What policy framework for synthetic fuels exist in Europe and what impact do they have?

Welche politischen Rahmenbedingungen für synthetische Kraftstoffe existieren in Europa und wie wirken sie sich aus?

Dr. Tobias Block, Algara Castle, eFuel Alliance e.V., Brussels, Belgium

Felina Neu, Kühne Logistics University, Hamburg, Germany

Abstract

This publication provides a short summary and assessment of the European Union's current policy framework regarding decarbonization in the transport sector, with focus on regulations addressing synthetic fuels. Some of those include Renewable Energy Directive, FuelEU Maritime, ReFuelEU Aviation, CO_2 standards for vehicles and the energy taxation directive. Furthermore, it predicts the impact those regulations will have on the demand and implementation of synthetic fuels within this decade. Concluding that synthetic fuels will face a low demand up of just 10-12 TWh till 2030 due to the current EU quotas being to unambitious and not following a technologically open approach, therefore often excluding the high decarbonization potential of synthetic fuels. Additionally, this paper proposes policy improvements to use the full potential synthetic fuels can provide.

Kurzfassung

Diese Publikation bietet eine kurze Zusammenfassung und Bewertung der aktuellen politischen Rahmenbedingungen der Europäischen Union bezüglich CO_2 Emissionssenkung in der Transportsektor, mit Fokus auf Verordnungen welche synthetischen Kraftstoffe adressieren. Dazu gehören Renewable Energy Directive, FuelEU Maritime, ReFuelEU Aviation, CO_2-Standards für neue Fahrzeuge und die Energiebesteuerungsrichtlinie. Darüber hinaus wird eine Prognose erstellt, wie sich diese Vorschriften auf die Nachfrage und die Einführung synthetischer Kraftstoffe in diesem Jahrzehnt auswirken werden. Zu dem Schluss kommend, dass die Nachfrage nach synthetischen Kraftstoffen mit 10-12 TWh bis 2030 gering bleiben wird, da die derzeitigen EU-Quoten zu niedrig sind und keinen technologieoffenen Ansatz verfolgen, wodurch das hohe CO_2 Einsparungspotenzial synthetischer Kraftstoffe ungenutzt bleibt. Darüber hinaus werden Verbesserungsvorschläge zu den Verordnungen gemacht, um das volle Potenzial synthetischer Kraftstoffe zu nutzen.

1. INTRODUCTION

The current European Commission has launched a major revision of climate legislation in Europe. In order to achieve the goal of reducing the EU's greenhouse gas emissions by 55% of 1990 levels by 2030, the European Commission presented the so-called Fit-for-55 package, which includes 13 climate regulations and directives that have been under discussion in parallel over the last two years. Most of these climate policy legislations have been finalised now. This paper analysis the impact of these regulations on the

future development of synthetic fuels. The availability of climate-friendly synthetic fuels will in turn have impact on the market share and future development of the internal combustion engine (ICE) in different sectors.

First, we will provide an overview of the final state of the most relevant legislations for the development of synthetic fuels such as the Renewable Energy Directive (RED), the FuelEU Maritime regulation, the ReFuelEU Aviation regulation, the revised CO_2 emission standards for passenger cars, light and heavy-duty vehicles as well as the revision of the Energy Taxation Directive (ETD). Second, we will calculate the 2030 final demand for synthetic fuels resulting from the targets, mandates or price incentives foreseen in the relevant provision. We assume that CO_2 prices, e.g. in the EU Emissions Trading Scheme (ETS), will not increase significantly, so that the cost differences to fossil fuels can be fully compensated. As result, synthetic fuels will be more expensive than their fossil equivalents, so it is unlikely that companies will over-fulfil mandatory legal requirements (such as the supply targets in the RED or the blending mandates for airlines) in order to avoid competitive disadvantages. Third, in an outlook, we will summarise our analysis and provide further political recommendations to foster the market uptake of hydrogen derived synthetic fuels.

