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Technical paper

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SUSTAINABLE BIOFUELS FOR THE DECARBONISATION OF THE TRANSPORT SECTOR IN CITIES

ABSTRACT: Decarbonising the transport sector is one of the major challenges in achieving climate neutrality in cities. In addition to high greenhouse gas emissions, this sector has a direct impact on the deterioration of air quality in urban areas. Integrating sustainable biofuels (biodiesel, biomethane, bioethanol, and renewable diesel) is one of the key ways to reduce pollution and achieve carbon neutrality. Modern technologies enable these biofuels to be produced from locally available feedstocks, such as used cooking oil and fats, the organic fraction of municipal waste, sewage sludge, etc. According to 2024 data, a total of 73,016 motor vehicles are registered in Kragujevac, accounting for approximately 30% of the city's final energy consumption. To evaluate the effects of substituting fossil fuels with locally produced alternatives, an analysis was conducted across three key mobility segments: the public transit system, the municipal vehicle fleet, and privately owned vehicles. The research results indicate that the use of sustainable biofuels in suitable blends can significantly reduce CO_2 emissions, as well as harmful pollutants. The use of sustainable biofuels represents an important and significant step in the energy transition, contributing to long-term improvements in air quality.

KEYWORDS: transport decarbonisation, sustainable biofuels, climate neutrality

UPOTREBA ODRŽIVIH BIOGORIVA ZA DEKARBONIZACIJU TRANSPORTNOG SEKTORA U GRADOVIMA

REZIME: Dekarbonizacija sektora transporta predstavlja jedan od najvećih izazova kada se radi o postizanju klimatske neutralnosti gradova. Pored visoke emisije gasova sa efektom staklene bašte, ovaj sektor ima direktan uticaj na pad kvaliteta vazduha u urbanim sredinama. Integracija održivih biogoriva (biodizel, biometan, bioetanol i

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obnovljivi dizel) predstavlja jedan od ključnih koraka za smanjenje zagađenja i tranziciju ka karbonskoj neutralnosti. Savremene tehnologije omogućavaju proizvodnju biogoriva iz lokalno dostupnih sirovina, poput iskorišćenog jestivog ulja i masti, organske frakcije komunalnog otpada i kanalizacionog mulja. U Kragujevcu je, prema podacima iz 2024. godine, registrovano ukupno 73.016 motornih vozila, što čini oko 30% finalne potrošnje energije na nivou grada. Kako bi se procenili efekti supstitucije fosilnih goriva lokalno proizvedenim alternativama, sprovedena je analiza u tri ključna segmenta mobilnosti: sistemu javnog gradskog prevoza, voznom parku u nadležnosti grada i sektoru privatnih vozila. Rezultati istraživanja pokazuju da korišćenje održivih biogoriva u odgovarajućim mešavinama i udelima može značajno doprineti redukciji emisija CO_2. Upotreba održivih biogoriva predstavlja važan i značajan korak u energetskoj tranziciji dugoročno doprinoseći unapređenju kvalitet vazduha.

KLJUČNE REČI: dekarbonizacija transporta, održiva biogoriva, karbonska neutralnost

INTRODUCTION

Increasingly pronounced climate change represents one of the main issues of the modern era. Cities are recognised as key areas for mitigating these problems, as they are responsible for 70% of global carbon emissions and two-thirds of the world's energy consumption (Winkler et al. 2023; Lučić et al. 2025). One of the greatest potentials for decarbonisation is the transport sector, which predominantly relies on fossil fuels. At the global level, this sector has the fastest growth in emissions over the past decades. It accounts for around 29% of total energy consumption and 25% of total CO_2 emissions resulting from energy use (Yılbası, 2025; IPCC, 2023). In addition to high greenhouse gas emissions, road transport has a direct impact on the decline in air quality in urban areas. Transport contributed approximately 20% of total air pollution in Europe in 2020 by emitting pollutants such as particulate matter (PM) and volatile organic compounds (VOC). In this way, it directly endangers human health (Mbandi, et al. 2023; Coelho, et al. 2022).

