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АНАЛІЗ ЄВРОПЕЙСЬКОЇ ПРАКТИКИ У СФЕРІ СЕРТИФІКАЦІЇ АВІАЦІЙНОГО ПАЛИВА

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ANALYSIS OF EUROPEAN PRACTICE IN SPHERE OF JET BIOFUELS CERTIFICATION

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Problem forming

Nowadays modern transport sector is faced to number of problems. One of them is constant growth of prices for fuel, caused by depletion of the world energy resources. Basing on statistical data, deposits of oil are estimated for 40 years, natural gas and coal – 70 and 230 years correspondingly. So resources are being exhausting but their demand is growing [1]. Another side of the problem is ecological situation and contribution of transport to its worsening. Air transport in particular has an impact on the environment both at local (atmospheric and noise pollution) and global (global warming, greenhouse gas emissions) levels. In terms of global pollution, air traffic is responsible for direct and indirect emissions of greenhouse gases: water vapors, carbon dioxide, tropospheric ozone, methane and so on [2]. All these facts have caused a necessity in substitution of conventional jet fuel with alternative one.

Various kinds of biofuels have been proposed as an ecologically benign alternative to fossil fuels. There is, however, considerable uncertainty in the scientific literature about their ecological benefit. Here, we review studies that apply life-cycle analysis (LCA), a computational tool for assessing the efficiency and greenhouse gas (GHG) impact of energy systems, to biofuel feedstocks. Published values for energy efficiency and GHG differ significantly even for an individual species, and we identify three major sources of variation in these LCA results. By providing new information on biogeochemistry and plant physiology, ecologists and plant scientists can increase the accuracy of LCA for biofuel production systems.

Analysis of researches and publications

Alternative fuels, known as non-conventional or advanced fuels, are any materials or substances that can be used as fuels, other than conventional fuels. In a general sense, alternative fuels as they are currently conceived, are those, produced or recovered without the undesirable consequences inherent in fossil fuel use, particularly high carbon dioxide emissions, an important factor in global warming. Conventional fuels include: fossil fuels (petroleum (oil), coal, propane, and natural gas) [2].

Alternative fuels are derived from resources other than petroleum. However, not all alternative fuels can be considered as ecologically friendly. For example, fuels produced from such alternatives as oil shales or oil sands still have negative impact on environment.

One more notion related to environmental safety of fuels in renewable fuels. *Renewable fuels* are socially and politically defined category of fuels that are generally defined as fuels that come from resources which are continually replenished on a human timescale and produced from renewable energy sources.

Biofuels are produced from living organisms or from metabolic by-products (organic or food waste products). Often, they produce less pollution than gasoline or diesel [2, 3].

These fuels are made by a biomass conversion (biomass refers to recently living organisms, most often referring to plants or plant-derived materials). This biomass can be converted to convenient energy containing substances in three different ways: thermal conversion, chemical conversion, and biochemical conversion. This biomass conversion can result in fuel in solid, liquid, or gas form. This new biomass can be used for biofuels. Biofuels have increased in popularity because of rising oil prices and the need for energy security.

During last decades implementation of alternative fuels and biofuels in particular for motor transport became very popular. Comparing to previous years, today in most countries there is a governmental obligation for use of certain share of biofuels. Today the share of biofuels comparing to oil-derived fuels is the USA is 6–7%, Brazil – 15%, China – 2,5%, EU countires up to 5–6%. International Energy Association forecasts that till 2030 world production of biofuels will increase up to 150 mln ton of oil energy equivalent. Annual temps of production growth are about 7 – 9% [3]. Thus, the share of biofuels in total balance of fuel in transport sector will reach 4–6% till 2030. According to other data [4, 5] the share of biofuels in total energy resources balance will be about 10 – 12%.

Only several years ago the question of alternative jet fuels use in aviation has rised. This process was stipulated by such organizations as IATA, ICAO and others.

"Drop-in" biofuels are biofuels that are completely interchangeable with conventional fuels. Deriving "drop-in" jet fuel from bio-based sources is ASTM approved via two routes.

The first route involves using oil which is extracted from plant sources like jatropha, algae, tallows, other waste oils, Babassu and camellina to produce bio-SPK (Bio derived synthetic paraffinic Kerosene) by cracking and hydroprocessing.

The growing of algae to make jet fuel is a promising but still emerging technology. Companies working on algae jet fuel are Solazyme, Honeywell UOP, Solena, Sapphire Energy, Imperium Renewables, and Aquaflow Bionomic Corporation. Universities working on algae jet fuel are Arizona State University and Cranfield University [5].

Major investors for algae based SPK research are Boeing, Honeywell/UOP, Air New Zealand, Continental Airlines, Japan Airlines, and General Electric.