This work defines synthetic fuels as 'renewable liquid and gaseous transport fuels of non-biological origin (RFNBO)' in reference to article two number 36 of REDII [1]. In article 27 paragraph three of the same regulation, it is further specified that the electricity to produce RFNBOs must have its origin in renewable sources. Furthermore, synthetic fuels based on renewable hydrogen are climate-neutral in the use phase, as the same amount of CO_2 is captured during the production these fuels as is later released during the combustion process. A multitude of lifecycle analysis are demonstrating that a CO_2 reduction of more than 90% in comparison to fossil fuels is possible [2]. Synthetic fuels will play a major role in decarbonising the transport sector – not just in hard-to-abate sectors like maritime and aviation, but also for a large existing fleet of more than 300 million vehicles with an ICE on the EU's roads [3]. However, synthetic fuels are also an interesting option for new vehicles as they can complement the electrification of road transport - especially for heavy-duty vehicles - and serve as a backup in case the expansion of the charging infrastructure is not progressing fast enough, or if there are not enough raw materials available for the enormous demand for batteries.

2. POLITICAL FRAMEWORK FOR SYNTHETIC FUELS IN THE EU

As mentioned, we will briefly describe the main political dossiers, which influence the future development of synthetic fuels in Europe. The revised CO_2 emission standards for heavy-duty vehicles and the revision of the ETD have not been finalised at the time of publication of this paper. In the following, only current political developments are described.

2.1. Renewable Energy Directive

The Renewable Energy Directive (RED) was developed in 2009. It defines the mandatory share of renewable energy in specific energy sectors. In the transport sector, all Member States must make sure that at least 10% of the energy used comes from renewable sources from 2020 onwards. A recent presentation by Müller-Langer et al. shows that in 2021, 13 Member States missed that target [4]. In the recast of the RED (so-called: REDII) of December 2018 the share of renewables in the transport sector was set at 14 % by 2030 [1]. However, the relevant provisions allow Member States to apply different multipliers when calculating the share of the various energy carriers in the energy consumption of the transport sector. For example, the renewable share of charging power for electric cars is counted fourfold. Hydrogen for fuel cell vehicles and advanced biofuels are double counted. These multipliers reduce the overall efforts to achieve the targets, as they simply inflate the share of renewables statistically, and lead to market distortion.

The recent revision of the RED (REDIII) increases the ambition level for the transport sector. On 30th of March 2023 the European Parliament and Council reached an agreement to raise the share of renewable energy in the EU's overall energy consumption to 42.5% by 2030 with an additional 2.5% indicative top up that would allow to reach 45%. In the transport sector, Member States have the possibility to choose between a binding target of 14.5% reduction of greenhouse gas intensity in transport from the use of renewables by 2030 or a binding share of at least 29% of renewables within the final consumption of energy in the transport sector by 2030. In addition, RED III sets a binding combined sub-target of 5.5% for advanced biofuels (Annex IX, Part A) and renewable fuels of non-biological origin (RFNBOs – mostly renewable hydrogen and its derivatives) of energy supplied to the transport sector. Within this target, there is a minimum requirement of 1% of RFNBOs. However, these sub-targets include the possibility of applying a 2-fold multiplier, so that the actual values have to be halved to 2.75 % and 0.5 % respectively. If we assume that synthetic fuels remain more expensive than biofuels until 2030, we can expect that fuel companies will only meet the binding sub-quota of 0.5 % considering the multipliers. This quota has to be further reduced because an additional multiplier of 1.5 exist if those RFNBOs are used in aviation or maritime [5].

From the point of view of synthetic fuels producers, it is positive that for the first time a binding target for synthetic fuels in the transport sector has been set, which will guarantee a secure demand. However, the level of ambition is relatively low, considering that the Commission's proposal initially envisaged a mandatory sub-target of 2.6%, which was increased later to 5% in the RePowerEU package as a reaction to the Russian invasion of Ukraine in order to reduce dependence on fossil fuel imports. The European Parliament even entered negotiations with Council with a 5.7% RFNBO quota. But Member States were not willing to go along with this pace and were instrumental in reducing the share of synthetic fuels in the transport sector to only 0.5 %. In the next chapter, we will analyse the consequential demand.

