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ON THE PATH TO RENEWABLE FUELS IN ROAD TRANSPORT

Summary. Experiencing continuous growth in motorization, transport energy needs are still mainly covered by fossil fuels. Fossil fuels are expected to remain the dominant transport fuel in the coming years and thus must be offset by introducing renewable fuels in the transport sector. It has been well established that decarbonizing the transport sector is likely to be more challenging than for other sectors, given the continuing growth in global demand, and the rapid increase in demand for faster transport modes in emerging economies [1]. The starting efforts in Macedonia referring introduction, production and usage of renewable fuels should be recognized. Also, it should be underlined that additional activities are needed in order to achieve the goal of 10% participation of biofuels in transport until 2020. Recommendations given in this analysis comprises concerted actions and proposes innovative practices, with a potential to accelerate and expand the use of renewable fuels in our transport sector.

1. INTRODUCTION

Transport fuel supply in road sector is dominated by oil, with reserves that are expected to last around 40 years [2]. Road transport alone now accounts for 25% of Europe's total GHG emissions and will become its largest source of emissions unless remedial action is taken [3]. The EU objective is an overall reduction of CO₂ emissions of 80-95% by the year 2050, with respect to the 1990 level. Decarbonisation of transport and the substitution of oil as transport fuel therefore have both the same time horizon of 2050. Energy efficiency, transport efficiency, and effective transport demand management, can substantially contribute to reduce emissions. But the ultimate solution to near full decarbonisation of transport is the substitution of fossil sources by CO₂-neutral alternative fuels for transport [2].

It is expected that alternative fuels will play a more and more prominent role in the decade to come in view of the EU objectives of gradually substituting fossil fuels with fuels of renewable origin, growth and jobs, competitiveness, transport decarbonisation and the diversification of the energy sources [4].

Republic of Macedonia has obligation to provide 10% participation of renewable fuels in transport until 2020. For our specific financial, infrastructural and agricultural conditions, referring production potential, renewable fuels in road transport comprise only biofuels (e.g., biodiesel). So far, the results in introduction and usage of this renewable fuel in road transport are modest, although biodiesel is produced in our country and put on the market since 2007. Hence, the fossil fuel are dominating energy source in road transport. At the moment, the most used alternative fuel is LPG; recently, CNG is introduced to the market as well, but the number of fuelling stations and vehicles on CNG is low. However, these beginnings in renewable fuels options in road transport should not to be neglected. Therefore, the aim of this paper is analyzing the current situation with renewable fuels to propose important recommendations, whose implementation will speed up and wider the use of these fuels in road transport.

2. POTENTIAL OF RENEWABLE FUELS FOR SUSTAINABILITY IN TRANSPORT

The EU transport heavily depends on oil products; for example, only in 2012 for the energy needs, about 94% were reached (fig. 1). Europe imports around 86% of its crude oil and oil products from abroad, with a bill up to EUR 1 billion per day [4].

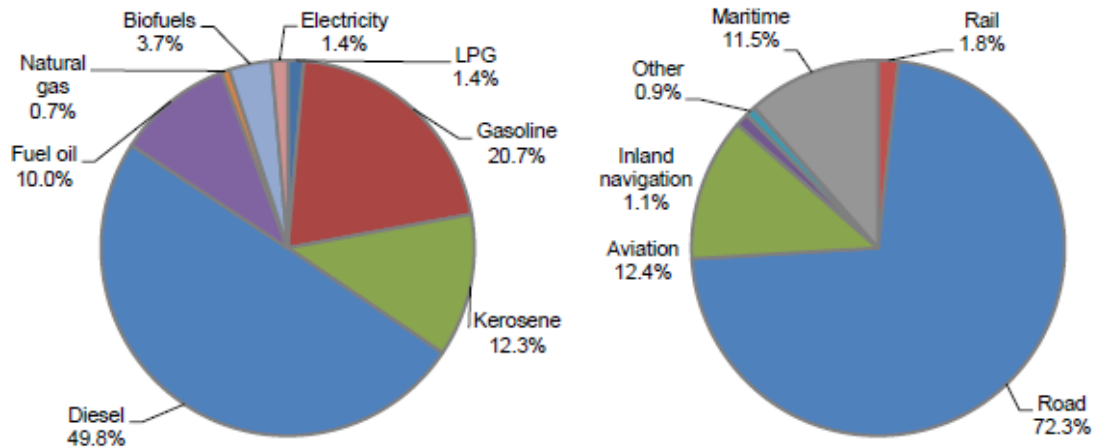


Fig. 1. Fuel consumption in transport in Europe
Source: [4]

Strong efforts would be required to drastically reduce the oil dependency and the greenhouse gas (GHG) emissions in the transport sector, in line with the goals put forward in the 2011 White Paper on Transport, i.e. a 20% reduction in the GHG emissions by 2030 relative to 2008 levels and a 60% reduction by 2050 relative to 1990 levels [4]. In the long term, most fuels would need to be of non-fossil origin in order to secure a reduction in GHG emissions.