The energy transition that is currently underway involves a shift from systems based on fossil fuels to systems based on renewable energy sources (RES), with the electrification of both heat and transport being one of its objectives. Although the electrification of transport is an inseparable part of the energy transition, it is a long-term process that requires strong integration of RES and the development of supporting infrastructure. The process of full electrification may take decades depending on the capacities of individual countries. Therefore, solutions that will enable a smooth and fair transition are necessary, primarily based on locally specific RES (Nikolić, et al. 2026). The legal framework for addressing this issue in the European Union was initially established by Directive 2009/28/EC and Directive 2018/2001 (RED II) (European Parliament and Council of the EU, 2018). The targets have been significantly strengthened by the latest Directive 2023/2413 (RED III) (European Parliament and the Council of the EU, 2023) which requires the share of renewable energy in transport to be at least 29% by 2030, while the share of advanced sustainable biofuels and renewable synthetic fuels must be at least 5.5%.

Sustainable biofuels are defined as fuels obtained from renewable, sustainable feedstocks, such as organic waste and non-food biomass. Due to their similar properties to conventional petroleum products, they can be used in existing internal combustion engines (ICEs) (Yılbası, 2025; Demuynck, et al. 2021). Their key advantage compared to fully electric systems and hydrogen systems is their volumetric energy density, as well as the possibility of using existing distribution infrastructure. Studies that have analysed life cycle assessment confirmed the importance of liquid biofuels in decarbonisation. The use of these fuels can reduce greenhouse gas emissions by 60% - 90% compared to conventional fossil fuels, depending on the choice of feedstock and processing technology (Correa, et al. 2019). For example, the consumption of one kilogram of biodiesel can result in an average reduction of 3 kg of CO_2, depending on the feedstock used for biodiesel production and the way it is used. In the case of urban buses, the use of blends, such as B20 (20% biodiesel), results in a 15.66% reduction in CO_2 emissions (Khan, et al. 2025). In addition to environmental benefits, the implementation of circular economy principles through the use of local resources (such as used cooking oil for biodiesel production) addresses the issue of organic waste management, reduces dependence on imported energy, and enables the decarbonisation of sectors that are the most technologically challenging to electrify.

Despite these potentials, transport is still predominantly dependent on fossil fuels (92.5%), while RES accounts for only 7.5%. Biofuels based on conventional crops account for 4%, while advanced biofuels and biogas account for only 0.8% of this share (ECA, 2023; Yılbası, 2025). At the European Union level, the share of biofuels in road transport amounted to 6.7% in 2023 (EUROSTAT, 2025). Currently, biodiesel, bioethanol, and biomethane are the most commonly used, while hydrotreated vegetable oil (HVO) has recently emerged as an exceptionally important solution. HVO was developed with the aim of overcoming certain technical disadvantages of traditional biodiesel. It is characterised by a higher energy content and higher cetane number, lower viscosity and a comparable or higher flash point, as well as significantly better storage stability (Knothe, 2010).

To encourage the use of biofuels, the Government of the Republic of Serbia passed the Regulation on the Share of Biofuels in the Market in 2019, which established a specific share of biofuels on the market, blended with oil-derived

fuels (Government of the Republic of Serbia, 2019). The market shares for the period 2022-2024 were determined by the Decision on Determining the Mandatory Share of Biofuels that System Obligated Parties Are Required to Place on the Market of the Republic of Serbia, which are 0.5% in 2022, 0.5% in 2023, and 1% in 2024 (Government of the Republic of Serbia, 2021). Given that the initial regulatory obligations were not adequately implemented in the market, the Government adopted the Decision on the Termination of Validity of the Decision on Determining the Mandatory Share of Biofuels that System Obligated Parties Are Required to Place on the Market of the Republic of Serbia (Government of the Republic of Serbia, 2023), resulting in the share of biofuels remaining negligible, i.e., 371 t in 2024 (Government of the Republic of Serbia,2024).

The implementation of sustainable biofuels at the local level represents a key step towards sustainable urban mobility, considering global targets and the need for rapid emission reductions in cities. This paper aims to present how sustainable biofuels can contribute to reducing CO_2 emissions from urban transport using a city (Kragujevac) in Serbia as an example.

METHODOLOGY

The calculation of CO_2 reduction was conducted based on the developed methodology presented in Figure 1. The methodology is based on the COPERT model (Ntziachristos & Samaras, 2025) and available statistical data and consists of several steps.

