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ROAD TO ECO-ROUTING: A MODEL OF REGULATORY APPROACH FOR THE EU

Abstract

Global warming is of key importance among the many negative manifestations of human impact on the environment. The main cause of climate change and the observed global warming is the emission of greenhouse gases (GHG) into the atmosphere, while the largest share of emissions is generated by transportation sector. It is declared that by 2050 GHG emissions in the transportation sector will be reduced by 90 per cent. In the part

relating to road transport, a key role is to be played by digitization, transport automation, the use of intelligent traffic control systems and the abandonment of combustion engines in favour of electric ones. This study aims to present possible legal solutions aimed at introducing eco-routing solutions for vehicle traffic in the EU and obstacles to its widespread implementation and is aimed to begin discussion about this matter and the further studies in this area.

KEYWORDS

eco-routing, greenhouse gas emission, transport, European Union, environmental policy, data

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eco-routing, emisja gazów cieplarnianych, transport, Unia Europejska, polityka ochrony środowiska, dane

1. INTRODUCTION

Many human actions, unfortunately, more and more lead us to an ecological imbalance. The threats to humanity seem to be the greatest challenge since the birth of civilization. The ongoing COVID-19 pandemic, migratory movements, climate change, rising sea levels are consequences of excessive human interference in the natural environment[1].

Global warming, which is the cause of many of the above-mentioned perceptible changes, is of key importance among the many negative manifestations of human impact on the environment[2]. Due to these alterations, humanity will be (and already is) struggling against serious effects of the changes taking place – in addition to the previously mentioned negative and sudden changes in weather, lack of drinking water, fires, and health problems. As indicated in the literature,

[1] S. Balsari, C. Dresser, J. Leaning, *Climate change, migration and civil strife*, "Current Environmental Health Reports" 2004, Vol. 7, pp. 404–405; J. Abatzoglou, A. Williams, *Impact on anthropogenic climate change on wildfire across western US forests*, "Proceedings of the National Academy of Sciences of the United States of America" 2016, Vol. 113, No. 42, pp. 11770, 11773.

[2] D. Stern, R. Kaufmann, *Anthropogenic and natural causes of climate change*, "Climatic Change" 2014, Vol. 122, p. 257; C. Rosenzweig, D. Karoly, M. Vicarelli *et al*., *Attributing physical and biological impacts to anthropogenic climate change*, "Nature" 2008, Vol. 453, pp. 355–356.

climate change caused by global warming has already posed the greatest threat to health (both individual and public) in the 21st century[3].

The main cause of climate change and the observed global warming is the emission of greenhouse gases (GHG) into the atmosphere. European Union is undoubtedly the world leader in reducing these emissions. The EU Member States are significantly reducing their GHG emissions in the energy sector. Reduction by 51 per cent between 1990 and 2019 was a result of the energy transition, i.e. switch to the renewable energy sources[4]. However, we can observe a worrying trend in the transportation sector. Namely, in contrast to the energy sector, in the EU, GHG emissions in this segment are increasing proportionally[5]. It is estimated that the domestic transportation sector generated 673 $MTCO_2$ in 1990 and 832 $MTCO_2$ in 2019 (increase in GHC by almost 25 per cent). Road transport plays an important role here. The largest share of emissions in this sector (over 70–75 per cent, i.e. over 624 $MTCO_2$) is generated by passenger cars and vans[6]. It is worth to mention that this growth exists despite the implementation of instruments aimed at reducing emissions in the field of transport[7], which allows for obtaining reliable information on the emissions by individual cars. Another solution proposed by EU legislation is Directive 98/70/EC relating to the quality of petrol and diesel fuels[8], which sets emission reduction targets by ensuring the appropriate quality of fuels. In comparison with the quoted data on GHG emissions in the transportation sector, it seems that these instruments are not sufficient. Thus, it is necessary to look for further solutions that will lead to the reduction of emissions in this sector. The EU has devoted a separate part of the European Green Deal policy to this issue. In the part concerning sustainable mobility, the goal is declared of reducing

[3] A. Costello, M. Abbas, A. Allen *et al*., *Managing the health effects of climate change*, "Lancet" 2009, Vol. 373, pp. 1693, 1728; see also C.J. Porter, K.T. Tart (eds.), *A human health perspective on climate change: A report outlining the research needs on the human health effects of climate change*, "Journal of Current Issues in Globalization" 2013, Vol. 6, issue 4, pp. 621–710.

[4] *Greenhouse gas emission intensity of electricity generation in Europe*, https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-3/assessment-1 (accessed 26.10.2021).