The second route involves processing solid biomass using pyrolysis to produce pyrolysis oil or gasification to produce a syngas which is then processed into FT SPK (Fischer–Tropsch Synthetic Paraffinic Kerosene).

The main challenges to a wide deployment of biojet fuels are not technical, but commercial and political

Currently, biojet fuels are significantly more expensive than Jet A/A1, therefore demand is low and risk is high for investment in production infrastructure. Carefully designed policy is needed to foster investment and development of biojet production capacity.

In the United States combination of incentives according to the Renewable Fuel Standard (RFS) and incentives for agriculture, under the right conditions, can open the possibility of price competitive biojet fuel being available. An example of late 2013 is the United Airlines purchase agreement (reported as price competitive) with AltAir Fuel to purchase 5 million gallons per annum for three years. The European Union, with its Biofuels Flightpath project, has set a target of two million tons per year of aviation biofuels in Europe in 2020, which is about three to four percent of total jet fuel use in Europe. Aireg in Germany has set a target of 10% of alternative aviation fuel for 2025. Indonesia has introduced a biojet fuel mandate of 2% commencing in 2016, rising to 5% by 2025. The most important and known flights executed using various kinds of biofuels are presented in table 1.

A three percent volume blend-in of sustainable second generation biojet fuel yearly worldwide would reduce aviation CO_2 emissions by about two percent, which would be a reduction of over 10 million tons of CO_2. This would require investment of around $10 – 15 billion in production and distribution facilities [1-3].

Purpose

The industry is exploring reliable alternatives to conventional jet fuel that are sustainable and have a smaller carbon footprint. Biofuels are being introduced with the aim of enhancing energy supply and reducing GHG emissions during aircraft operation. The impact on the former is clear, while that on the latter is uncertain. LCA, the preferred method today for estimating the latter, has become an important tool in the design, implementation, and measurement of policy impacts toward biofuels. LCA is a construct that is valuable but prone to misuse and to errors.

Analysis suggests further methodological development such as the inclusion of price effects, dynamics of carbon emissions and technological change, general equilibrium effects, and a distinction between marginal and average effects before it is employed as a decision-making tool by policy makers.

Table 1 World experience in jet biofuels use

Date	Operator	Platform	Biofuel	Details
June 2011	KLM	Boeing 737-800	Processed cooking oil	KLM flew the world's first commercial biofuel flight, carrying 171 passengers from Amsterdam to Paris
July 2011	Lufthansa	Airbus A321	Jatropha, camelina, plant and animal fats	First German commercial biofuel's flight, and the start of 6 month regular series of flights from Hamburg to Frankfurt with one of the two engines use biofuel. It officially end at January 12, 2012 with a flight from Frankfurt to Washington and would not take biofuel further unless the biofuel was more widely produced.
July 2011	Finnair	Airbus A319	Processed cooking oil	The 1,500 km journey between Amsterdam and Helsinki was fuelled with a mix of 50 percent biofuel derived from used cooking oil and 50 percent conventional jet fuel. Finnair says it will conduct at least three weekly Amsterdam-to-Helsinki flights using the biofuel blend in both of the aircraft's engines. Refueling will be done at Amsterdam Airport Schiphol.
March 2013	KLM	Boeing 777-206ER	Processed cooking oil	KLM begins weekly flights by a Boeing 777-200 between JFK Airport in New York City, USA and Amsterdam's Schiphol Airport, Netherlands using Biofuel supplied by SkyNRG.

Policy makers should also consider non-GHG environmental impacts that would result from biofuels which has not received much attention in the LCA literature. Fuel quality standards based on LCA are likely to be more costly than controlling GHG emissions by a carbon tax or a global cap-and-trade scheme.

Main requirements for jet biofuels

The biofuel industry, which produces liquid fuels mostly from grain, sugar, and oil crops, emerged to a large extent in response to the rising price of fuels and the increased dependence on fossil fuel produced in politically unstable regions. The impetus for the production of biofuel is also its supposed contribution to a slowdown of climate change. Theoretically, net emissions of greenhouse gases (GHG) from biofuels may reach zero because the carbon emitted while burning was sequestered during photosynthesis. In reality, however, the production of biofuel requires energy (for fertilizer production, transportation and conversion of feedstock, etc.), and this gives rise to net positive GHG emissions, like other fuels. Thus, the more pertinent question is whether biofuels emit less overall GHG than other fuels. The methodology of life-cycle analysis (LCA) has been used to compare the total energy and the net GHG emissions of various biofuels with that of gasoline or other liquid fossil fuels. Proposed policies suggest relying on LCA to regulate the use of various biofuels. LCA is a systems approach to evaluating the environmental footprint of industrial processes. The goal behind the development of LCA was to quantify the resource and environmental footprint of industrial activities over its entire life cycle from raw material extraction, manufacturing, and use until ultimate disposal. By resource footprint we mean the total physical flow of both extractive resources such as materials, energy, water, etc. and polluting resources like greenhouse gases, criteria air pollutants, toxic chemicals, etc. through the various stages of the life cycle. Studies that use LCA to analyze corn ethanol have come to widely different conclusions about the net GHG benefits. Farrell et al., through a meta-analysis of several earlier LCA studies, conclude that corn ethanol generates 0.8 units of GHG for each unit it saves.