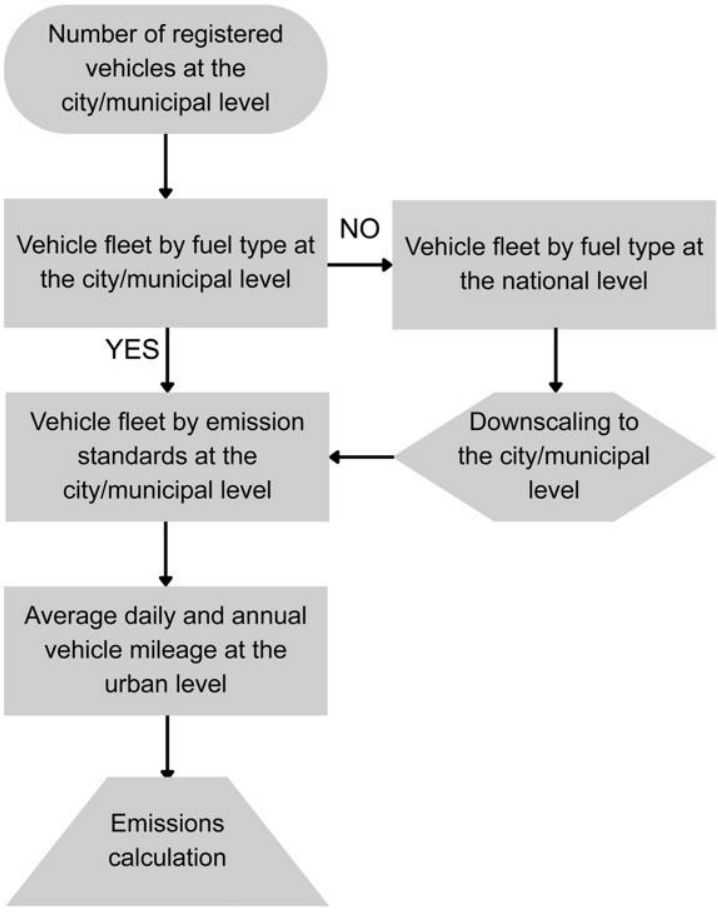


Figure 1 Proposed methodology

The number of registered vehicles in the transport sector in Serbia has been monitored annually. The data are published on a quarterly and annual basis. Some data are available at the municipality/city level and include the number of registered vehicles divided into categories (mopeds, motorcycles, passenger cars, buses, heavy trucks, work vehicles, and trailers) and by fuel type (petrol, diesel, and hybrids). Data on engine displacement and fuel used are available at the national or regional level. The methodology allows the number of vehicles by fuel type, as well as by engine size, to be determined based on available statistical data at the municipality/city level. In addition, local governments often adopt different strategic documents, such as the Energy Efficiency Programme, the Sustainable Energy and Climate Action Plan, and similar documents. These documents often contain more precise data on the number of vehicles.

Data on vehicles' emissions standards are defined based on statistical data on the import, sale, and registration of vehicles. In Serbia, it is possible to import vehicles with the EURO 3 emission standard and higher. These data are available at the national level, but they can be proportionally distributed to municipalities/cities. In addition, precise data are often available in the official strategic documents of municipalities/cities. The mileage by vehicles driven in urban areas on a daily and annual basis depends on several factors, such as citizen habits, the quality of the public transport system (the existence of metro-subway and urban railway lines), environmental restrictions, and the availability of public parking.

The calculation of emissions of pollutants from a certain vehicle fleet is carried out according to the official EMEP/EEA methodology for emission inventories (Ntziachristos & Samaras, 2025). The total mass of the emitted pollutant during the observed period *E* [g] can be expressed as (1):

$$E_{j,k} = N_{j,k} \cdot M_{j,k} \cdot ef_{j,k} \cdot mc \quad (1)$$

Where are:

$N_{j,k}$ [-] – number of registered vehicles within category *j* (passenger cars, light commercial vehicles, heavy-duty vehicles, buses, motorcycles) equipped with a *k* emission standard (Euro standard),
$M_{j,k}$ [km/god] – average annual mileage of a vehicle from category *j* with *k* emission standard,
$ef_{i,k}$ [g/km] – specific emission factor for category *j* with *k* emission standard,
mc [-] – correction factor due to degradation.

