Concawe's transport and fuel outlook towards the EU 2030 climate targets (baseline and sensitivity analysis)

Enquiries: marta.yugo@concawe.eu

Objective

This article summarises the findings of a Concawe report[1] which provides an outlook for the European transport sector for the 2018–2030 period. The main objectives of the outlook are to:

- conduct a thorough assessment of the progressive penetration into the EU vehicle fleet of energy efficiency measures and different powertrain technologies, combined with the market-based availability of alternative fuels and energy carriers; this will define the baseline towards 2030;
- assess the potential of various renewable alternative fuels, with a focus on biofuels and electricity which, when combined with different powertrains, could contribute to reducing greenhouse gas (GHG) emissions and fossil fuel demand in the EU transport sector, taking into consideration factors such as availability of supply, technology readiness and existing fleet constraints;
- explore the potential of the EU transport sector to integrate renewable fuels and reduce GHG emissions towards 2030, and compare the baseline versus the EU targets (currently in revision) for carbon dioxide (CO_2) standards in vehicles, along with the Renewable Energy Directive 2 (RED II) and Fuel Quality Directive (FQD);
- perform a sensitivity analysis on key parameters identified to show the individual impact on reaching these targets; and
- inform the currently ongoing process of defining future RED II targets for road transport (to be agreed in 2021).

A new Concawe report identifies key enablers and potential barriers associated with boosting the penetration of renewable energy and improving GHG intensity in the European transport sector towards 2030. This article summarises the findings of the report, which aims to provide stakeholders with an informed view on current trends and the parameters that may need to be enhanced in order to meet current 2030 objectives.

The baseline modelled in the Concawe report is based on statistics, market-based projections and the best educated view of the experts involved in the working group for both the fleet modelling and the outlook on alternative fuels. This could be complemented by additional reports in the future, assessing the impact of different scenarios on GHG emissions and energy demand in EU transport for the same time frame, taking into account alternative and accelerated scenarios to meet higher-ambition targets triggered by the recently published European Green Deal[2] and 2030 Impact Assessment,[3] which will have an impact on future RED II / FQD targets.

The analytical tool

To conduct the analysis, an analytical fleet-based model has been used which projects the evolution of the fleet composition as well as the corresponding fuel demand towards 2020+. In recent years, the paradigm in road transport has changed drastically as a result of different pieces of legislation aimed at accelerating the transition to a lower GHG-intensive transport sector in Europe. As a consequence of legislation such as the CO_2 regulations for cars and heavy-duty vehicles, as well as the RED I/II targets, the development and progressive penetration of different forms of electrification and new powertrains in road transport, as well as the announcement and build-up of alternative fuels-related projects beyond the conventional crop food-based biofuels, are likely to change the previous trends in energy consumption and GHG emissions in transport.

[1] https://www.concawe.eu/wp-content/uploads/Rpt_21-2.pdf

[2] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[3] https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/impact_en.pdf

As a consequence of this change in trends, a major update of the fleet model has been conducted to enable a scientifically sound, market-based baseline definition. The main assumptions are presented throughout the report, defining current trends and allowing the exploration of different projections and sensitivities.

The fleet model is based upon historical road fleet data (for both light- and heavy-duty vehicles), updated with recent statistics aggregated at the European level (EU-27 + UK, Norway and Switzerland). Once the calibration has been conducted up to 2018, projections for the vehicle fleet are conducted towards 2030, including the effects of key parameters such as the potential composition of new sales in 2030 (meeting the CO_2 regulatory targets for both passenger cars and heavy-duty vehicles), scrappage rates or expected efficiency improvements in different powertrains. The modelled fleet composition leads to a road transport fuel demand and provides the basis upon which the introduction and availability of alternative fuels are explored (market-based in the case of liquid/gaseous fuels, as well as IEA projections in the case of electricity) to assess the total contribution of renewable energy and GHG emissions in transport. In addition, current and future estimates of both the total energy requirements and alternative fuel penetration have been included for other transport modes (aviation, rail and maritime sectors) and compared with the current RED II targets.