Sustainable jet biofuels allow airlines to reduce their carbon footprint, ease their dependence on fossil fuels, and offset the risks associated with the high volatility of oil and fuel prices.

Biofuels should be made from a wide variety of sustainable, non-food biomass sources such as:

Camellina is an energy crop that grows in rotation with wheat and other cereal crops.

Halophytes thrive in salty regions where little else grows.

Jatropha can be grown on degraded lands and is resistant to drought.

Switch grass grows quickly, needs little water and produces a high yield of biomass.

Used cooking oil can be easily collected and recycled.

Agricultural and forestry by-products yield valuable biomass without requiring dedicated land.

Municipal waste contains biomass and can be diverted from landfills.

Algae are simple, photosynthetic organisms.

Can be grown in polluted or salt water.

Can produce up to 250 times more oil per unit area than soybeans.

Main requirements for sustainable alternative jet fuels:

Can be mixed with conventional jet fuel, can use the same supply infrastructure and do not require adaptation of aircraft or engines (drop-in fuel).

Meet the same specifications as conventional jet fuel, in particular resistance to cold (Jet A: -40˚C, Jet A-1: -47˚C), and high energy content (min 42.8 MJ/kg).

Meet sustainability criteria such as lifecycle carbon reductions, limited fresh water requirements, no competition with food production and no deforestation

Automotive bioethanol and biodiesel are not suitable.

Sustainable aviation biofuels ("biojet fuels") are one of the most promising solutions to meet the industry's ambitious carbon emissions reduction goals.

Lifecycle greenhouse gas emissions from biofuels can be up to 80% lower than traditional jet fuel emissions.

A Sustainable Aviation Fuel (SAF) sustainability certification verifies that the fuel product, mainly focusing on the biomass feedstock, has met criteria focused around long-term global environmental, social and economic "triple-bottom-line" sustainability considerations. Under many carbon emission regulation schemes, such as the European Union Emissions Trading Scheme, a certified SAF product may be granted an exemption from an associated carbon compliance liability cost. This marginally improves the economic competitiveness of environmentally favorable SAF over traditional fossil-based jet fuel. However, in the near term there are several commercialization and regulatory hurdles that are yet to be overcome through the collaboration of a variety of stakeholders for SAF products to meet price parity with traditional jet fuel and to enable widespread uptake.

The first reputable body to launch a sustainable biofuel certification system applicable to SAF was the academic European-based Roundtable on Sustainable Biofuels (RSB) NGO. This multi-stakeholder organization set a global benchmark standard on which the sustainability integrity of advanced aviation biofuel types seeking to use the claim of being a Sustainable Aviation Fuel can be judged. Leading airlines in the aviation industry and other signatories to the Sustainable Aviation Fuel Users Group pledge support the RSB as the preferred provider of SAF certification. These airlines believe it important for any proposed aviation biofuels have independently certified sustainable biofuel long term environmental benefits compared to the status quo in order to ensure their successful uptake and marketability.

Jet Biofuels Certification on Sustainability

The Derective on the promotion of the use of energy from renewable sources (Renewable energy directive – RED), adopted in 2009, was put in place to ensure that all the 27 member states of the European Union achieve specified targets for use of renewable fuels and reduction of greenhouse gas (GHG) emissions across all energy sectors, with specific requirements for the subset of fuels used for transportation [6]. A companion directive, the Fuel Quality Directive (FQD), has additional, complementary requirements for GHG reductions within the transport sector [7]. These directives place certain obligations on EU member states, but also create certain requirements with which developers or producers of renewable fuels must comply in order for their fuels to qualify as "renewable" under the regulations.

The Renewable Energy Directive sets targets for the use of renewable fuels which member states must meet, by enacting national laws consistent with the Directive. These targets are as follows:

Derive 20% of overall energy consumption, across all sectors, from renewable sources by 2020.

Derive 10% of energy consumption within the transport sector from renewable sources by 2020.

Achieve greenhouse gas emission reductions of at least 35%, relative to fossil fuels, by mid-2010, with this target rising to 50% in 2017 and 60% in 2018, for fuels produced in 2017 or later. However, fuel production plants that were in operation as of January 2008 had until April 2013 to meet the 35% GHG reduction requirement.