Calculating emissions and fuel (energy) consumption should include the cumulative mileage driven by the vehicle, as the same vehicle will not have the same emissions if it, for example, has driven 80,000 or 250,000 km. The total mileage for the vehicle is calculated using the years in which the specific EURO standard was implemented. To simplify calculation and obtain average values, the average of the years between two introduced standards is used. The total mileage is quantified by the correction factor due to degradation, *mc*.

The energy converted through the fuel consumption can be calculated using Equation (2):

$$EC_{j,k} = N_{j,k} \cdot M_{j,k} \cdot sf_{j,k} \cdot LHV \quad (2)$$

where are:

$sf_{j,k}$ [l/km] – specific fuel consumption of vehicle category j with k emission standard,
LHV [MJ/l] – lower heating value of fuel.

Based on the calculated emissions and energy, the average emission factor for petrol and diesel can be calculated for a certain territory. This value differs from the one defined by the EU directives due to the correction resulting from engine degradation as a result of the mileage driven. The average emission factor enables the calculation of reduction in emissions resulting from the use of biofuels. The average emission factor EF_{avg} [g/MJ] is calculated using Equation (3):

$$EF_{avg} = \frac{E}{EC} \quad (3)$$

The calculation of emission reductions resulting from the integration of biofuels is based on an energy consumption calculation. The volumetric shares of biofuel SH_{bio} [%] are converted into energy based on the lower heating value and conversion factors defined in the RED II Directive. The energy obtained by using a certain volumetric share of biofuels EC_{bio} [MJ] can be calculated as Equation (4):

$$EC_{bio} = EC \cdot SH_{bio} \cdot \frac{LHV_{bio}}{LHV_{fos}} \quad (4)$$

The CO_2 equivalent emissions resulting from the use of biofuels are calculated as Equation (5):

$$E_{bio} = EC_{bio} \cdot EF_{bio} \quad (5)$$

where:

EF_{bio} [g/MJ] – emission factors of biofuels defined in the RED II Directive.

Finally, the CO_2 equivalent emission reduction resulting from the use of a specific amount of biofuel as a substitute for fossil fuels is calculated according to Equation (6):

$$E_{new} = (EC - EC_{bio}) \cdot EF_{avg} + E_{bio} \quad (6)$$

SO_x emissions are only determined by the fuel's sulphur mass fraction. Vehicle technology is irrelevant in this context. Biofuels are sulphur-free, and using a particular proportion of biofuel reduces SO_x emissions linearly.

RESULTS AND DISCUSSION

According to data from the Statistical Office of the Republic of Serbia, a total of 73,016 motor vehicles (excluding work machinery) were registered in Kragujevac in 2024. This represents an increase of approximately 4% compared to the previous year. The total number of registered vehicles by year is shown in Figure 2.

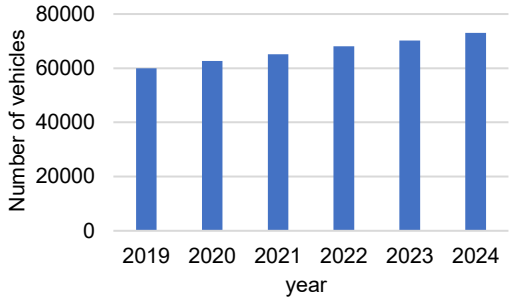


Figure 2 *Number of registered vehicles by years*

Passenger cars account for 89.21% of the total number of registered vehicles. The average age of vehicles in Kragujevac is 17.4 years, based on data from the Road Traffic Safety Agency (Road Traffic Safety Agency, 2022). Diesel vehicles account for 60%, petrol vehicles for 35%, while hybrid vehicles (most commonly with a petrol engine) and electric vehicles account for approximately 5%. According to engine displacement, among petrol vehicles, the dominant ones have an engine displacement of up to 1,399 cm³, with a share of 67.5%. The vehicles with an engine displacement up to 1,999 cm^3 have a share of 30.9%, and vehicles with an engine displacement above 2,000 cm^3 have a share of 1.6%. Among vehicles powered by diesel engines, vehicles with an engine displacement of 1,400–1,999 cm^3 dominate, with a share of 85.3%, while vehicles with an engine displacement up to 1,399 cm^3 and above 2,000 cm^3 account for 8.6% and 6.1%, respectively.