Due to rapid developments in technology and their potential impact on the current assumptions and projections, this baseline could be updated periodically as market trends change. The baseline is also complemented in the present report by sensitivity analyses of key individual parameters, allowing the reader to understand their impact on the RED II targets and providing both information and material for further investigation in several research areas where energy and transport compositions interact. Furthermore, the baseline is used to explore alternative scenarios which will be published in due course to complement the results presented in the report.

Due to simplifications made and estimates used, the fleet model should be considered as a 'scenario tool': it will not lead to an optimised strategy but instead looks at a variety of scenarios for fleet and fuel development. The assumptions made should not, therefore, be considered as a forecast of, or commitment to, the future availability of vehicle technologies or vehicle features.

Results

The analytical tool is used to simulate different parameter combinations of vehicle and fuel (including renewable fuel) technologies to assess fuel demand scenarios, looking at:

- vehicle fleet mix;
- fossil fuel demand and diesel/gasoline balance;
- total renewable energy demand (including conventional and advanced biofuels); and
- the demand for renewable energy in transport needed to achieve the RED II and FQD targets.

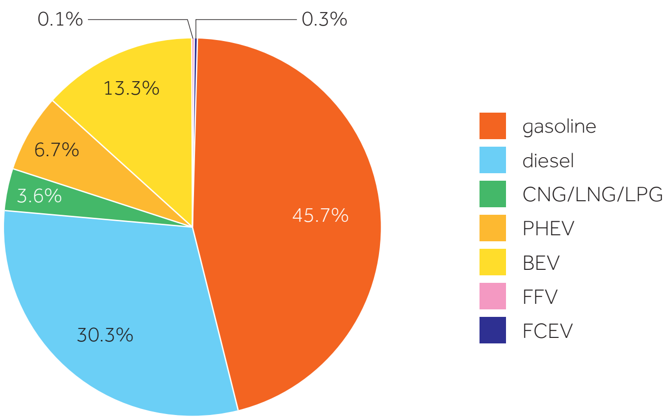
Fleet evolution/energy demand

Calibrated for the year 2018 (including historical trends), the updated baseline models the evolution of the fleet towards 2030, and includes the following:

- Improvements in terms of the energy efficiency of conventional powertrains (internal combustion engines (ICEs)), running on either gasoline or diesel-like fuel, as well as the projections in terms of new sales, activity levels or scrappage rates of old vehicles.
- The progressive penetration of new types of powertrains towards 2030, especially in the heavy-duty segment: as a result of the update, the model now integrates natural gas-powered vehicles using both compressed and liquefied fuels (CNG/LNG), as well as different levels of electrified vehicle (EV) powertrains moving from different levels of hybridisation with ICEs (hybrid electric vehicles (HEVs) to plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs) or hydrogen fuel cell electric vehicles (FCEVs)).
- The composition of new sales in 2030 (Figure 1) has been defined based on market trends and experts' views, in compliance with the current 2030 CO_2 intensity targets for new sales in road transport (expressed in NEDC terms for comparison purposes):
  - **Passenger cars:** 95 g CO_2/km in 2021 and a further 37.5% reduction by 2030 (equivalent to about 59 g CO_2/km NEDC in 2030 baseline).

    In line with the JEC Tank to Wheels (TTW) v5 report,[4] it is worth noting that, for passenger cars, a representative medium-size (C-segment) vehicle has been selected as the reference for the best available technology for 2025 onwards; this cannot, therefore, be considered as being fully representative of all new registrations.