The Fuel Quality Directive (FQD), formally known as Directive 2009/30/EC of the European Parliament and of the Council, and which amended Directive 98/70/EC, was also adopted on April 23, 2009. It establishes the specifications (standards) for transportation fuels to be used across the EU. The Directive also requires that all fuel suppliers (e.g. oil companies) must meet a 6% reduction of GHG emissions by 2020, relative to 2010 baseline levels, across all fuel categories. This reduction in emissions could be achieved using any low-carbon fuel options, such as hydrogen or electricity, but it is generally expected that the use of biofuels will account for most of the targeted reductions. The target of 6% is designed to be consistent with the use of 10% biofuel with an average 60% carbon saving to comply with the Renewable Energy Directive, as described above. The FQD also establishes that ethanol may be blended into gasoline (petrol) up to a limit of 10% v/v, although this is subject to national laws in the member states.

More importantly, renewable fuels must be produced sustainably: that is, in order for a fuel to be considered as "renewable" under the RED, it must be analyzed and certified to be in compliance with sustainability criteria established in the Directive. The required sustainability analysis incorporates, but goes well beyond, considerations addressed in typical LCAs [8]. There are twelve different factors which must be considered in these analyses, including Local Food Security, Human and Labor Rights, Rural and Social Development, and others including lifecycle GHG emissions. The requirements to conduct these analyses are quite complicated, and for this reason the EU has established a requirement that any proposed scheme or methodology for conducting sustainability analyses under the RED must be certified by the EU before any fuel provider can rely on such a scheme to establish its eligibility. Figure 1 represents the basic scheme for biofuels certification in European Union.

