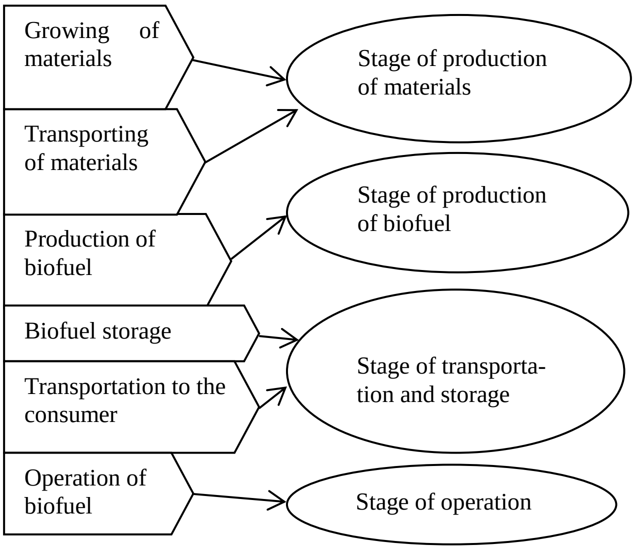

Fig. 2. Life cycle stages of biofuels from algae raw materials.

Table 2. Risk classification according to the stages of the biofuels life cycle.

Stage	**Risks**
1	2
Stage of production of materials	Lack of investment risk
	Climate risk that may impede the growth of algae raw materials
	The risk of lack of clear technology for the collection, processing of raw materials and biodiesel production
	Territorial risk, that is, not enough free space for the location of open-type bioreactors
Stage of production of biofuel	Risk of insufficient technological support in biofuel production
	The risk of a small number of alternative fuels professionals in general
	Risk associated with biofuel infrastructure
Stage of transportation and storage	Transport risks arising from the transportation of biofuels
	Explosion hazard of biofuels
	Risk of change in fuel quality due to prolonged storage
	Risk associated with poor packaging
	The human factor
Stage of operation	Risk of non-compliance with international regulations governing the quality of biodiesel
	Risk of unavailability of diesel engines for the operation of this fuel
	Environmental risks, namely: - pollution of the environment both during refueling and with the help of biofuel combustion products; - the impact of emissions from the use of biodiesel based on microalgae on human and animal health.
	Force majeure risks
	Risks associated with the qualification of filling station personnel

The analysis identified the strengths and weaknesses of the production and use of biofuels based on microalgae. Based on the analysis data, we can determine that the strengths are greater than the weaknesses, so it can be concluded that this type of fuel will be promising and effective in the future.

Potential opportunities for switching to biofuels and the threats that could result from the introduction of this type of fuel were also considered.

Analyzing the situation related to fuel and energy resources, ecology, economy in Eastern European countries, we can conclude that the transition to biofuels from microalgae is very expedient and relevant.

SWOT-analysis of the process of biofuel production from microalgae

SWOT analysis is an abbreviation for strengths, weaknesses, opportunities and threats and is a structured planning method that assesses these four elements of a project or business enterprise (Fig. 3). SWOT analysis can be conducted for a company, product, location, industry or person. It involves defining the purpose of an entrepreneurial activity or project and identifying the internal and external factors that are favorable and unfavorable to that end. The degree of correspondence of the internal environment of the firm to the external environment is expressed by the concept of strategic suitability (Humphrey 2005):

- strengths: characteristics of a business or project that give it an edge over others;
- weaknesses: characteristics that put a business or project at a disadvantage to others;
- opportunities: elements in the environment that a business or project can use to their advantage;
- threats: environmental elements that can cause problems for a business or project.

Identifying SWOTs is important as they can inform the next steps in planning to reach the goal. First, decision makers need to consider whether the goal can be achieved by considering SWOT. If the goal is not achievable, they must choose a different goal and repeat the process (Humphrey 2005).

SWOT analysis users must address issues that generate meaningful information for each category (strengths, weaknesses, opportunities, and threats) in order to make the analysis useful and find their competitive edge.