[5] W. Todts (ed.), CO_2 emissions from cars: The facts. A report by European Federation for Transport and Environment AISBL, Brussels 2018, https://www.transportenvironment.org/wp-content/uploads/2021/07/2018_04_CO2_emissions_cars_The_facts_report_final_0_0.pdf (accessed 7.06.2021).

[6] G. Fontaras, N.-G. Zacharof, B. Ciuffo, *Fuel consumption and CO_2 emissions from passenger cars in Europe: Laboratory versus real-world emissions*, "Progress in Energy and Combustion Science" 2017, Vol. 60, pp. 97, 98; C. Buysse, J. Miller, *Transport could burn up the EU's entire carbon budget*, 2021, https://theicct.org/blog/staff/eu-carbon-budget-apr2021 (accessed 3.10.2021).

[7] European Parliament and Council Directive 1999/94/EC of 13 December 1999 relating to the availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars (1999) OJ L 12/16.

[8] European Parliament and Council Directive 98/70/EC of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Directive 93/12/EEC (1998) OJ L 350/58.

by 90 per cent the 2050 GHG emissions in the transportation sector. In the part relating to road transport, a key role is to be played by digitization, transport automation, the use of intelligent traffic control systems, and the abandonment of combustion engines in favour of electric ones. The reduction of emissions in this sector will be important not only in terms of limiting climate change, but above all, it will affect the health of the inhabitants of the EU cities, because it is road traffic that has become the most serious source of local air pollution[9].

The emissivity of road traffic is influenced by a number of factors, including not only the vehicle design or fuel quality but also the behaviour of drivers, their driving style, terrain, speed, road conditions, etc. Therefore, two issues play an important role here. The first, "eco-driving" refers in principle to the skills of the driver who can drive a car in a way that reduces fuel consumption[10]. The second, "eco-routing" is understood as a set of external factors influencing fuel consumption – topography, traffic or weather[11]. Possibilities of taking such conditions into account appear in various car navigation systems, which make it possible to calculate the route to a given destination as causing the least emission. Today, these solutions are of interest to researchers in the field of sustainable mobility[12].

This study aims to present possible legal solutions aimed at introducing eco-routing solutions for vehicle traffic in the EU and discuss the obstacles to its widespread implementation. The research is based mainly on the legal methods. The conclusions in the key issues required especially to analyse the normative legal material, including the EU Treaties and relevant secondary legislation. However, the findings concerning the problem of the necessity for issuing the regulations in this area were based also on the relevant scientific papers analysis.

This is the first contribution which considers the possibility and necessity of introducing a regulation of the eco-routing navigation systems in the EU. It may begin an in-depth discussion of this matter and inspire further studies in this field. Especially, it may affect searching solutions for decreasing the GHG emissions in the EU transportation sector.

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[9] F. Palmgren *et. al., Actual car fleet emissions estimated from urban air quality measurements and street pollution models*, "Science of the Total Environment" 1999, Vol. 235, issue 1–3, pp. 101, 102.

[10] M. Rohani, *Bus driving behaviour and fuel consumption*. Ph.D. Thesis, University of Southampton 2012, p. 90, https://www.researchgate.net/publication/299464233_Bus_driving_behaviour_and_fuel_consumption (accessed 1.06.2021); see also J. Anderson *et al., Autonomous vehicle technology: A guide for policymakers,* Santa Monica, CA 2016, p. 29; L. Chen Chiu, *Energy-saving and carbon reduction effects of longterm green transportation policy in Taiwan*, "The Kyoto Economic Review" 2014, Vol. 83, pp. 70, 79, https://www.jstor.org/stable/24898543 (accessed 3.04.2023).

[11] *Eco-routing*, "Long Run", https://h2020-longrun.eu/ecorouting/ (accessed 3.04.2023).

[12] A. Elbery, H.A. Rakha, *City-wide eco-routing navigation considering vehicular communication impacts*, "Sensors" 2019, Vol. 19, No. 2, p. 5 *et seq.*

2. CAR NAVIGATION AS AN ECO-ROUTING TOOL

The first navigation instrument that assisted the driver in viewing his current route by moving tapes with printed maps in a special device, was the Inter Avto system introduced in the 1930s[13]. Since then navigation programs have become widely available as one can use them on almost every device. Studies show that the current development phase in the discussed market is characterized by the dominance of the largest software delivery platforms: Google and Google Maps software[14]. Their development is supported by the results of the research. More than 90 per cent of the smartphone users in the US use navigation software, and the vast majority of it is the Google Maps software[15].