2.2. FuelEU Maritime

On March 23rd, European legislators agreed on the first European climate regulation for the maritime sector. It sets general greenhouse gas (GHG) emission reduction goals for ships calling at European ports: By 2030, ship owners must reduce the GHG emission by 6 % compared to a 2020 baseline. All inter-European trips are covered. If ships from outside the EU enter a European port, only 50% of the fuel consumption is taken into account. Vessels with a gross tonnage (GT) of less than 5,000 do not fall within the scope of the regulation. A dedicated sub-target for synthetic fuels is also included in this regulation: The maritime industry should endeavour to fuel its ships with 1% synthetic fuels in 2030. If this non-binding blending mandate is not met a binding target of 2 % will be set in 2034 [6]. In **Table 1** the GHG targets are summarised. Recent announcements of the second and third largest shipping companies Maersk and CMA CGM show that more than 35 vessels capable of running on synthetic fuels have been ordered [7, 8]. The amounts of synthetic fuels that those vessels would consume are likely to exceed the non-binding sub-quota in 2030. In chapter three we will analyse the potential demand for this sector.

Table 1: Limits on GHG intensity for the European maritime sector

Year	GHG targets
2025	-2%
2030	-6%
2035	-14.5%
2040	-31%
2045	-62%
2050	-80%

2.3. ReFuelEU Aviation

On April 25th, the European Parliament and Council agreed on a fuel obligation regulation for the aviation industry. From 2030 onwards, a blending of 6% of sustainable aviation fuels (SAF), which includes both sustainable biofuels, synthetic fuels as well as hydrogen and low-carbon fuels, is mandatory. With a sub-quota for synthetic fuels of 1.2% in 2030, 2% in 2032 and 5% in 2035, synthetic fuels are to be promoted in the long term. The quotas will gradually increase to reach 70% in 2050, 35% of which will be synthetic fuels. The regulation only includes commercial flights that depart from airports located in the EU [9].

Table 2: Fuel obligations for the European aviation sector

Year	SAF quota	Thereof synthetic fuels
2025	2%	-
2030-2031	6%	1.2% in average (minimum of 0.7% per annum)
2032-2033	6%	2% in average (minimum of 1.2% per annum)
2034	6%	2%
2035	20%	5%
2040	34%	10%
2045	42%	15%
2050	70%	35%

2.4. CO_2 emission standards for new passenger cars, light and heavy-duty vehicles

The first CO_2 standards for new passenger cars and light-duty vehicles have been introduced in 2009. They set mandatory emission reduction targets for new cars from 2015 onwards. A target of 130 g/km on average for the annually sold vehicles in Europe applied between 2015 and 2019. From 2020 onwards, the emission target is 95 g/km with a consumption of 4.1 l/100 km of petrol or 3.8 l/100 km of diesel [10]. The weight of new vehicles is considered to set individual targets for OEMs in different market segments: heavier vehicles are allowed to emit slightly more CO_2. The goal of that initial regulation was to improve the efficiency of the ICE. Therefore, solely the CO_2 emissions at the exhaust pipe have been taken into account and the energy carrier has been neglected. The underlying problem with this approach is, that an electric vehicle always has zero gram per kilometre by default – even if it is charged with electricity from fossil fuels – while a vehicle with an ICE is always considered as 100% fossil fuelled even if renewable fuels are used.

In April 2019, the European parliament and the council adopted the CO_2 standards for new cars and vans. The ambition level has further increased by 15% in 2025 and 37,5% in 2030 from the 2021 starting points. The ambition level for newly registered vans has been increased to 31% in 2030. Different incentive mechanism for BEVs and Plug-in Hybrid electric vehicles (PHEV) exist (so-called: ZLEV-mechanism). In addition, pooling, exemptions (the most emitting 5% of registrations are not counted at all, the so-called "phase-in") and derogations for "niche" OEMs were implemented. These modalities have already been used in different variations, e.g., Fiat Chrysler Automobiles likely paid Tesla $560 million to pool their new vehicles together [11]. If OEMs can't reach their fleet target values, penalties ("excess emission premiums") of 95 €/g/km per vehicle sold, apply. Assuming an average mileage of 200,000 km over lifetime, these penalties result in CO_2 abatement costs of 475 €/t. Volkswagen had to pay €100 million in 2020 despite all facilitations [12]. It is obvious that such a benchmark can only be achieved with zero

emission vehicles. For that reason, most car manufacturers have prioritized electrification, and some have invented all-electric strategies – at least for the European market.