Figure 1: Shares of new car registrations in 2030 per powertrain in the baseline

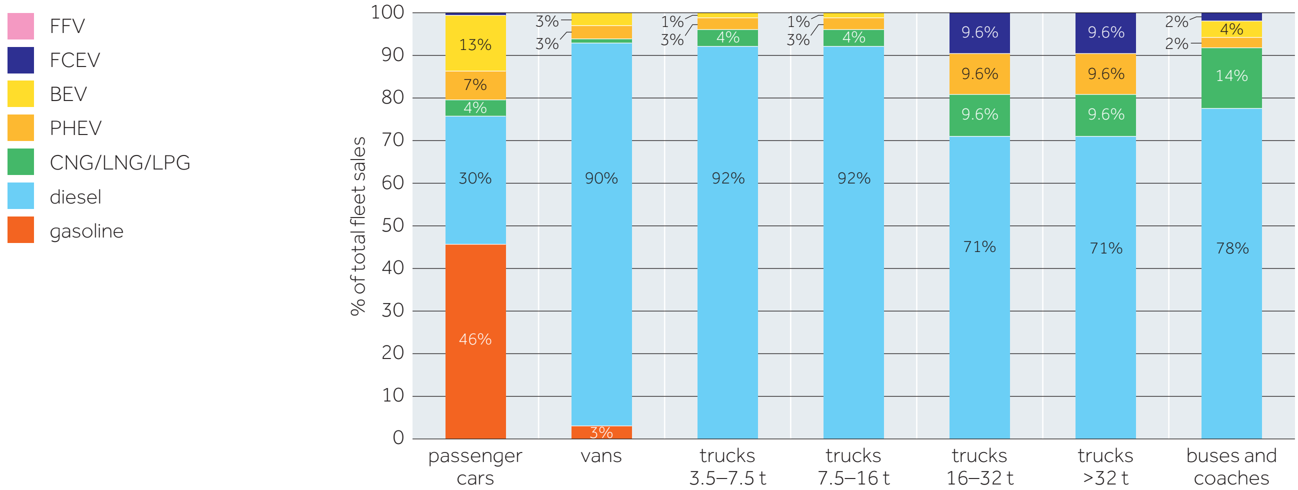


  - **Light commercial vehicles (vans):** 147 g CO_2/km in 2020, and 31% less CO_2-intensive (TTW) in 2030 than in 2020/2021 (equivalent to ~100 g CO_2/km modelled in the 2030 baseline).
  - **Heavy duty vehicles:** 30% reduction in emissions by 2030, compared to 2019 (for trucks >16 t in g CO_2/tkm) and a value of 536 g CO_2/km as the average for heavy-duty commercial vehicles in 2030.

[4] https://ec.europa.eu/jrc/en/publication/jec-tank-wheel-report-v5-passenger-cars

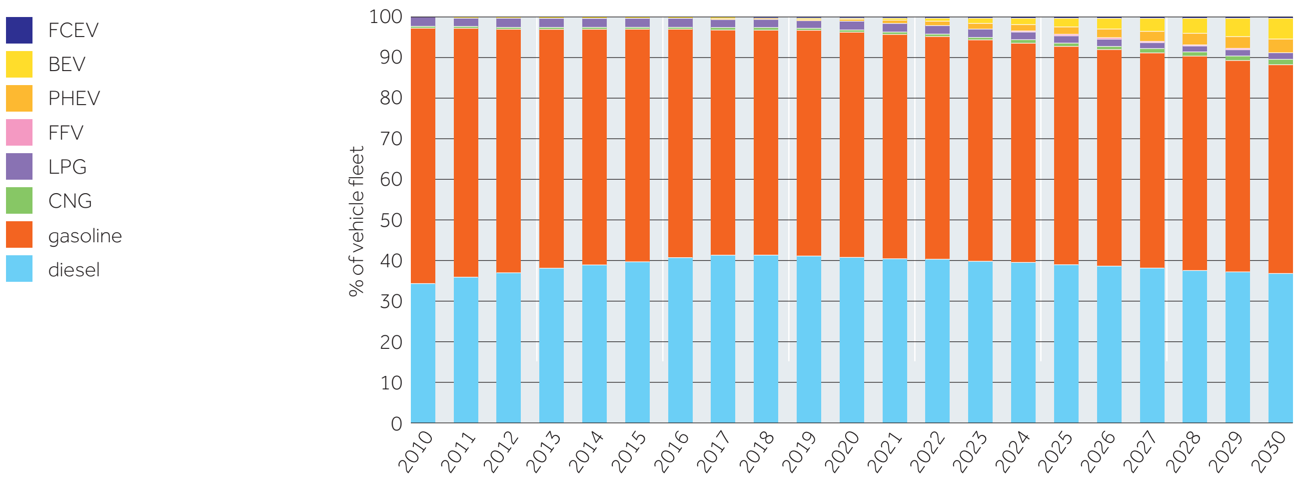
Overall, the share of alternative vehicles (including PHEVs, BEVs, FCEVs and CNG/LNG/LPG-powered vehicles) in new sales for road transport accounts for ~24% of passenger cars (versus ~4% in 2018), 7% of vans (versus 1.9% in 2018), 8% of heavy-duty trucks <16 t (versus 2.2% in 2018), 29% of heavy-duty trucks >16 t (versus 0.5% in 2018), and 23% in the case of buses and coaches (versus 4.7% in 2018) (see Figure 2).