2.1. THE MARKET OF TRANSPORT SERVICES

It can be observed that the market of the road transport is undergoing relatively limited digital transformation as compared to other industries. The changes affecting this market were mainly limited to the transfer of the route planning system into a digital form for the purpose of the organization of shipping. It should be noted that the development of technology in the field of vehicles themselves is extremely dynamic and does not affect the basic elements of the organization of the discussed market. In 2015, the transport market was responsible for almost 30 per cent of global energy consumption, most of which, as much as 96 per cent, came from fossil fuels[16]. The above may lead to the conclusion that one of the most energy-consuming sectors on a global scale is also one least subject to technological changes, which could significantly contribute to reducing its energy consumption.

At the same time, recently a number of research has been undertaken on the technological development of vehicles, including research on autonomous or electric vehicles. Although the regulatory environment is not conducive to the rapid introduction of new technologies for widespread use, which is of particular

[13] M. Lelovic, *Car navigation history: From rolled paper maps to car play connected Sygic app*, 2018, https://www.sygic.com/pl/blog/2018/car-navigation-history (accessed 27.07.2018).

[14] N. Vasistha, *History of incar navigation*, 2021, https://medium.com/chargetrip/history-of-in-car-navigation-e7afbf3d23ca (accessed 7.06.2021).

[15] Y. Wurmser, *Maps and navigation apps: Discovery, exploration features open up ad opportunities*, 2018, https://www.emarketer.com/content/maps-and-navigation-apps (accessed 7.06.2021).

[16] International Renewable Energy Agency, Renewable energy policies in a time of transition, 2018, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_IEA_REN21_Policies_2018.pdf (accessed 7.06.2021).

importance for vehicles travelling on public roads, there is no doubt that the automotive market will undergo a definite transformation[17].

2.2. FACTORS RELEVANT TO DRIVING ECONOMY AND THE ROLE OF NAVIGATION INSTRUMENTS IN THE EFFECTIVE ECO-ROUTING

New technologies very often offer tools to improve professional activity, which until recently has been available only to the largest corporations with extensive research and development budgets. One such solution that enables the reduction of cost intensity is the implementation of an appropriate system for the utilization of available resources which already functions in many industries. Appropriate planning of the resource use allows, for example, to reduce the demand for the resources, which results in lower purchase costs (less resources) and lower operating costs (less activities performed, less demand for employees, or lower energy costs). Eco-routing is a collective term used by the authors to describe functionality in routing and navigation programs, taking into account the economics of travelling a given route, as well as the method of calculating a more economical (and/or ecological) route. For this purpose, it is necessary to determine factors influencing the fluctuation of the cost-consumption of a given activity type. There are external and internal factors to be taken into account. External factors, such as all the actions of natural forces or geography, include in particular: road traffic intensity, manner of road traffic organisation (including the number of collision and collision-free intersections, etc.), topography, type of selected route, number of crossing points including borders or foreseeable weather conditions. In addition to the above-mentioned, attention should also be paid to internal factors, i.e. those relating to the vehicle itself and its driver such as, in particular: type of car (type of engine, vehicle size and tonnage), adjusting the appropriate tires, proper inflation of tyres to a specific tonnage in accordance with the manufacturer's recommendations, selection of the appropriate route, driving style, including in particular eco-driving skills.

The above division, as well as the elements of each category, should be treated only as an example of data allowing theoretically for obtaining lower indications of transport cost-effectiveness on a given route. The analysed results of the research show that eco-routing is possible and effective[18]. In this context, it should be noted that research in the scope potentially convergent with research on

[17] Z. Navas-Anguita, D. Garcia-Gusano, D. Iribarren, *A review of technoeconomic data for road transportation fuels*, "Renewable and Sustainable Energy Reviews" 2019, Vol. 112, p. 11.

[18] X. Huang, H. Peng, *Eco-routing based on a data driven fuel consumption model*, Ann Arbor 2018, https://www.researchgate.net/publication/322756338_Eco-Routing_based_on_a_Data_Driven_Fuel_Consumption_Model (accessed 7.06.2021).

eco-routing (or even falling within the scope of eco-routing) – that on the development of a route energy forecasting model for the needs of the growing market for electric vehicles – can be largely adapted also for non-electric vehicles[19]. The above is mainly due to the possibility of using research in a wide range of vehicle energy consumption. Although research on the use of specific mechanisms for eco-routing has been carried out for many years[20], the recently presented studies, in which researchers had the opportunity to take into account data about the road transportation market, were of extremely high importance due to the fact that the analysed data were obtained from devices/vehicles that accounted for almost 2 per cent of the total number of vehicles at the test site. Research conducted in such a wide range allows for the collection of a large number of precise measurements constituting the basis for further calculations. It was clearly indicated that the "constrained eco-routing" system used to calculate travel routes enables to lower the energy consumption by 5 per cent, at the same time increasing the travel time by less than 1 per cent compared to the standard selection of the fastest route option[21]. These results should be considered very promising in the context of further research, although they are not as good as assumed. For example, in a study commissioned by the California Energy Commission it was assumed that eco-routing can contribute to a reduction in energy consumption and the emission of certain gases by up to 15 per cent, which is a value exceeding the findings from the previously discussed study[22]. However, the wide-scale implementation of the eco-routing solutions may lead to the significant reduction of the GHG emission in the light transport (cars and vans) sector in the EU. In the specific numbers, if eco-routing solutions were commonly implemented, these emissions in the EU would have fallen by 31 $MTCO_2$ – 93 $MTCO_2$ per year (depending on given data).