In the Fit-for-55 package the CO_2 emission standards for cars and vans have been revised again. From the beginning on, the Commission has proposed a 100% reduction target in 2035, which means a de-facto ban of the ICE in the current framework. In October 2022, the European parliament and Council agreed on a provisional deal, which confirms the 100% reduction target. Based on an intervention of the German government, which formed a blocking majority together with Italy, Poland, Hungary and other countries, the regulation could not get a final approval. The blocking member states insisted on an exception for vehicles, which run on synthetic fuels. In March 2023, the European legislators agreed on a compromise. The Commission shall develop a methodology to define a new vehicle class in the type-approval regulation for vehicles, which exclusively run on synthetic fuels. In addition, a delegated act for the CO_2 emission standards will be proposed [13]. One of the key questions is how it is going to be verified that a vehicle is only running on synthetic fuels – a pragmatic approach is required. So far, the Commission has not presented a viable solution.

In June 2019, the first CO_2 emission standards for heavy-duty vehicles entered into force. Truck manufactures must reduce CO_2 emissions of new vehicles by 15% until 2025 and 30% in 2030. Penalties for non-compliance will start in 2025 with 4,250 €/g/tkm per vehicle [14]. This regulation follows the same misleading tailpipe approach as the passenger car regulation. As a result, the CO_2 reduction of renewable fuels is not considered. Truck manufacturers can only comply if they introduce zero emission trucks to the market.

In February 2023, the Commission published a revision of the CO_2 emission standards for heavy-duty vehicles as part of the Fit-for-55 package. The Commission proposed to increase the ambition level in 2030 to -45% and expand the scope to busses and include more vehicle groups. The Commission also introduced new targets beyond 2030 (-65% in 2035 and -90% in 2040) [15]. As mentioned above, a trajectory of up to -90% is only possible if truck manufactures focus on battery or hydrogen trucks. Trucks with an ICE on board, which could use renewable fuels like biomethane or synthetic fuels, are politically almost excluded. The legislative process is still ongoing and is expected to be finalized in the first half of 2024. It would be incomprehensible if the Commission is developing a solution for synthetic fuels for cars but not for trucks. In addition, various political groups have tabled different amendments in the European parliament to consider the climate impact of renewable fuels.

Why is this important for the further development of synthetic fuels? First, in comparison to dedicated mandates for the aviation and maritime sector it is an unambiguous political signal that renewable fuels should not be used in the road sector in the long-term. This decreases future demand and investments in new synthetic fuels projects. Further, if those tailpipe-based regulations would be altered, a viable market for synthetic fuels can be established. Gatzen et al. have shown that a premium of up to 1.6 €/l of synthetic fuels would be paid if car manufactures could avoid penalties [16]. This equals to CO_2 abatement cost of up to 475 € per ton. A lot of synthetic fuel project would become instantly economic viable. In addition, by-products often exist in the production of synthetic fuels [17]. If those by-products cannot be sold to the road sector, synthetic fuels for aviation and maritime sector need to cover the price differences and will appreciate in price. Even if electric vehicles will undoubtably play a significant role for the road sector it would be irresponsible to exclude synthetic fuels for the road sector from the beginning.

2.5. Revision of the Energy Taxation Directive

The European energy taxation defines minimum tax shares for different energy carriers in the EU. The current regulation has been published in 2003. Thus, recent technological developments are not considered. For example, a definition of a specific tax share on synthetic fuels does not exist. For that reason, renewable