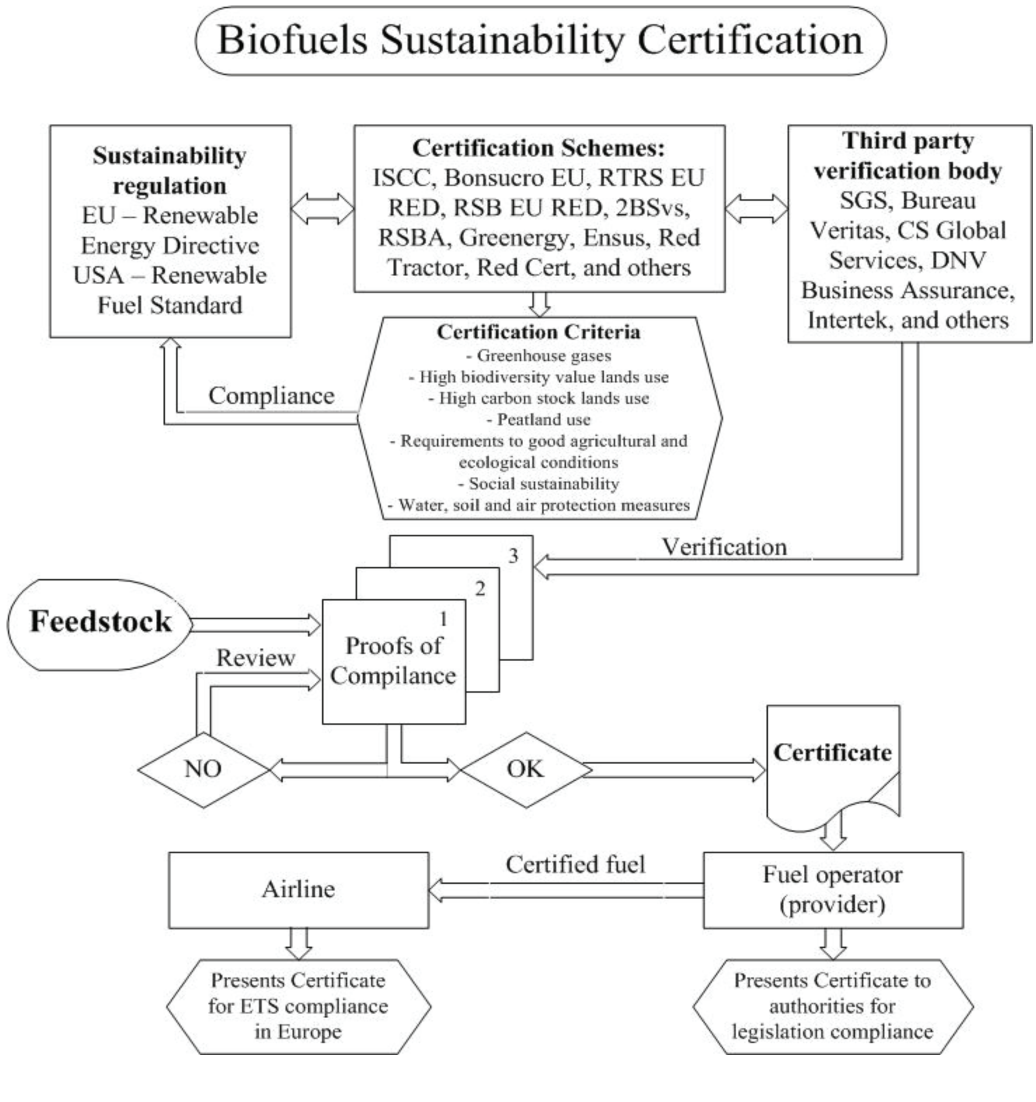

Fig. 1. Biofuels sustainability certification scheme

Companies that are producing fuels that are included within the "look-up table" within the RED can rely on the carbon intensities specified in the regulations. However, companies developing a new pathway must not only conduct an LCA to establish the carbon intensity but must also have the fuel pathway certified as sustainable. Because the EU sustainability criteria go beyond technical issues and encompass social issues, this imposes a requirement that is broader in scope than what is required in the U.S under the Renewable Fuel Standard (for example), and so this may be somewhat burdensome to biofuel producers, especially smaller, newer companies. However, several companies have announced successful completion of these requirements. To give two recent examples:

Agro2 S.A., located in Veraguas, Panama, says it is the first company in Panama to be certified under the EU's Renewable Energy Directive by the International Sustainability and Carbon Certification. This certification confirms the compliance of Agro2's production and processing of ethanol using a cassava feedstock with the sustainability criteria set out in the EU RED.

Argos Oil has become the first European company to introduce sustainable certified sugarcane ethanol into the European market. The certification was granted by Bonsucro, one of the international organizations whose sustainability criteria meet the requirements of the EU Renewable Fuels Directive. The Solaridad network, a specialized organization for sustainable development, assisted in obtaining this certification.

The adoption of the RED seems to have stimulated the growth of the biofuel industry in Europe, although it seems likely that biofuel use is not growing as rapidly as might be needed to meet the directive's goals for later this decade. Although the comprehensive sustainability analysis required under the directive would seem to be a deterrent for companies wishing to enter the EU market with renewable fuels, there is ample evidence that many companies, large and small, have taken the steps to have their products certified under one of the approved schemes mentioned above [8, 9].

Quantifying how biofuels reduce GHG emissions and how energy efficient they are requires a life-cycle analysis (LCA). This holistic approach ideally takes full account of all stages of the production and use of a biofuel, including the GHG emissions and energy efficiencies associated with the resources required for its production.

As a rule of thumb, the life-cycle energy balance improves and global warming potential decreases when cultivation is less intensive, particularly with less fertilizer and less irrigation, and if the end product is straight vegetable oil rather than biodiesel. The energy-efficient use of the by-products also significantly improves the sustainability and environmental impact of biofuels.

Life-cycle-assessments (LCA) of biofuels show a wide range of net greenhouse gas balances compared to fossil fuels, depending on the feedstock and conversion technology, but also on other factors, including methodological assumptions[10]. For ethanol, the highest GHG savings are recorded for sugar cane (70% to more than 100%), whereas corn can save up to 60% but may also cause 5% more GHG emissions. The highest variations are observed for biodiesel from palm oil and soya. High savings of the former depend on high yields, those of the latter on credits of by-products. Negative GHG savings, i.e. increased emissions, may result in particular when production takes place on converted natural land and the associated mobilisation of carbon stocks is accounted for. Land conversion for biofuel crops can lead to negative environmental impacts including implications such as reduced biodiversity and increased GHG emissions.

Efforts to find sustainable, renewable sources of energy are growing and at the center of that trend is the switch from fossil fuels to crop-based biofuels. However, there are big differences. While corn-derived ethanol is among the least efficient, most environmentally damaging, and overall least sustainable biofuel feedstock, in comparison earns green credentials and can be grown on marginal land without replacing food crops.

Environmental impacts of the production system are divided between biofuel and by-products according to their energy content or heir economic value. Moreover, the results when no allocation is made are presented, i.e. when the whole environmental impact is allocated to the biofuel. One advantage of energy allocation is that this method is constant over time. Within the RED of the EU a decision is made that energy allocation is to be used when calculating the environmental performances of biofuel. In the calculation methodology being developed in the Renewable Energy Directive of the EU, it is, as previously mentioned, proposed that carbon stock changes due to changes in cultivation systems are to be included, i.e. direct land use effects, where relevant. This proposal is in turn based on the current international research on LCA of biofuels that describes the need to consider this aspect. In addition, biogenic emissions of nitrous oxide are to be included independently of land use reference as these emissions are usually calculated on the basis of the amount of nitrogen fertilizer applied. Hence the results of the present study are also presented using this methodology. This assessment, however, is marred by uncertainties and is mainly to be seen as an attempt to minimize the risk of underestimating the effects of direct land changes. Another uncertainty is the large variation in the size of the carbon losses from grasslands, which amongother things, depend on how long the ground has been grass-covered. Carbon stock changes are slow processes that may proceed for 30-50 years before new states of equilibrium are reached.