Most of the planned eco-routing models depend on the algorithm used (i.e. based on the correct type of data) and the appropriate amount and quality of the data submitted for the calculations. This requires, however, permanent access to a network enabling the exchange of road data with other road users[23]. Therefore, the above is also related to the issue of interoperability of navigation software

[19] C. De Cauwer, J. Van Mierlo, T. Coosemans, *Energy consumption prediction for electric vehicles based on real-world data*, "Energies" 2015, Vol. 8, issue 8.

[20] H.A. Rakha, K. Ahn, K. Moran, *INTEGRATION framework for modeling eco-routing strategies: Logic and preliminary results*, "International Journal of Transportation Science and Technology" 2012, Vol. 1, No. 3, pp. 259, 260–261.

[21] X. Huang, H. Peng, *op. cit.*

[22] L. Mirviss, *Public interest energy research 2014.* Annual Report. Publication No. CEC-5002015-009-SD, California Energy Commission, Energy Research and Development Division 2015, pp. 58–59.

[23] J. Wang, A. Elbery, H.A. Rakha, *Real-time vehicle-specific eco-routing model for onboard navigation applications capturing transient vehicle behavior*, "Transportation Research", Part C "Emerging Technologies" 2019, Vol. 104, No. 3, pp. 1–3, 12–19; see also H.A. Rakha, K. Ahn, K. Moran, *op. cit*., p. 272.

and the willingness to share one's data with the competitors. However, it should be noted that this problem seems to be already noticed by lawmakers – the US Department of Transportation issued in 2016 a notice of proposed law requiring connectivity between vehicles (in order to reduce the number of car accidents).

2.3. ECO-ROUTING NOW

The mentioned studies confirmed that eco-routing is not just a theory, and that such results are achievable outside the laboratory conditions. Despite the fact that such mechanisms are prone to immediate utilization not everyone is willing to implement given functionality and share their data. Therefore, research questions regarding the need to implement the relevant regulation as well as its form should be considered justified.

Market reacts to such information much faster, and some navigation software vendors have already introduced to their products an eco-routing functionality. In particular, attention should be paid to the largest entity responsible for most of the navigation software market – Google. Google Maps has limited the choice to two types of routes: the fastest and with the lowest carbon footprint. The application is to select the route with the lowest carbon footprint by default[24]. According to the scarce media reports, the eco-routing model that is being introduced is based in particular on the use of data on road gradient and traffic volume[25]. Most likely, these are not the only factors included in the developed model. No information is available on the role of the AI algorithms in the process, which can also be a significant factor to take into account in the discussion concerning eco-routing methods and their effectiveness.

The supplier mentioned above may play the greatest role in reducing the energy consumption of the automotive industry in general, due to its market share. In the foreseeable future, solutions such as eco-routing or its parts will be further developed and utilized for the benefit of electric and/or autonomous vehicles. In this regard, we can refer to the example of the Chargetrip start-up, which indicates the best possible route for an electric vehicle, taking into account the information on the characteristics of the current vehicle and external factors such as dedicated infrastructure[26]. The problem that may still limit or slow down the transformation of the discussed industry, with special focus on utilization of AI methods, is ensuring the widest possible access to data on which the accuracy of

[24] D. Paresh, *Google Maps to start directing drivers to 'eco-friendly' routes*, 2021, https://www.reuters.com/technology/google-maps-start-directing-drivers-eco-friendly-routes-2021-03-30/ (accessed 7.06.2021).

[25] Glasgow D., *Redefining what map can be with new information and AI*, https://blog.google/products/maps/redefining-what-map-can-be-new-information-and-ai/ (accessed 8.06.2021).

[26] N. Vasistha, *op. cit*.

calculations and the achieved results depend. Therefore, the above will be important for the assessment of the need to introduce appropriate regulations and their shape in this regard.