fuels are taxed in the same way as fossil fuels. Hence, this scheme does not support climate friendly solutions.
In 2011, the Commission initiated an attempt to change the energy taxation. In the communication brief to the parliament, council and European committees, the Commission stated that a "More rational and targeted energy taxation will contribute in a technology-neutral manner to cleaner and more efficient consumption of energy" [18]. However, tax issues need to be decided upon unanimously in the EU. Back then, the proposal was refused by Luxembourg, Poland and Germany.
In 2019, as part of the Green Deal, the Commission announced the next attempt to revise the energy taxation. The Commission published a new proposal of the energy taxation in July 2021. It includes very low tax rates for synthetic fuels [19]. This potentially has a significant economic leverage. A full consideration of the carbon footprint of the energy carrier would increase the willingness to pay of different market participants, who bring renewable fuels into the market. For example, in Germany climate-neutral petrol would have a price advantage of up to 0.65 €/l compared to fossil fuels.
The revision of the energy taxation is also important because the United States of America are offering massive tax incentives for green hydrogen and synthetic fuels.

3. CALCULATION OF THE FUTURE DEMAND OF SYNTHETIC FUELS

In this chapter, we calculate the short-term demand of synthetic fuels until 2030 by first analysing the demand generated by the ReFuelEU Aviation and FuelEU Maritime regulations. Secondly, the effects of the revised RED are derived. Finally, we will present the total demand of synthetic fuels to meet the respective regulation. To analyse the respective fuel demand, first, the total future fuel consumption has to be determined. This is not an easy task as such predictions depend on many assumptions such as economic developments, mobility behaviour or potential technology leaps. In addition, the ReFuelEU Aviation and FuelEU Maritime are exempting parts of international transportation and smaller vessels or planes, which has an impact on actual fuel consumption. Here, we refer to other organisations, who have modelled the future demand of those sectors.
For FuelEU Martime, the lobby group Transport & Environment has calculated a total demand for marine fuel of 348 TWh in 2030 based on the official reference scenario from the European Commission and data from the International Maritime Organization [20]. Consequently, a sub-quota of 1% for synthetic fuels in 2030 would result in a demand of 3.48 TWh. Considering a capacity factor of 4,500 full load hours it would lead to an electrolysis capacity of 0.77 GW.
For ReFuelEU Aviation, the official impact assessment of the Commission indicates a total fuel demand of 580 TWh in 2030 [21]. A sub-quota of 1.2% for synthetic fuels in 2030 results in 6.96 TWh. Considering the same capacity factor for synthetic fuel plants as mentioned above, this brings an additional 1.55 GW of electrolysis capacity.
The calculation for the revised RED is much more complex and is shown in figure 1. Here we consider the mixed scenario of the European Commission for delivering the Green Deal [22]. According to that scenario the total fuel demand for the transport sector in the EU will increase by 11% from 2020 to 2030[1]. The fuel demand is expected to be 3,606 TWh in 2030. The largest consumer is the passenger car sector. Maritime, aviation and heavy-duty transportation are on a comparable level between 519 and 695 TWh. The total fuel consumption of the maritime and aviation sector differs in comparison to the FuelEU Maritime and ReFuelEU Aviation because different scopes and exemptions exist as mentioned above. The ambition level of the RED is a 29% renewables share of energy final consumption in the transport sector, as described

[1] Please note that 2020 was a Covid-19 year and fuel consumption in road transport and aviation was low.

above. For that reason, 1,046 TWh have to come from renewable energy sources. Fuel companies, which need to comply with the RED, have different options available to meet that requirement. If they don't comply penalties are pending, which exceed the cost of investments in the production of renewable energy carriers.

First, conventional crop-based biofuels can be used as a relatively cost-competitive compliance options, which already exist on the market. But for sustainability reasons, conventional biofuels are capped at 7% of the total fuel demand. For that reason, not more than 252 TWh can be used for the compliance option 'conventional biofuels'.

The second compliance option is to use renewable energy in electric vehicles and railways. According to the official impact assessments of the CO_2 emission standards for passenger as well as heavy-duty vehicles, the forecasted electricity demand is 88 TWh for cars and 14 TWh for trucks in 2030 [23, 24]. The European Commission expects a share of renewable electricity of 65% in 2030 as stated in the RED [5]. The amount of renewable electricity for electric vehicles is accounted quadrable. In addition, the electricity demand for railway is expecting to be 55 TWh and has a multiplier of 1.5. In total, the compliance option 'electricity' accounts for 348 TWh or one third of the ambition level. This is by far the most relevant driver and is another indicator that political decision makers push significantly for more electrification.