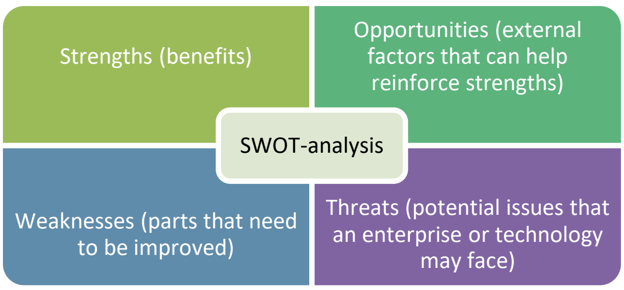

Fig. 3. The main components of SWOT analysis.

Strengths and Opportunities: The potential of biodiesel for diesel engines or biokerosene for jet engines (that is, the positive side) makes full use of the opportunities available (to observe a positive trend).

Strengths and Threats: The positive aspects of biofuels are minimizing existing threats (also a positive trend).

Weaknesses and opportunities: The disadvantages of using biofuels are high costs, but by increasing consumer incomes, competition is able to move to a price-independent sector.

Weaknesses and Threats: High costs exacerbate the use of biofuels when competitors are intensified (negative trend) (Humphrey 2005).

The SWOT method involves identifying project goals and identifying internal and external factors that have a positive effect on goal achievement or, conversely, impede goal achievement. In Table 3 the main strengths, weaknesses, potentials and potential risks of biofuel use in algae raw materials in Eastern European countries are explored in detail.

Table 3. Investigation of biofuels from microalgae by SWOT-analysis.

Strengths	Weaknesses
1	2
Higher productivity of microalgae compared to traditional oilseeds	High cost of microalgae cultivation technology and production of oil for biofuel production in closed-type bioreactors
High energy efficiency per unit of land compared to traditional crops	Insufficient knowledge of technologies for obtaining biodiesel from algae raw materials
Microalgae for biofuel production can be grown in both salt and fresh water	Less energy per unit volume than traditional petroleum fuels
The use of biodiesel from algae feedstocks reduces the likelihood of environmental pollution	At present, there is no interest in the countries and, accordingly, the financing of this technology by the state
No negative impact on ecosystems	Inability to grow algae in open-air bioreactors in the fall and winter due to climatic conditions
Low levels of CO2 emissions when using microalgae based biofuels	Prices for biodiesel from microalgae largely depend on the price of raw materials, which should be further regulated by the state
This biodiesel is less toxic than conventional fuels	Growing raw materials in open bioreactors requires large areas (even if they are unfit for agriculture)
The cultivation of microalgae and the production of biofuels would create new jobs for the population	Lack of qualified personnel in the field of alternative energy
The use of biodiesel from microalgae opens up opportunities for agricultural development and improvement	Lack of regulatory framework in the field of production of biofuels from algae raw materials
Favorable weather conditions for growing algae in open-air bioreactors in warm season	
Microalgae can be grown on unsuitable land for agriculture or in laboratory in small areas	

(continued)

Table 3. *(continued)*

Opportunities	Potential threats
The use of biofuels based on microalgae can contribute to the development of the agronomic sector	Poor state support compared to traditional fuel resources
Reducing the price of biofuels in the process of technology development	Agrarians do not want to risk the area of land that may be involved in the production of microalgae in open bioreactors, since no one can guarantee the profitability of the technology right now
The transition of the country to green biofuels and as a result, the reduction of consumption of traditional fuels	Climate unpredictability, natural disasters, man-made disasters that can affect microalgae cultivation
Improvement of the environment	The market for biofuels, in particular biodiesel, is fairly new and underdeveloped
Delivery of biofuels to other countries is possible	

The SWOT analysis shows that the strengths are greater than the weaknesses and there are more opportunities than threats.

Conclusions

The main task in the work was to determine the efficiency of the use of biofuels from microalgae raw materials, for this purpose a SWOT-analysis was performed, which showed that introduction, production of this type of fuel and its direct use by enterprises in Eastern Europe has more strengths than weaknesses, which speaks about efficiency and extraordinary relevance. Despite the considerable risks associated with the introduction of the new technology of algae cultivation and their further conversion into biofuels, the prospects and opportunities for present are great. The results of the analysis can be used in the design of production, even on an industrial scale. And also can be used for pre-project economic assessment for investors to justify the feasibility of introducing investments in this technology and making profit in the future.

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