It should be also noted that eco-routing is not only important for the autonomous vehicles that are yet to come. As indicated and confirmed in the research projects, the impact of utilization of road or traffic data can be positive as well – cutting the energy use and GHG emissions by half – or double them in the most negative scenario[27]. Therefore, eco-routing as a policy should be implemented regardless of developments in the vehicle industry or transport market.

3. SELF-REGULATION OR REGULATION?

Despite the actual introduction of modes commonly referred to as "ECO" in some navigation systems, these activities do not result from any national or international legal regulations. It is a proposal of the producers themselves, addressed primarily to environmentally conscious users of their devices or applications. Therefore, it seems reasonable to ask whether adapting car navigation to eco-routing requirements should be left to the self-regulation of service providers? The idea of self-regulation is supported by the fact that for years corporations have been subject to social pressure to implement environmentally friendly behaviour and solutions[28]. It is worth mentioning, for instance, the more and more frequent manifestations of "green-banking"[29]. In the European context, support for self-regulation of public and private entities in the field of environmental protection can be also observed – an example is the eco-management system operating on the basis of Regulation (EC) No. 1221/2009[30]. The regulation states that joining the system is voluntary. However, the introduction of self-regulatory solutions is of a very limited effectiveness. Currently, the system associates slightly more than 3,500 organizations which is not a significant number[31].

[27] A. Sciarretta, A. Vahidi, *Energy-efficient driving of road vehicles: Toward cooperative, connected, and automated mobility,* Springer 2020, p. 2.

[28] R. Andrews R., *Environmental regulation and business 'self-regulations'*, "Policy Sciences" 1998, Vol. 31, No. 3, pp. 177, 179–189.

[29] K. Alexander, *Greening banking policy.* Input paper in support of the G20 Green Finance Study Group, 2016, p. 13, http://unepinquiry.org/wp-content/uploads/2016/09/10_Greening_Banking_Policy.pdf (accessed 7.06.2021).

[30] European Parliament and Council Regulation (EC) No. 1221/2009 of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No. 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC [2009] OJ L 342/1.

[31] https://ec.europa.eu/environment/emas/pdf/statistics/EMAS_Statistics_April_2020.pdf (accessed 7.06.2021).

Nevertheless, bearing in mind the evidence of progressing global warming and wide-ranging environmental changes, it seems that any socially viable and economically feasible attempt to reduce GHG emissions should be made. Possible self-regulation and growing social pressure may prove insufficient to make business decisions by the largest automotive concerns and technology companies, or to change certain habits and social behaviours. Therefore, it seems that legislative actions, preceded by extensive consultations and assessment of the potential effects of the regulation, are necessary. They should cover the largest possible geographical areas in order to achieve the assumed, real pro-environmental goal within the returns to scale. The examples of proposed regulatory solutions need some kind of legal incentive.

In the authors' opinion, ultimately every navigation system should be equipped with eco-routing mode within the next few years. The eco-route should in some sense be imposed on the navigation user as the default setting in the route determination, superseding the quickest or shortest route modes. Another key solution, impossible to achieve solely through self-regulation, is the need for a specific synergy through close cooperation of entities, very often competing with each other on a daily basis on the global market. From the technical point of view, in cars equipped with hundreds of various sensors that test current parameters, it is not a problem to obtain individual data for use in the selection of the route of one vehicle. However, the challenge is to create a system of exchange of the finally adopted route choices between the navigation systems in order to avoid the opposite effect from the originally assumed. If all users of a road network are directed to the same route, it will lead to a potential disturbance of the smoothness of the driving (due to an increase in traffic congestion and the formation of traffic jams), and thus to an increase in exhaust emissions. Therefore, there is a need to create a dedicated communication system, and to appoint an international operator for the collected data. Such a solution cannot be created without taking real legislative actions within a boldly conducted environmental policy.

4. NATIONAL OR EU REGULATION?

4.1. THE DIVISION OF COMPETENCES BETWEEN THE EU AND THE MEMBER STATES: GENERAL REMARKS

The analysis conducted so far has shown that legal regulation of eco-routing is justified. In this context, the starting point should be an answer to another key question: at what level should the relevant legislation be adopted? In other words, whether the discussed issues should be regulated at the EU level, or is it sufficient to introduce appropriate regulations at the level of individual Member States –

both from the perspective of the admissibility itself, but also guarantee of the highest possible effectiveness of the discussed regulations.