As a third compliance option, advanced biofuels of Annex IX Part A of the RED are considered. Those are biofuels from waste materials and residuals. As mentioned, a combined quota of 5.5% for advanced biofuels and synthetic fuels exist. Assuming that advanced biofuels are cheaper than synthetic fuels as different studies show [4] the majority of this quota will be met with advanced biofuels. The sub-quota of 1% for synthetic fuels must be subtracted here and the multiplier of two needs to be considered. In the end, the compliance option 'advanced biofuels of Annex IX Part A' could cover 162 TWh.

A fourth option is biofuels of Annex IX Part B. Those are biofuels from animal fats and cooking oils. This option is capped by 1.7% due to sustainability reasons and has a multiplier of two as well. Hence, it could lead to 123 TWh of renewable energy in the transport sector.

Hydrogen and synthetic fuels represent the last compliance group. Here, just a sub-quota of 1% and a double counting exist, which could lead to a contribution of 36 TWh. Without the multiplier, not more than 18 TWh will be demanded if the multiplier is subtracted. If we further consider that another multiplier of 1.5 for RFNBOs, which are used in the aviation and maritime sector, exist and we take into account that ReFuelEU Aviation and FuelEU Maritime will lead to a demand of approximately 10 TWh the majority of the sub-quota will be met with synthetic fuels for the aviation and maritime sector. In conclusion, not more than 10-12 TWh of demand for synthetic fuels can be expected while considering all regulations of the Fit-for-55 package. This results in an electrolysis capacity of 2.22-2.67 GW.

Although a compliance gap of 125 TWh is left in our analysis it can be expected that this gap is closed with cheaper compliance options like more electric vehicles or more advanced biofuels. New investments will mainly take place in advanced biofuels of Annex IX Part A and B as well as to a lesser extent in synthetic fuels.