In the past, the adoption of renewables in transport has been hampered by a number of barriers. These include high costs, misconceptions about the sustainability of biofuels and a lack of supporting policies in many countries [5].

However, the policy support that has been in place over the past decade and the gradual commercialization of advanced biofuels (e.g. from biomass crops or waste) mean there is a realistic prospect that renewable solutions could be competitive with incumbent technologies and fuels by 2020, as long as policy support for deployment is reinforced and expanded [5].

Production and usage of biofuels are receiving strategic significance in the national economies, because of the positive effects that biofuels have in several areas (agriculture, energy production, environmental protection, economic issues). The main advantage is decrease of the dependence of imported fossil fuels. Overall, biofuels have significant contribution to sustainability (fig. 2).

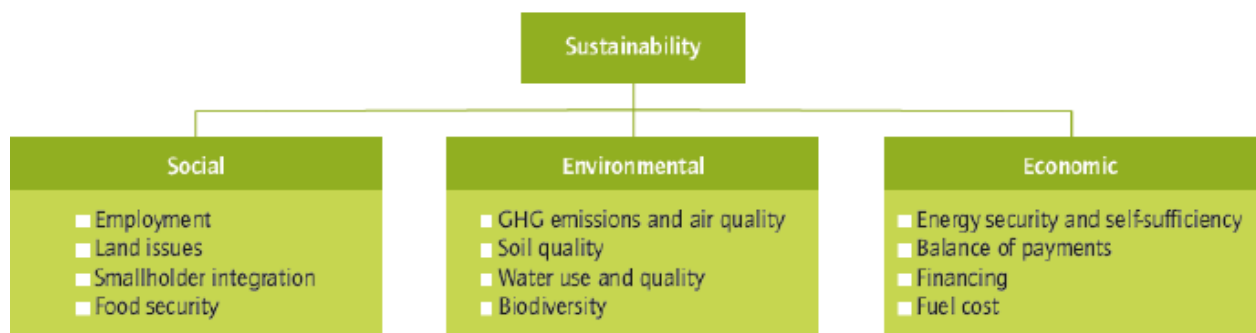


Fig. 2. Sustainability in biofuels production
Source: [6]

Macedonia is a country without fossil fuel sources. Therefore, production and usage of renewable fuels, e.g., biofuels, is a possible solution for integration of energy factors, environmental protection and social economy. Producing and using renewable fuels will have positive impact on sustainability not just in transport sector, but in society, environment and state economy.

3. CURRENT PRACTICES AND PROJECTIONS OF RENEWABLE FUELS IN MACEDONIA

Next, the analysis focuses on renewable fuel presented in Macedonia, e.g., biodiesel. Considering that the other renewable fuels aren't presented at the market in the moment (such as alcoholic fuels and hydrogen), and in order to define the future prospects of biodiesel, the analysis includes two alternative fuels (LPG and CNG) used in our transport sector, just for the purpose of comparison.

3.1. Biodiesel

Biodiesel production at the moment is performed in two ways:

1. as an industrial product for commercial use; here, as a resource, an unrefined oil from beet seed is used (producer Makpetrol AD, with a production capacity of 20 000 tones/year); in this stage, the unrefined oil is imported
2. domestically obtained product from used cooking oil (from the restaurants) and its processing in biofuel.

The first factory for biodiesel production in the Republic of Macedonia has been opened since 2007. The owner of the refinery is private company Makpetrol AD. Another factory for biodiesel production is planned in Veles, for oil extraction from sunflower, beet and soy, with a raw processing capacity of 20 000 tones/year and production of 13 000 tones of biodiesel [7].

Makpetrol has introduced biodiesel on Macedonian market for liquid transport fuels, with a vision to create a new, bioenergetic platform with adopted standards for production, distribution and quality of biofuel [8].

Production of biodiesel B100, i.e., clean biodiesel, Makpetrol performs in its own factory, with a standard technology of trans-esterification of beet seeds. The produced biodiesel fulfils the technical European standard MKS EN 14214, which allows blending with fossil diesel according to the standard MKS EN 590 [8]. For quality maintenance of biodiesel, an independent licensed laboratory of Makpetrol is responsible.

Also, B100 biodiesel produced in Makpetrol is exported in the neighboring countries, because of its quality [8]. At the same time, on the basis on the license received from the Regulatory commission for energetic, Makpetrol offers B6 biodiesel, which is a blend of 6% biodiesel and 94% fossil diesel.