The environmental impact categories considered are:

1) the greenhouse effect (Global Warming Potential, GWP);

2) eutrophication potential (EP);

3) acidification potential (AP);

4) formation of photochemical oxidants (Photochemical Oxidant Creation Potential, POPC);

5) particulates;

6) energy balance.

In particular, the greenhouse gas balance and eutrophication potential are investigated, as shown in extra detail in the Appendix, since these two environmental effects are considered to be the most critical for biofuels today.

LCA during production of alternative jet fuels

Various kinds of alternative jet fuels had appeared during recent years. Among them are: derived from unconventional oil resources such as oil sands and oil-shales, derived synthetically from natural gas, coal, or biomass via the FT-process, derived from renewable oils (biodiesel, biokerosene, hydroprocessed renewable jet – HRJ or Hydrotreated Vegetable Oil – HVO).

However, emissions from the jet engine are not the only environmental concern connected to aviation industry activity. The whole life-cycle of the fuels must be studied. This variety of alternative jet fuels developed nowadays requires complex multiple analysis that comprises raw material limitation, impact on environment and human health, energy safety, trends and dynamics of price formation.

When considering biofuels, issues such as land use, fertilizer use, water for irrigation, waste products etc. must be addressed. This type of analysis is called “cradle to grave” or “life cycle assessment” and must be conducted for every kind of new fuel before its industrial production. Similarly, with use of coal or shale, there are issues with mining, both deep-hole and strip mining, water use, run-off from mine sites, and waste material utilization. Processes of oil-shales refining and fuel manufacturing usually require considerably larger energy inputs than during crude oil refining, and consequently emissions of greenhouse gases are also more significant. Moreover, formation of greenhouse gases is influenced by factors such as construction of installation for oil-shale refining, use of electric power for installation heating, way of energy receipt, value and quality of by-products, availability of device for CO_2 and other gases catching. During process of synthetic jet fuel production from gas, volume of discharged greenhouse gases is in 1,8 times and from coal is in 2 – 2,4 times higher than resulting from oil refining. Thus any processing of raw material into finished fuel is energy intensive, resulting in emissions of carbon dioxide, a significant greenhouse gas. In contrast, growth of biomass removes carbon dioxide from the atmosphere so use of biomass-derived fuel in place of fossil-derived fuel can potentially result in a net decrease in carbon dioxide emissions.

Today a great variety of technologies and raw material for alternative jet fuels production are available. In the final analysis any of these fuels should possess the following characteristics:

worldwide distribution on account of intercontinental flights;

the compatibility of alternative fuels with existing engines with no need to make significant changes to the engine or aircraft construction;

alternative fuels must provide both environmental and exploitation safety at all stages of its life cycle.

Conclusions

Assessment of the sustainability of biofuels is challenged by the varied perspectives of diverse disciplines that contribute to biofuel research. Although LCA is a holistic approach to biofuel energy systems, much of the LCA work published so far has been isolated from the plant science and ecology communities, whose members study processes, such as the biogeochemical cycles of carbon, nitrogen and water, that underlie the sustainability of biofuel crops. The literature that reports environmental and energy benefits of biofuels is controversial owing to the lack of adherence to proposed LCA standards, and these standards are not well informed by ecological theory. Most LCA results for perennial and ligno-cellulosic crops conclude that biofuels can supplement anthropogenic energy demands and mitigate GHG emissions to the atmosphere. Wide-ranging estimates of biofuel GHG balances can be refined by identifying plant-mediated processes that should be included in LCA. Nutrient cycling and pollution mitigation, processes controlled by ecological systems, are currently not well integrated into LCA studies. A clear assessment of the environmental consequences of producing biofuels is essential for determining their sustainability relative to fossil fuels. Standardized and equally holistic assessments of biofuel and fossil fuel production systems must be made to acquire a scientific consensus about the benefits of biofuels. Of the studies reviewed here, the most complete side-by-side LCA of biofuel production relative to fossil fuel production resulted in the largest estimated reduction of GHG with biofuels.

Plant scientists and ecologists must place new discoveries of genetically modified biofuel crop species and their interactions with climate, soil and microbial communities in the context of clearly defined spatial and temporal boundaries. Furthermore, these discoveries must be communicated in a common terminology to engineers, economists and policy-makers who work on other aspects of the biofuel production system. Biogeochemical processes that are mediated by biofuel crops must be fully integrated with the economic costs and benefits of the biofuel production chain and compared with parallel holistic descriptions of the fossil fuel production chain. Second-generation biofuels hold great promise for supplementing the energy supply, but the ecological and environmental consequences of increasing our use of biofuels will not be fully understood without a transparent and standardized approach to LCA, based on new collaborations among ecologists, economists.