An analysis conducted for the Sustainable Energy and Climate Action Plan (Centre for Development and Support, 2026) reveals that the majority of these vehicles belong to the EURO 3 and EURO 4 emission standards. This is largely because the regulation permitting the import of vehicles with EURO 3 engines and above is still in effect. Figure 3 shows the share of registered vehicles in Kragujevac by their emission standards.

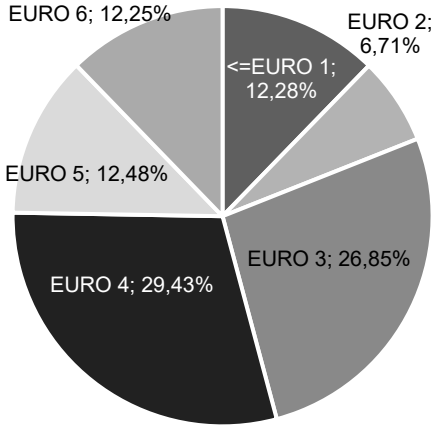


Figure 3 *Share of motor emission classes (EURO 1 includes vehicles before EURO standard)*

Some studies indicate that the average annual vehicle mileage in Serbia is approximately 10,000 km (Josijević, et al. 2022). (Živković, et al. 2016) states that average mileage in the city is about 3500 km annually. On the other hand, specialised unofficial platforms like CarVertical report a significantly higher average of around 16.000 – 18.000 km. However, data from these platforms is primarily obtained from authorised service centre databases. Since vehicles are typically maintained at authorised centres only while under the manufacturer's warranty, this higher figure likely overestimates the real national average. Furthermore, many of these vehicles belong to corporate fleets, making it difficult to isolate their mileage within specific municipalities. Due to the lack of exact local data, an approximation was performed. Aligning with broader European trends indicating that diesel vehicles generally cover greater distances (Marrero, et al. 2020), this study adopts an annual average of 13,000 km for diesel vehicles and 10,000 km for petrol vehicles.

The total mileage for each vehicle category was calculated based on the adopted average annual mileage and the number of years the respective emission standard was in effect Table 1.

Table 1 Total mileage of vehicle in Kragujevac

EURO standard	EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6
diesel [km]	416,000	364,000	305,500	247,000	188,500	78,000
petrol [km]	320,000	280,000	235,000	190,000	145,000	60,000
hybrid [km]						40,000

The public transport system in Kragujevac operates with 72 buses, covering an urban network of 336 km with an average route length of 14.6 km. When suburban transit is included, the total network expands to 638 km. The total number of buses registered within the city territory is 143. The buses operating in Kragujevac are powered by compressed natural gas (CNG) engines complying with the Euro 6 standard and diesel engines complying with the Euro 5 standard. The total annual mileage of the public transport bus fleet is approximately 3,000,000 km (RECEEKG, 2018).

The local government owns 49 passenger vehicles, 15 of which are powered by diesel engines and 34 by petrol engines. The public utility company Šumadija has 35 vehicles for waste collection and transportation.

The COPERT model considered three sectors: the urban public transport system, the vehicle fleet under the jurisdiction of the city, and the private vehicle sector. The carried out calculation showed that the annual converted energy amounts to 648.23 TJ for diesel vehicles, 312.29 TJ for petrol and hybrid vehicles, and 21.39 TJ for CNG buses.

Table 2 presents the energy consumption by fuel type and engine emission standards.

Table 2 Energy Consumption of the Vehicle Fleet by Fuel Type and EURO Emission Standard

EC	EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6	TOTAL
diesel [TJ]	79,88	46,12	173,1	173,45	103,48	72,2	648,23
petrol [TJ]	41,71	23,54	92,95	83,59	35,44	56,45	336,59
CNG [TJ]						21,39	21,39

Using the same methods, the CO_2 equivalent emissions have been computed as 48,197.65 t for diesel vehicles, 22,477.26 t for petrol vehicles and 1222,27 t for CNG buses. Results presented in Table 3 show that vehicles belonging to the EURO 3 and EURO 4 emission standards have the highest total emissions.