The division of competences between the Member States and the EU is based on two elements. First one is the principle of conferral expressed in Art. 5(1) sentence 1 of the TEU[32], according to which the EU acts only within the limits of the powers conferred on it by the Member States in the Treaties to achieve the objectives set out therein. At the same time, the TEU stipulates that all competences not conferred on the EU by the Treaties belong to the Member States (Art. 5 (2) sentence 3 TEU). The second component, related to the division of the EU's competences into exclusive – in which the Member States are essentially unable to act independently – and non-exclusive ones, which enable both the EU and the Member States to legislate in the areas covered by them. Within the latter category, we can distinguish shared competences and the so-called supporting competences (also known as coordinating or complementary competences).

Although in case of the areas of exclusive competence, Member States are generally deprived of the possibility to act independently, this does not mean that the EU institutions are able to legislate in this area freely. The exercise of competences by the EU (including excluded ones) is subject to the principle of proportionality – the action must be appropriate to the intended purpose and not go beyond what is necessary to achieve it. On the other hand, in the case of nonexcluded competences, the measures adopted by the EU must additionally comply with the principle of subsidiarity, which is met only when the objective of the intended action cannot be sufficiently achieved by the Member States, and at the same time due to its scale or possible effects they are better achieved at EU level[33].

In the light of the above considerations, in the first place it should be determined whether the eco-routing issue falls within the scope of the competences of the EU, and if so, what competences it covers and on what legal basis such a regulation could be adopted. The answer to these questions is the starting point for determining whether at the EU level it is possible to bring forward a legislative initiative on emission limiting navigation systems, and if so, to what requirements the proposed EU legal measure in this field would have to be subject.

[32] Consolidated Version of the Treaty on the European Union (2012) OJ C 326/13 (TEU).

[33] G. Davies, *Subsidiarity: The wrong idea, in the wrong place, at the wrong time*, "Common Market Law Review" 2006, Vol. 43, p. 63; see also D. Cass, *The word that saves Maastricht? The principle of subsidiarity and the division of powers within the European Community*, "Common Market Law Review" 1992, Vol. 29, p. 1107.

4.2. REGULATION OF ECO-ROUTING FROM THE PERSPECTIVE OF EU COMPETENCES

The main consequence of the mentioned principles is the need to find an appropriate legal basis for an EU legal act. In practice, this is important insofar as the adoption of a legal measure based on an inadequate legal basis constitutes the basis for its annulment (Art. 263 TFEU)[34]. The analysis of the provisions of the Treaties leads to the conclusion that the EU undoubtedly has the competence to adopt a legal measure regulating eco-routing. This regulation should be considered in the first place from the perspective of the EU policy in the field of transport (Art. 90 *et seq*. TFEU) and in the field of the environment (Art. 191 *et seq*. TFEU).

Art. 90 TFEU establishes a common transport policy and applies, *inter alia*, to transport services in the field of road transport (cf. Art. 100 (1) TFEU). This policy aims to remove obstacles between Member States to facilitate the free movement of people and goods within the EU. The means to achieve these goals are establishing common rules for international transport, promoting free competition between operators from Member States, eliminating discrimination against carriers based on their seat or improving transport safety. Art. 91 (1) TFEU broadly outlines the competences of the EU institutions to adopt legal measures to achieve these goals. It was the basis for adopting a number of measures aimed at harmonizing tax and technical regulations[35], administrative regulations[36] or social regulations[37].

However, an analysis of the EU legislative practice to date allows for the assumption that the more appropriate legal basis for the adoption of the emission reduction navigation provisions is Art. 192 (1) TFEU, which authorizes the EU institutions to take measures to implement the EU environmental policy. On this basis, legal measures have been adopted that affect road transport in the Member States, but which primarily take into account environmental considerations[38]. Also recently adopted regulation setting emission performance standards for passenger cars[39] was adopted on the basis of Art. 192 sect. 1 TFEU. The explanatory

[34] Consolidated version of the Treaty on the Functioning of the European Union (2012), OJ C 326/47 (TFEU).

[35] E.g. European Parliament and Council Directive 1999/62/EC of 17 June 1999 on the charging of heavy goods vehicles for the use of certain infrastructure (1999) OJ L 187/42.

[36] E.g. European Parliament and Council Directive 2006/126/EC of 20 December 2006 on driving licenses (2006) OJ L 403/18.

[37] E.g. European Parliament and Council Directive 2002/15/EC of 11 March 2002 on the organization of the working time of persons performing mobile road transport activities (2002) OJ L 80/35.

[38] E.g. European Parliament and Council Directive 2009/33/EC of 23 April 2009 on the promotion of clean and energyefficient road transport vehicles (2009) OJ L 120/5.

[39] European Parliament and Council Regulation 2019/631 of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles and repealing Regulation (EC) No. 443/2009 and (EU) No. 510/2011 (2019) OJ L 111/13.

memorandum to the draft regulation emphasizes that the objectives of the EU environmental policy include, *inter alia*, preserving, protecting, and improving the quality of the environment as well as promoting measures at international level to deal with regional or worldwide environmental problems. Legal regulation concerning emission limiting navigation systems should undoubtedly also be seen in the context of achieving these goals.