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РЕФЕРАТ

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Проаналізовано досвід європейських країн у сфері сертифікації авіаційного біопалива. Детальний аналіз інформації свідчить про те, що сировиною для виробництва авіаційного біопалива може стати велике різноманіття біомаси, але лише стійкої. Основною метою застосування авіаційних біопалив є зниження викидів вуглекислого газу на 80% у порівнянні з використанням традиційних авіаційних палив. Сьогодні низка авіакомпаній вже розпочала практику застосування біопалив для повітряно-реактивних двигунів під час регулярних рейсів. У статті подано інформацію про компанії, що вже досягли успіху у даному напрямі. Проте, перед застосуванням в авіації біопалива повинні відповідати низці певних вимог. З метою уніфікації цих вимог урядом Європейського Союзу було прийнято Директиву про відновлювану енергетику, що детально розглянута у даній статті. Крім того, інша Директива - про якість палива, також стосується обговорюваного питання. У статті представлено детальний огляд зазначених документів. Іншим питанням, що обговорюється в даній роботі є практика європейських країн з сертифікації біопалива на його стійкість. Описано діючу схему сертифікації авіаційних біопалив на стійкість, а також діяльність провідних компаній, що уповноважені виконувати сертифікаційні роботи такого роду. У статті приділено увагу критеріям, відповідність яким контролюється під час сертифікації біопалив. Серед них викиди парникових газів, використання земель з високим біорізноманіттям, використання торфових земель, соціальна стійкість, заходи з охорони атмосферного повітря, водних та земельних ресурсів. Ще одним питанням, розглянутим у статті є оцінка життєвого циклу біопалив. Оцінка життєвого циклу є інструментом для аналізу зниження об'ємів викидів парникових газів за використання біопалив у порівнянні з традиційними авіаційними паливами. Іншими словами вона використовується як методологія для оцінки ефективності використання біопалив. Результати оцінки життєвого циклу альтернативних палив показали, що палива отримані з відновлюваної сировини спричиняють менший негативний вплив на навколишнє природне середовище у порівнянні з традиційними викопними паливами. У статті коротко описано основні найбільш розроблені та популярні технології виробництва альтернативних авіаційних палив (як з відновлюваної та і не відновлюваної сировини). Проте, не зважаючи на те, яка сировина використовується у процесах виробництва, існує низка загальних вимог, яким мають відповідати палива для повітряно-реактивних двигунів. Ці вимоги передбачають певні фізико-хімічні та експлуатаційні властивості, якими мають володіти палива. Зазначені властивості розглянуто у статті та наголошено на обов'язковості дотримання вимог щодо якості палива. У першу чергу це пояснюється тим, що якість авіаційного палива відіграє одну з ключових ролей у забезпеченні надійності повітряних суден та безпеки польотів.

КЛЮЧОВІ СЛОВА: АВІАЦІЙНІ БІОПАЛИВА, АЛЬТЕРНАТИВНІ АВІАЦІЙНІ БІОПАЛИВА, БІОПАЛИВА, ЖИТТЄВИЙ ЦИКЛ, АНАЛІЗ ЖИТТЄВОГО ЦИКЛУ

ABSTRACT

Iakovlieva A.V., Lejda K., Boichenko S.V., Vovk O.O. Analysis of European practice in sphere of jet biofuels certification. Visnyk National Transport University. Scientific and Technical Collection: In Part 2. Part 1: Series «Technical sciences». – Kyiv: National Transport University, 2014. – Issue 30.