Table 3 Annual CO2e Emissions from the Vehicle Fleet by Fuel Type and EURO Emission Standard

E CO_2e	EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6	TOTAL
diesel [t]	5939,55	3428,92	12869,99	12896,52	7694,24	5368,43	48197.65
petrol [t]	3001,82	1694,63	6690,35	6013,57	2550,4	2526,49	24225.63
CNG [t]						1222,27	1222.27

Biofuels produced from biomass have often been considered as carbon-neutral fuels when they are produced in a sustainable manner. Given that they are predominantly of plant origin, it can be assumed that the amount of CO_2 emitted during their usage is equal to the amount of CO_2 absorbed by the plants from the atmosphere during their growth. However, crop cultivation, their transport, and processing require the use of certain technologies that are still largely based on fossil fuels. This means that biofuels are not completely carbon neutral. When considering biofuels that can be used at the local level, the feedstocks available in that region or country are of greatest importance.

Table 4 presents the lower heating values and emission factors for biofuels produced from crops cultivated in Serbia. In addition to crops, used cooking oils (UCO) are of particular importance as sustainable feedstocks for biodiesel and renewable diesel (HVO). Used cooking oils are generated in restaurants and hotels, and biofuels produced from them have significantly lower CO_2 emissions than those produced from crops.

Biodiesel and renewable diesel produced from UCO account for 24% of biofuel consumption in the EU, representing the largest share after biodiesel produced from rapeseed, which accounts for 34%. In Serbia, biodiesel and renewable diesel can also be produced from sunflower in addition to UCO and rapeseed, but sustainability aspects need to be taken into account.

In an attempt to support the integration of biofuels into the distribution system and contribute to the energy transition, the Government of the Republic of Serbia adopted the aforementioned Decision in 2021, but subsequently withdrew it in 2023. According to this Decision, the volumetric share of biofuels was to reach 1% by 2023. At the European Union level, the share of advanced sustainable biofuels and renewable synthetic fuels must account for at least 5.5% of the energy content by 2030.

Table 4 Lower heating values (LHV) and CO2e emissions of fossil fuels and biofuels

Fuel	LHV [MJ/l]	emission gCO_2e/MJ
petrol	32	69.3*
diesel	36	74.1*
CNG	50 [MJ/kg]	57.1*
bioethanol (sugar beet)	21	30.7 (38.2)
bioethanol (corn)	21	48.5 (56.8)
biodiesel (rapeseed)	33	45.5 (50.1)
biodiesel (UCO)	33	11.2 (14.9)
biodiesel (sunflower)	33	40.0 (47.0)
HVO (rapeseed)	34	45.8 (50.1)
HVO (UCO)	34	11.9 (16.0)
HVO (sunflower)	34	39.4 (43.6)
biomethane** (wet manure)	50 [MJ/kg]	-103.0 (35.0)
biomethane** (corn)	50 [MJ/kg]	26.0 (30.0)
biomethane** (biowaste)	50 [MJ/kg]	10.0 (14.0)

*calculated value

** close digestate with off-gas combustion

Biofuels such as biodiesel and bioethanol can be blended with conventional fossil fuels, although the maximum share that can be used without engine modification depends on the specific vehicle technology, age, and manufacturer approval. Standard, unmodified engines are generally compatible with lower biofuel blends, while the use of blends with higher biofuel shares requires compatibility with the specific vehicle and fuel standard. On the other hand, HVO and biomethane can, in suitable vehicles and applications, be used up to 100%, but there is an availability limit. Since the complete substitution of conventional fuels with biofuels is not practically feasible at the fleet level, the study considered three blending scenarios: a 1% volumetric share, a 5.5% energy share, and a 20% volumetric share. Emission reductions were calculated for each scenario.

If the volumetric share of biofuels were 1%, CO_2e emissions could be reduced by 229.80 to 507.05 t, depending on the type of biofuel used. The reduction directly depends on the feedstock used for biofuel production. Figure 4 shows the emission reductions depending on the feedstock from which the biofuels are produced. Biofuels produced from used cooking oil as a sustainable feedstock have the best effect in terms of emission reduction.