It should be emphasized that pursuant to Art. 4(2) TFEU, EU environmental policy (as well as transport policy) falls within shared competences. Thus, following the remarks made earlier, the proposed legal measure would have to be compatible, *inter alia*, with the principle of subsidiarity. Therefore, an analysis is required as to whether, in the light of this principle, the adoption of the eco-routing legal regulation would be acceptable, and if so, which EU legal instrument would be the most appropriate.

4.3. REGULATION OF ECO-ROUTING FROM THE PERSPECTIVE OF THE SUBSIDIARITY PRINCIPLE AND THE NATURE OF THE LEGAL INSTRUMENT

In the light of Art. 5 (3) TEU, verification whether the EU action complies with the subsidiarity principle is of a two-stage nature. Firstly, it is necessary to establish whether the Member States are not able to achieve the intended goal on their own sufficiently (both at central, regional, and local level). Secondly, it must be verified whether the action taken at the EU level will contribute more to the achievement of the objective of the planned action than at the level of the Member States themselves.

The EU regulation of emission limiting navigation systems should meet both of these criteria. Taking action at EU level makes sense not only in view of the very specificities of the road transport sector, which is inherently cross-border in its nature, but also the impact of climate change having the same dimension. Without top-down initiative, there could be a number of different navigation models with different parameters – often inconsistent with each other – which would consequently lead to fragmentation of the internal market, with the risk of its disruption. From the perspective of navigation manufacturers, the necessity to always adapt to various requirements provided for in national regulations, including additional costs associated with it, could discourage them from wider use, undermining the achievement of the intended environmental protection objective, including combating climate change. Moreover, the aforementioned additional costs would be borne not only by the navigation manufacturers, but also by the users themselves, who would ultimately suffer the consequences of a lack of coordinated action. Hence, the adoption of common standards and eco-routing solutions would allow for a more effective achievement of the intended regulatory

objectives, while ensuring a higher level of protection for all market participants and limiting the risk of distortions of competition in the internal market.

Regardless of the legitimacy of regulating this issue at the EU level, the question arises about the choice of the legal form of such a measure. Pursuant to Art. 288 TFEU, binding acts of secondary law may take the form of regulations, directives or decisions. Each of them is characterized by a different legal nature[40]. In the authors' opinion, the most appropriate EU legal instrument from the perspective of regulating eco-routing is a regulation. Regulation is directly applicable, which means that, unlike directives, it does not need to be transposed into national law. In order for the navigation systems to achieve the intended purpose, and at the same time to avoid the risk of market fragmentation described above, it would be reasonable to establish unified rules and parameters. An inherent feature of the directives is that the Member States are free to choose the form and means of implementing them. Direct applicability of a regulation would reduce the risk of legal fragmentation and, at the same time, increase legal certainty through a top-down set of rules that is the same for all, contributing positively to the smooth functioning of the internal market. Moreover, in most cases, the addressees of the new regulations will not be the Member States of the EU themselves, but manufacturers of passenger cars and trucks, as well as providers of navigation services and devices. Thus, the EU regulation imposing the obligations directly on the group of the largest international economic entities operating on the global market seems to be more appropriate than a directive which due to its legal nature does not impose any obligations on the individuals.

Considering the returns to scale, only the EU as a whole, as part of a consistently implemented and innovative global energy and climate policy, can effectively influence, and has ongoing impact on the directions selected in connection with the idea of eco-routing. The EU regulation, which covers 27 Member States and thus affects the market rules covering more than 446 million people, seems to be the only right and the most effective way to face this challenge.

5. CONCLUSION

The conducted analysis has proved that the adoption of the eco-routing legal intervention at the EU level is not only acceptable (both from technical and regulatory perspective) but also required in the near future, bearing in mind the increasing GHG emissions in the EU transportation sector. However, the activities undertaken in the field of eco-routing should be preceded by extensive socio-market consultations, technical and economic analyses, including the schedule, imple-

[40] G. Búrca, P. Craig, *EU law: Text, cases, and materials*, Oxford 2015, p. 105.

mentation method, and some kind of gradation of planned obligations. The result of the above process should be the determination of the milestones within the framework of future regulation, socially and economically acceptable and, above all, realistic steps to be achieved by the obligated economic entities.