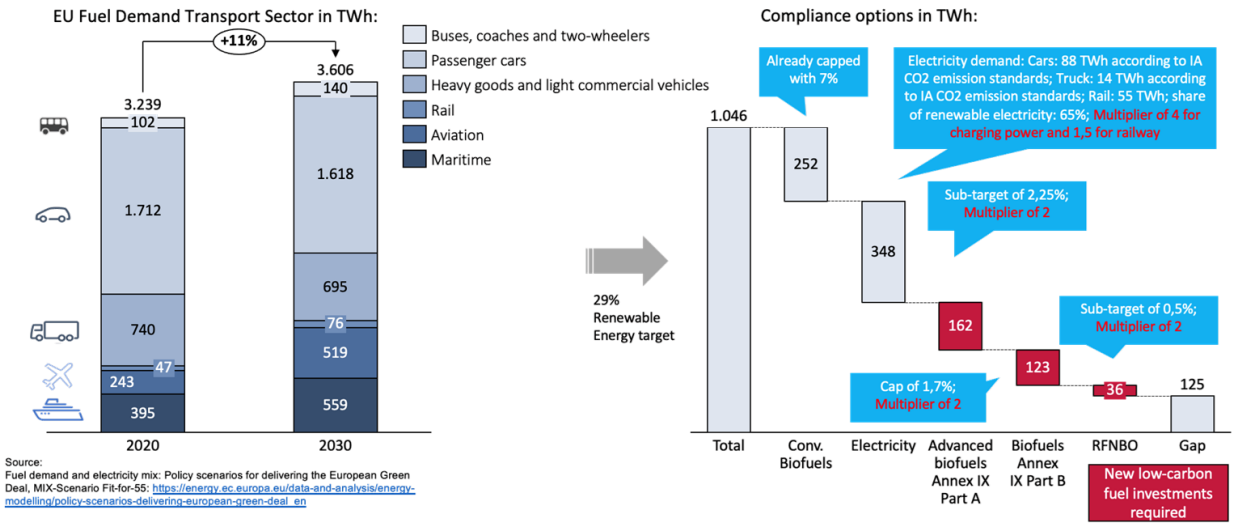

Figure 1: Different compliance option to meet REDIII requirements

4. SUMMARY AND POLITICAL RECOMMENDATIONS

We have shown that the recently finalised European Green Deal legislations will not lead to a significant demand for synthetic fuels in the transport sector before 2030. It can be expected that 10-12 TWh of synthetic fuels will be produced in 2030 to meet the regulatory requirements. This results in an electrolysis capacity of only 2.2-2.7 GW. But the European hydrogen strategy foresees 2x40 GW – 40 GW in Europe and 40 GW as exports to Europe. By 2024, 6 GW should already be installed [25]. Of course, the industry and heating sector will lead to additional volumes of renewable hydrogen and synthetic fuels, but probably will not meet the strategic targets in time. This is all the more disappointing considering that in the RePowerEU package the European Commission recommended a binding sub-target of 5% for hydrogen and synthetic fuels, which would have created a demand of 250 TWh and electrolysis capacity of 55 GW. However, the RED has to be implemented in national law. Some Member States have already announced higher quotas for synthetic fuels in the transport sector. Romania recently adopted a hydrogen law, which sets a binding sub-quota of 5% for hydrogen and synthetic fuels in 2030 [26]. The previous Finish government wanted to go for 3% of synthetic fuels by 2030 [27]. Also, the Spanish government mentioned targets even above 5% in their latest update of the National Energy and Climate Plans [28].

For the further development of synthetic fuels in the transport sector, we recommend the following political steps:

- More ambitious quotas and mandates in the national implementation of the REDIII.
- Consideration of synthetic fuels in the CO_2 emission standards of new vehicles to enable a use in all sectors and take advantage of the high CO_2 abatement costs in the road sector.
- Revision of the energy taxation so that it takes into account the carbon footprint of different energy carriers.

5. REFERENCES

[1] European Parliament, "Directive (EU) No 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)", EU Directive 2018/2001, 2018, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001, accessed on 26.07.2023

[2] Jens Perner and Theresa Steinfort, “The overall CO2 impact for drive technologies in individual transport today and in the future", https://www.efuel-alliance.eu/fileadmin/Downloads/RPT-Frontier-Uniti-LCA-16_01_2019_EN_stc.pdf, 2016, accessed on 26.07.2023

[3] European Commission, “EU Transport in figures, statistical pocketbook 2022”, https://op.europa.eu/en/publication-detail/-/publication/f656ef8e-3e0e-11ed-92ed-01aa75ed71a1, 2022, accessed on 26.07.2023

[4] Müller-Langer, F., Schröder, J., Naumann, K., 2023. Overview of quota developments in selected EU Member States. 20th International Conference on Renewable Mobility "Fuels of the Future", Berlin, 23.-24.01.2023.

[5] European Council, “Council and Parliament reach provisional deal on renewable energy directive”, 2023, https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/, accessed on 26.07.2023

[6] European Council, “FuelEU Maritime initiative: Provisional agreement to decarbonise the maritime sector”, 2023, https://www.consilium.europa.eu/en/press/press-releases/2023/03/23/fueleu-maritime-initiative-provisional-agreement-to-decarbonise-the-maritime-sector/, accessed on 26.07.2023

[7] Maersk, “Maersk orders six methanol powered vessels”, 2023, https://www.maersk.com/news/articles/2023/06/26/maersk-orders-six-methanol-powered-vessels, accessed on 26.07.2023

[8] Argus Media, “CMA CGM in $3bn methanol, LNG ship deal”, 2023, https://www.argusmedia.com/en/news/2438212-cma-cgm-in-3bn-methanol-lng-ship-deal, accessed on 26.07.2023

[9] European Parliament, “Fit for 55: Parliament and Council reach deal on greener aviation fuels”, 2023, https://www.europarl.europa.eu/news/en/press-room/20230424IPR82023/fit-for-55-parliament-and-council-reach-deal-on-greener-aviation-fuels, accessed on 26.07.2023

[10] European Commission, “Reducing CO2 emissions from passenger cars - before 2020”, 2021, https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/co2-emission-performance-standards-cars-and-vans_en, accessed on 27.07.2023