Analysis of European experience in the spehere of aviation biofuels certification is presented in the article. Detailed analysis of the material shows that feedstock for aviation biofuel production can be obtained from a great diversity of biomass, but it should be sustainable obligatory. The main purpose of aviation biofuels application is aimed on reduction of carbon dioxide emissions 80 % lower comparing to the use of conventional jet fuel. Today, number of airlines has already started practicing jet biofuels during their regular flights. The list of companies succeeded in this experience is given in the article. However, before application in aviation, biofuels need to meet a set of requirements. In order to unify these requirements EU authorities introduced the Renewable energy directive (RED) that is considered in the article. One more directive – about fuel quality (FQD) is also related to this topic. The article gives detailed overview of these directives. Another issue presented in the article is sustainability certification of biofuels in EU. The current scheme of certification of aviation biofuels sustainability is described along with the activity of leading companies executing such kind of certification. The article pays attention on the criteria that should be met during biofuels certification. Among them are: greenhouse gases, high biodiversity value lands use, high carbon, stock lands use, peatland use, requirements to good agricultural and ecological conditions, social sustainability, water, soil and air protection measures. One more issue considered in this work is life-cycle assessment (LCA) of biofuels. Life-cycle assessment is used as a tool for estimation greenhouse gases emissions reduction using biofuels comparing to traditional jet fuels. Other words it is used as a methodology for biofuels efficiency estimation. Results of life-cycle assessment of various kinds of alternative fuels have shown that fuels obtained from renewable feedstock have less negative impact on environment comparing to conventional fossil fuels. The article describes briefly the most developed and popular technologies of alternative jet fuel production (including both from renewable and non renewable feedstock). However, despite the type of resource used, there is a set of general requirements that jet fuels should meet. These requirements foresee certain physical-chemical and exploitation properties, which fuels should posses. The requirements are described in the article and should be satisfied obligatory. First of all it is explained by that fact that jet fuels quality plays an exclusively important role in provision of flight safety and aircraft reliability.

KEYWORDS: JET BIOFUELS, ALTERNATIVE JET FUELS, BIOFUELS, LIFE-CYCLE, LIFE-CYCLE ANALYSIS, CERTIFICATION

РЕФЕРАТ

А.В. Яковлєва. Анализ европейской практики в сфере сертификации авиационных биотоплив / Яковлєва А.В., Лейда К., Бойченко С.В., Вовк О.А. // Вестник Национального транспортного университета. Научно-технический сборник: в 2 ч. Ч. 1: Серия «Технические науки». – К. : НТУ, 2014. – Вып. 30.

Проанализирован опыт европейских стран в сфере сертификации авиационного биотоплива. Детальный анализ информации свидетельствует о том, что сырьем для производства авиационного биотоплива может стать большое разнообразие биомассы , но исключительно устойчивой. Основной целью применения авиационных біотоплив является снижение выбросов углекислого газа на 80% по сравнению с применением традиционных авиационных топлив. Сегодня ряд авиакомпаний уже начал практику применения биотоплив для воздушно-реактивных двигателей во время осуществления регулярных рейсов. В статье приведена информация о компаниях, которые уже достигли успехов в данном направлении. Однако, перед применением в авиации биотоплива должны соответствовать ряду определенных требований. С целью унификации этих требований властями Европейского Союза было принято Директиву о возобновляемой енергетике, которую подробно рассмотрено в данной статье. Кроме того, другая Директива – окачестве топлива, также касается обсуждаемого вопроса. В статье представлено подробный обзор указанных документов. Другим вопросом, который обсуждается в данной работе является практика европейских стран по сертификации биопалива на его устойчивость. Описано действующую схему сертификации авиационных биотоплив на устойчивость, а также деятельность ведущих компаний, которые уполномочены осуществлять сертификационные работы такого рода. В статье уделяется внимение критериям, соответствие которым контролируется во время сертификации биотоплив. Среди них выбросы парниковых газов, использование земель с высоким биоразнообразием, использование торфовых земель, социальная устойчивость, средства по защите атмосферного воздуха, водных и земельных ресурсов. Еще одним вопросом, рассмотренным в статье является оценка жизненного цикла биотоплив. Оценка жиненного цикла является инструментом для анализа снижения объемов выбросов парниковых газов в случае применения биотоплив по сравнению с традиционными авиационными топливами. Другими словами она используется как методология для оценки эффективности применения биотоплив. Результаты оценки жизненного цикла альтернативных топлив показали, что топлива полученные из возобновляемого сырья причиняют меншее негативного воздействия на окружающую природную среду по сравнению с традиционными ископаемыми топливами. В статье коротко описано основные наиболее разработанные и популярные технологии производства альтернативных авиационных топлив (как из возобновляемого так и невозобновляемого сырья). Однако, не смотря на то, какое сырье применяется в процессах производства, существует ряд общих требований, которым должны отвечать топлива для воздушно-реактивных двигателей. Эти требования предусматривают определенные физико-химические и эксплуатационные свойства, которыми должны владеть топлива. Указанные свойства рассмотрено в статье и указано на обязательность соблюдения требований относительно качества топлива. В первую очередь это объясняется тем, что качество авиационного топлива играет одну из ключевивы ролей в обеспечении надежности работы воздушных суден и безопасности полетов.

КЛЮЧЕВЫЕ СЛОВА: АВИАЦИОННЫЕ БИОТОПЛИВА, АЛЬТЕРНАТИВНЫЕ АВИАЦИОННЫЕ БИОТОПЛИВА, БИОТОПЛИВА, ЖИЗНЕННЫЙ ЦИКЛ, АНАЛИЗ ЖЕЗНЕННОГО ЦИКЛА

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