3.2. Liquid petroleum gas - LPG

LPG is a mix of propane and butane and is an economical and environmental friendly fuel. As a low-carbon fossil fuel, LPG is more used in the vehicles in Macedonia. In 2014 the number of vehicles on LPG was 11 828, of which 10 976 are passenger cars [9].

The reason for usage of LPG is mainly economical – the price of LPG is almost 50% lower compared with the gasoline [9]. Vehicle manufacturers are following the development of gasoline engines, hence the technology in the moment offers efficacious and safe solutions for conversion (gasoline engine to LPG engine).

3.3. Compressed natural gas - CNG

Compressed natural gas is suitable as a more economical and cleaner substitute compared with other fuels, and could be used in passenger cars, light and heavy duty vehicles. This fuel is offered at 4 fuel stations owned by Makpetrol AD. One of these stations is located in the public transport company

in Macedonian capital city Skopje, intended for fueling of city buses. The maximal capacity of this station is around 100 buses for the period of 7-8 hours [10].

Unfortunately, although the usage of CNG is environmentally most clean, the number of vehicles in Macedonia is very small (unofficially, around 200 vehicles). The State statistical office doesn't have any data about the number of vehicles on CNG, but it could be assumed that the number is low, considering the limited number of fuel stations and limited possibility for engine conversion.

3.4. Strategy for renewable fuels, i.e., biofuels, in Macedonia

Until 2020, every member state of EU must fulfill the obligation of at least 10% participation of renewable energy (mainly biofuels) in the transport sector. This has been imposed from several reasons [11]:

1. transport sector has the most rapid increase of greenhouse gases, compared with the other economy sectors
2. biofuels comprise the problem with fossil fuel dependency, which is one of the most serious problems in energy supply in the EU.

Hence, the Directive sets a system that will guarantee the sustainability in the environment through achievement of maximal level of decrease of greenhouse gases.

In Macedonia, biofuels consumption until 2020 is planned at the level of 10% of transport consumption, i.e., 48-56 ktoe/year, which is leveled with the planned production capacities [11]. These amounts of biofuels would replace the proper amounts of diesel and gasoline consumption in transport.

Tab. 1

Prognosis of the biofuel consumption in transport in Macedonia to 2020 (ktoe/year)

	Scenario as usual					Scenario of decelerated growth				
	Gasoline [ktoe]	Diesel [ktoe]	Total [ktoe]	Biofuel [%]	Biofuel [ktoe]	Gasoline [ktoe]	Diesel [ktoe]	Total [ktoe]	Biofuel [%]	Biofuel [ktoe]
2015	156	299	455	7	32	131	252	383	7	7
2016	163	319	482	8	39	138	271	408	8	33
2017	169	340	509	8.5	43	144	290	433	8.5	37
2018	175	361	536	9	48	150	309	459	9	41
2019	182	382	563	9.2	52	156	328	484	9.2	44
2020	188	403	591	9.5	56	162	347	508	9.5	48

Source: [11]

Participation of biofuels until 2030 is assessed to the amount of at least 20% in total gasoline and diesel consumption, i.e., 145-163 ktoe [11].

Further, the EU proposes that 60% of the fuel is produced from food resources, and the rest of 40% from other resources. This obligation is not included in the Directive 2009/28/EC, but it is stressed that proper measures for promotion of the criteria for sustainability of biomass production, as well as measures for development of the second and third generation of biofuels should be undertaken.

Biomass production needed for biofuels, will be supported for the purpose of the growth of the total agricultural production and usage of degraded land [11]. Furthermore, a biofuel production from waste and non-food cellulose materials will be stimulated.

The technologies for production of this second generation biofuel are in the process of development; however, the terms for their usage in Macedonia should be developed as well. Namely, from the total biomass produced from agricultural lands, 40% must be returned to the soil, 30% to be used for animal feed and for the farm purposes, and the rest of 30% could be used for biofuel production.

Provision of the biomass for biofuel production is not completely studied. Therefore, additional studies and stimulation measures, especially for raw production, are needed. Considering that Directive allows import of the biofuels, the most significant should be their stimulation and usage [11].

4. RECOMMENDATIONS FOR SUPPORT OF THE RENEWABLE FUELS IN MACEDONIA

In order to achieve the goal of 10% participation of renewable fuels in transport, clearly defined measures for stimulation of the usage of biofuel blends without significant increase of the prices are needed. This could be realized for example, by decreasing the taxes for the biofuels (which is already a practice in some EU member state) and by increasing the taxes for oil derivatives which aren't used in transport. Considering that biofuels have relatively small participation in the total fuel consumption in transport, especially in the first years, the combination of these two measures would have insignificant influence on the fuel prices and on the budget in Macedonia [11].