[11] Totaro, L., Lepido, D., “Fiat to Pool Cars With Tesla to Meet EU Emissions Targets on CO2”, 2019, https://www.bloomberg.com/news/articles/2019-04-07/fiat-chrysler-teams-with-tesla-to-meet-eu-emissions-targets, accessed on 27.07.2023

[12] FAZ, “100 Millionen Euro Strafe für VW wegen verfehlter CO2-Ziele“, 2021, https://www.faz.net/aktuell/wirtschaft/unternehmen/verfehlte-co2-ziele-100-millionen-euro-strafe-fuer-vw-17157638.html, accessed on 27.07.2023

[13] European Council, „‘Fit for 55’: Council adopts regulation on CO2 emissions for new cars and vans“, 2023, https://www.consilium.europa.eu/en/press/press-releases/2023/03/28/fit-for-55-council-adopts-regulation-on-co2-emissions-for-new-cars-and-vans/, accessed on 27.07.2023

[14] European Parliament, "Regulation (EU) No 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC, 2019, https://eur-lex.europa.eu/eli/reg/2019/1242/oj, accessed on 27.07.2023

[15] European Commission, „Reducing CO_2 emissions from heavy-duty vehicles“, 2023, https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en, accessed on 27.07.2023

[16] Gatzen, C., Zähringer, M., Bothe, D., „Crediting System for Renewable Fuels: Functionality & Benefits, 2020, https://www.efuel-alliance.eu/fileadmin/Downloads/crediting-system-for-renewable-fuels.pdf, accessed on 27.07.2023

[17] Soler, A., “Role of e-fuels in the European transport system. Literature review”, 2020, https://www.efuel-alliance.eu/fileadmin/Downloads/Rpt_19-14.pdf, accessed on 27.07.2023

[18] European Commission, “Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee, smarter energy taxation for the EU: Proposal for a revision of the Energy Taxation Directive”, 2011, https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=CELEX:52011DC0168, accessed on 27.07.2023

[19] European Commission, “Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast)”, 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0563, accessed on 27.07.2023

[20] T&E, “Why an e-fuel mandate for ships?”, 2023, https://www.transportenvironment.org/wp-content/uploads/2023/01/202301_TE-Briefing-Why-an-e-fuel-mandate-for-shipping.pdf, accessed on 27.07.2023

[21] European Commission, “Commission Staff working document – Impact Assessment – Accompanying the Proposal for a Regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport”, 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021SC0633, accessed on 27.07.2023

[22] European Commission, “Policy scenarios for delivering the European Green Deal”, 2021, https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-european-green-deal_en, accessed on 27.07.2023

[23] European Commission, “Commission Staff Working Document Impact Assessment Part 1 Accompanying the document Proposal for a Regulation Of The European Parliament And Of The Council amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union’s increased climate ambition”, 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021SC0613, accessed on 27.07.2023

[24] European Commission, “Commission Staff Working Document Impact Assessment Part 1 Accompanying the document Proposal for a Regulation of the European Parliament and of the Council setting CO2 emission performance standards for new heavy duty vehicles”, 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=comnat:SWD_2018_0185_FIN, accessed on 27.07.2023

[25] European Commission, “EU Hydrogen Strategy”, https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1296, accessed on 27.07.2023

[26] Lexology, “Romania announces new framework for hydrogen energy integration”, 2023, https://www.lexology.com/library/detail.aspx?g=c5e484da-e88a-4cc8-a4c4-99b82ff92da4, accessed on 27.07.2023

[27] Hydrogeninsight, “'Competitive advantages' | Finland wants green hydrogen-based e-fuels to make up 3% of all transport fuels by 2030”, 2023, https://www.hydrogeninsight.com/production/competitive-advantages-finland-wants-green-hydrogen-based-e-fuels-to-make-up-3-of-all-transport-fuels-by-2030/2-1-1402625, accessed on 27.07.2023

[28] European Commission, “Spain - Draft Updated NECP 2021-2030”, 2023, https://commission.europa.eu/publications/spain-draft-updated-necp-2021-2030_en, accessed on 27.07.2023