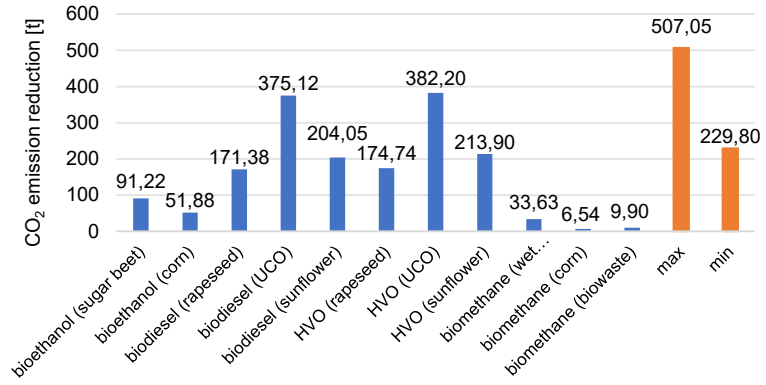


Figure 4 *CO_2e emission reduction at a 1% volumetric share by biofuel feedstock*

Achieving the European Union target of 5.5% of biofuels in the energy content could contribute to a reduction in emissions from 1,489.00 to 3,204.19 t CO_2e (Figure 5).

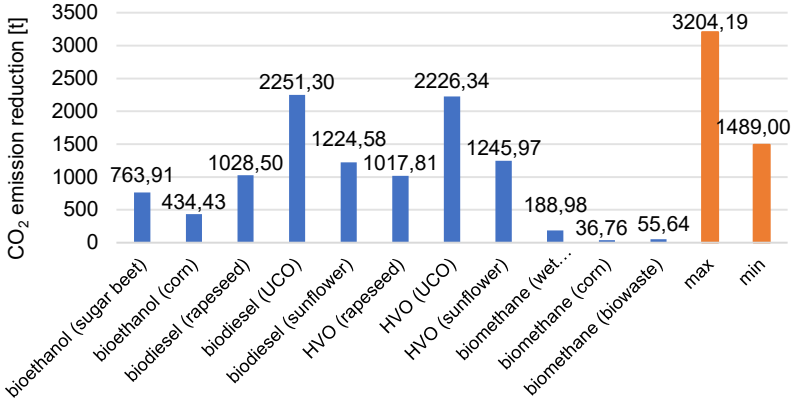


Figure 5 *CO_2e emission reduction at a 5.5% share in the energy by biofuel feedstock*

At a 20% volumetric share of biofuels, CO_2 equivalent emissions could be reduced by 4,598.77 to 10,155.76 t, depending on the type of biofuel used (Figure 6).

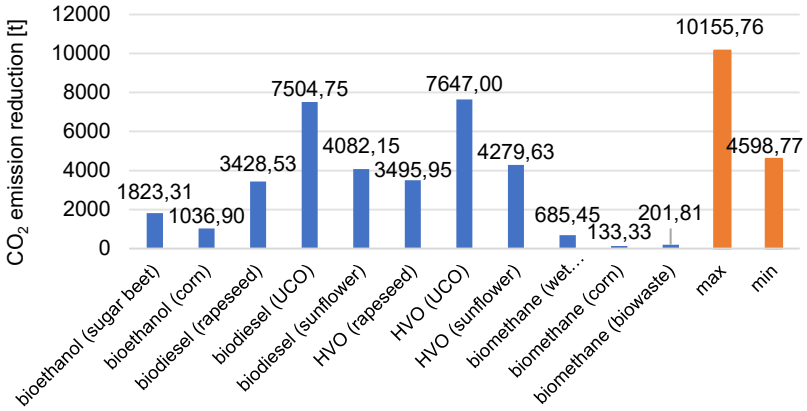


Figure 6 *CO_2e emission reduction at a 20% volumetric share by biofuel feedstock*

Three analysed cases show that biofuels produced from sustainable feedstocks, such as UCO, can have the greatest effects on CO_2e emission reduction. The maximum and minimum values shown in Figures 4-6 refer to the emissions that can be achieved through the simultaneous use of bioethanol in petrol vehicles, biodiesel or HVO in diesel vehicles, and biomethane in CNG buses.