The following main recommendations towards substitution of oil as transport fuel with renewables should be taken into consideration [2]:

- assessment of the market potential, technological issues, economic viability, industrial implications, social and demographic aspects, environmental impacts, and safety of the different renewable fuels considered as part of a long term oil substitution for transport fuels
- consideration of factors that could affect long term viability of renewables, including security of supply, availability of feedstock and resources required for the fuel chain
- development and field testing program and identification of the needs for public support
- design of scenarios towards full substitution of fossil energy for transport fuels.

Hence, the implementation of renewable fuels needs to be based on their complete lifecycle performances. Additionally, the assessment underlying future decisions should comprise following recommendations [4]:

- careful selection of the location of refueling stations to best accommodate the initially small vehicle number and to create maximum impact in early stages of deployment
- encouragement of the investors and operators of refueling stations to offer renewable fuels together with fossil fuels, on the basis of an analysis of market-demand and/or the technical (including health and safety) and financial implications
- reporting on an annual basis of the number of renewable fuel vehicles registrations, average fuel prices and total consumption of each renewable fuel for the transport sector by mode.

Public acceptance of renewable fuels should be obtained introducing the following activities [4]:

- promotional campaigns to encourage citizens to switch to renewable fueled vehicles
- promotion of actions to improve the public perception of safety of renewables as fuels for transport and ensuring that differences are explained properly
- introduction of financial and non-financial incentives for clean vehicles (e.g. bonuses for low-emission vehicles, tax exemptions for company cars, no tax on renewable fuels, reserved highway lanes, free or reduced public parking prices etc.)
- ensuring appropriate access to information by the consumer on the location of refueling possibilities for different fuel types.

Furthermore, it would be necessary to undertake proper measures for harmonization of the legislation, referring EU standards for biofuel quality. Also, in the frame of the programs for

agriculture development, a stimulation of the production of domestic resources for biofuels would be needed, through the support of the producers (confident funding schemes, investments, guaranteed buying off, acceptable credits etc.) [11]. Stimulation of the production of domestic resources for biofuels should contribute for increase of the total agricultural production and usage of non-utilized lands, without decreasing the production of food and other agricultural products.

5. SWOT ANALYSIS

Next, a SWOT analysis for the potential of renewable fuel (i.e., biofuels) production and usage in road transport in Macedonia is carried out. This analysis primarily refers to biodiesel, as a representative of renewable fuels most used at the moment and with the highest potential to be used in the future periods.

Table 2:

SWOT analysis for renewable fuel production and usage

Strength	<ul style="list-style-type: none"> - dependency reduction of oil import and energy supply - good substitute for fossil fuels - environmental protection (reduction of air pollution and greenhouse gasses) - development of rural areas [12] - job creation potential - climate and agricultural advantages - available biomass resources for production - cost-reduction of bio-waste disposal (improved waste management)
Weaknesses	<ul style="list-style-type: none"> - inadequate infrastructure - lack of industrial technologies - incomplete and undeveloped regulation - land usage and need for pesticides during the production [12] - limited funding - high distribution costs
Opportunities	<ul style="list-style-type: none"> - national policy support - market opportunities - increased export - increased budget contribution - increased attraction for foreign investors [12]
Threats	<ul style="list-style-type: none"> - lack of support mechanism [12] - bad management of the whole process [12] - high manufacturing costs - climate changes - food vs fuels - inefficient use of biomass waste streams - land availability and feedstock production shortage [12]

Source: made by the authors

6. CONCLUSION

The smart use of renewable fuels in the transport sector can provide multiple benefits in terms of security of supply, reduction of GHG emissions, air pollution and overall sustainability. The potential of a renewable fuel candidate to make significant inroads into the market depends on several elements like e.g. the availability of potential feedstock and the complexity of the production process, the compatibility with engine technologies and distribution infrastructure, and the GHG savings potential [4].

Efforts that has been putted in the production and stimulation of usage of renewable fuels, mainly biodiesel in the transport sector in Macedonia, should be acknowledged. However, additional stricter efforts would be needed in order to achieve the goal of 10% participation of renewable fuels in the transport until 2020. The presented analysis supports the current situation that this country in on the right path to increase participation of this and other renewables in the total fuel consumption. Implementation of proposed recommendations will additionally support their consistency on the market, equally attracting producers and final consumers, i.e., drivers in road transport.

During introduction phase of renewable fuels, their capacity to actually improve energy security should be considered, as well as their potential to become economically viable and to reduce carbon emissions (and meet additional sustainability requirements) so that counterproductive and expensive lock-in is avoided [13]. Country-based deployment projections, with a timeline indicating areas of deployment, number of vehicles and number of fuelling points, breaking point for economical viability of the technology, could be requested to base deployment targets for a particular fuel [13].

In fact, any objective assessment of the role that renewable fuels for road transport can play in decarbonising the transport sector, improving energy security and promoting economic growth, should be supported on national level, as well as widely accepted by the public [5].

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