In view of the determined and already chosen course for the EU to achieve a net zero-emission economy under the European Green Deal program, as well as the designated GHG emission reduction indicators in the transportation sector, the correctness of the proposed solutions should not raise any doubts or social resistance. It is worth emphasizing that some users already now independently select settings within the ECO mode, available in some applications and navigation devices. So why not make this as a standard? The key question, therefore, is not actually the question of "whether to introduce" the regulation, which, given the enormous scale of the use of passenger and freight wheeled transport, undoubtedly has a chance to reduce the level of GHG emissions in the area of transport in the EU, but the question of "how" this initiative should be carried out. Limited framework of this study does not allow for the presentation of full concepts and ideas for specific, comprehensive, and effective legal solutions. However, the issues presented here should become a source of a broad discussion. Its result should be measures to supplement the energy and climate policy with a new, innovative solution based on artificial intelligence algorithms and big data sets.

The EU already has a number of extremely rich experiences in the gradual, cyclical introduction of legal regulations and the achievement of partial goals resulting from long-term pro-environmental strategies. They can constitute an example or a specific starting point for new regulations concerning eco-routing. It is worth mentioning here a whole range of regulations promoting the use of energy from renewable sources, with the latest directive on the promotion of the use of energy from renewable sources[41] (setting the binding targets for individual Member States and the entire EU), regulation on binding annual greenhouse gas emission reductions[42] or the already cited regulationsetting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles. The EU institutions, more cautious and, at the same time, richer in the lessons learned from the scandal related to, among others, the activity of the Volkswagen Group within the so-called *Volkswagen emission scandal* or *dieselgate* should have no problem preparing a comprehensive, proportionate, consistent, reliable, and effective legal regulation, supplemented with an entire range of control and verification possibilities.

[41] European Parliament and Council Directive 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources (2018) OJ L 328/82.

[42] European Parliament and Council Regulation 2018/842 of 30 May 2018 on binding annual greenhouse gas emission reductions achieved by Member States from 2021 to 2030, contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No. 525/2013 (2018) OJ L 156/26.

But where should we start? Undoubtedly, the proposed regulations will in many cases have to be legal and technical regulations, characterized by a high degree of detail. The first step in the legislative work should be to determine the method and standards of providing information and data necessary to adapt the current and to prepare new navigation software, allowing for taking into account the entire catalogue of the aforementioned potential variables – related directly to vehicles and the landscape. It is also necessary to develop standards for remote communication and exchange of information between the navigation devices themselves or, more broadly, between cars (communication between passing vehicles or with the central database), conducted during the journey with the use of navigation programs and thus improving the functioning of the system. In this regard, however, it should be remembered that at the same time the anonymity of the owners of individual vehicles is to be ensured.

As it seems now, the key to the first phase of introducing the new regulations will be the future-oriented regulation, i.e. covering, in the coming months and years, newly manufactured and introduced to the market motor vehicles (passenger and delivery vehicles), equipped with factory-installed navigation devices. The designed solutions should allow for the real use of a maximally wide catalogue of variables, related both to the technical properties of a given vehicle (collected, pre-analysed and provided on an ongoing basis by a car computer), the environment (topography, weather, traffic intensity, possible traffic difficulties), the way the vehicle is driven or also the number of passengers and the weight of the transported goods.

Based on a number of data provided as part of the first stage of eco-routing implementation by car manufacturers and suppliers of certain parts (mainly indicators provided by tire manufacturers), a central European database on motor vehicles and emission reductions in relation to the application of individual solutions and eco-routing settings should be created. Information collected in this way, while ensuring the full anonymity of car users, could also become the basis for further pro-environmental research in the field of eco-routing. Legal regulation in the above scope would also be an additional stimulus to strengthen competition on the market of motor vehicles and navigation devices, due to ensuring equal access to the collected data. Therefore, such a database should be built, maintained, managed and made available by an independent data operator, e.g. in the form of an EU agency, guaranteeing third parties' access to properly prepared information packages.

Subsequently, the experience gained and the collected data should allow for the introduction of detailed regulations, setting requirements and adopting standards relating to two following other areas:

1. New external devices for navigation with integrated navigation software,
2. Software updates for external devices already in use and factory navigation devices in older cars and vans.

In both cases, for the full use of eco-routing, it would be necessary for manufacturers of navigation systems to use the data provided to the aforementioned central database by vehicle manufacturers. Moreover, it is also worth adding that car computers that have been installed for several years now, collect a whole range of data about a vehicle for service purposes. So we are dealing with an almost ready base that allows for at least partial implementation of eco-routing to older vehicles.

The information gathered, the experience gained, and the selected directions, with the full cooperation of all those obliged under the proposed regulation of economic entities, would allow for faster achievement of the assumed results, including the set GHG emission reduction targets in the transportation sector.

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