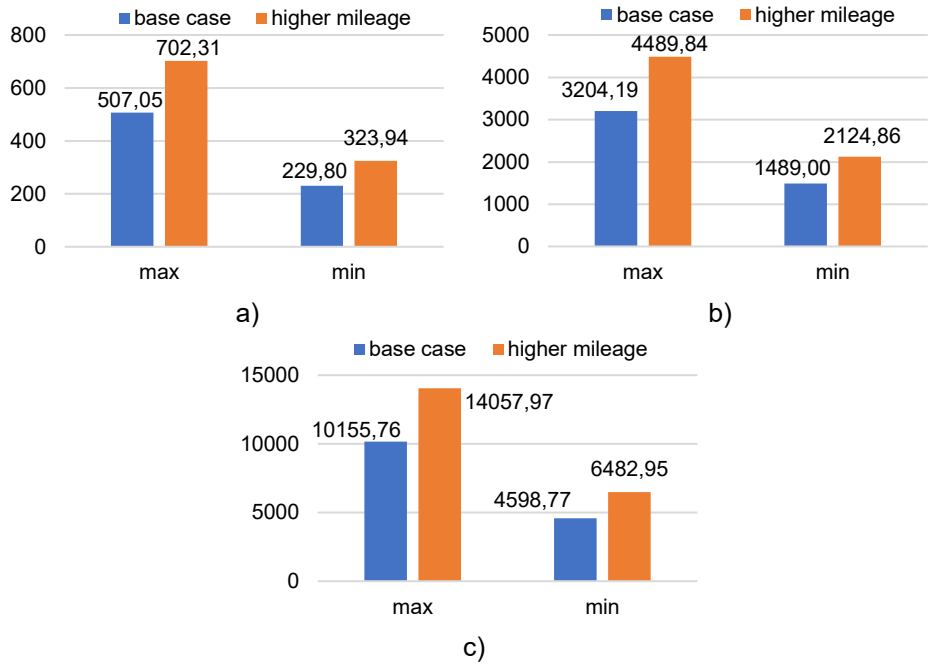


Figure 7 *Sensitivity analysis of CO_2e emission reductions under increased annual mileage scenarios: a) 1% volumetric share; b) 5.5% energy share; c) 20% volumetric share*

To evaluate how the model responds to changes in vehicle utilisation, a sensitivity analysis has been performed using an increased annual mileage of 18,000 km for diesel vehicles and 16,000 km for petrol and hybrid vehicles. The results show that an increase in annual mileage leads to a proportional increase in the total CO_2e emission reductions for all considered scenarios. For the 1% volumetric share, the maximum potential reduction increases from approximately 507 t to 702 t. For the 5.5% energy share, the corresponding reduction increases from around 3,200 t to almost 4,500 t, while for the 20% volumetric share it increases from 10,155 t to around 14,000 t. These results indicate that higher vehicle utilisation leads to greater absolute CO_2e emission savings from the use of sustainable biofuels.

CONCLUSIONS

The decarbonisation of urban transport requires a comprehensive approach that includes electrification, infrastructure improvement, and the indispensable integration of advanced biofuels. The research conducted on the example of a fleet of more than 73,000 vehicles in Kragujevac indicates that the direct substitution of conventional

fossil fuels with sustainable biofuels, such as bioethanol, hydrotreated vegetable oil (HVO), biodiesel, and biomethane produced from waste feedstocks, provides measurable and rapid benefits.

The application of a developed methodology which is based on the COPERT method showed that even conservative scenarios, with a biofuel share of 1%, result in a reduction in CO_2e emissions of up to 507 t annually. Alignment with the European Union Directive target of a 5.5% energy share would result in a several-fold greater reduction in emissions (more than 3,200 t), while an optimistic scenario involving a 20% volumetric share of biofuels could significantly decarbonise local transport, with emission reductions of more than 10,000 t. In addition to reducing the carbon footprint, replacing conventional diesel with sulphur-free biofuels leads to a linear decrease in SO_x emissions, which directly contributes to improving air quality in urban areas.

However, the calculated technical potential also indicates a significant gap with the current legislative framework. The suspension of the Decision on the mandatory biofuel share at the national level slows down the energy transition and makes it more difficult to achieve climate targets at the local level. The transition to sustainable biofuels, based on the principles of sustainability and the use of local waste feedstocks, does not require infrastructure or vehicle fleet modifications but only a supportive regulatory policy. Future research should focus on conducting a detailed techno-economic analysis of the possibilities for the production and supply chain of advanced biofuels at the local level.

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