Figure 2: New fleet sales mix in 2030 required to meet the CO_2 emissions targets



- As a result of both the evolution of the existing fleet and the penetration of alternative powertrains in new sales, the composition of the European passenger car fleet includes more than 280 million cars on the road in the baseline: ~12% of these vehicles are not expected to be running on either conventional gasoline or diesel in 2030 (versus the current ~3% in 2018) (Figure 3).

Figure 3: Examples of fleet model output: powertrain types in fleet stock — passenger cars



- As a result of the composition of the fleet and the fuel efficiency improvements towards 2030, the total energy demand in road transport has been estimated as 239 Mtoe/year. In addition to the road transport segment, the evolution of the aviation, rail and maritime sectors (international extra-EU trips considered) generally increases in activity towards 2030, representing an additional ~80 Mtoe/year, resulting in an estimated ~318 Mtoe/year energy demand for the whole EU transport sector in the 2030 baseline.
- The composition of the road transport fleet along with the projected energy demand in other transport modes defines how this total energy demand is split between the different types of fuels (liquid, gaseous, hydrogen or electricity — see Figures 4 and 5), which will define the basis for the fuel composition/availability assessment described on the following pages.

Figure 4: Total energy use per fuel or energy carrier

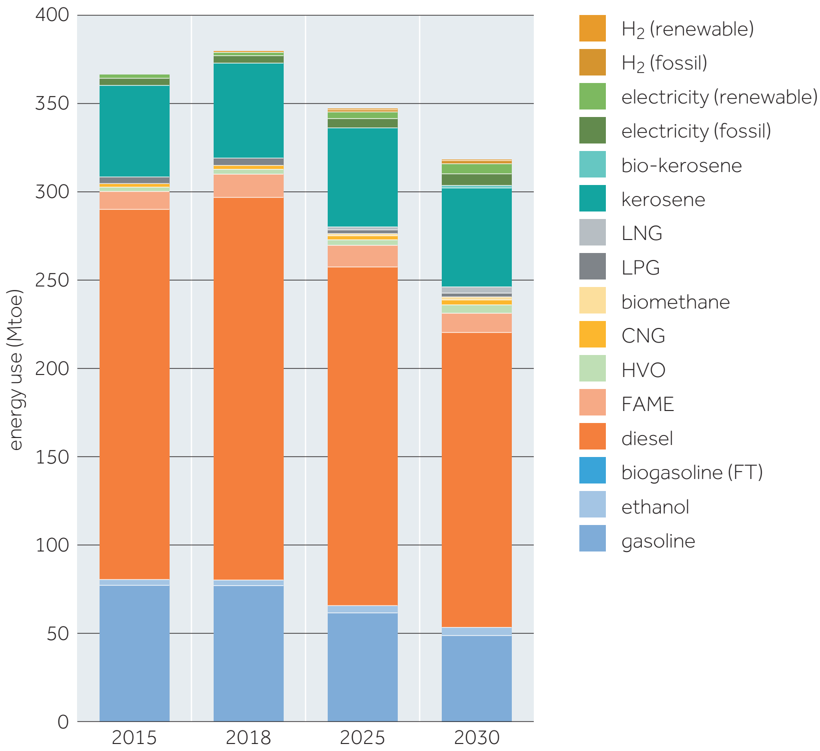
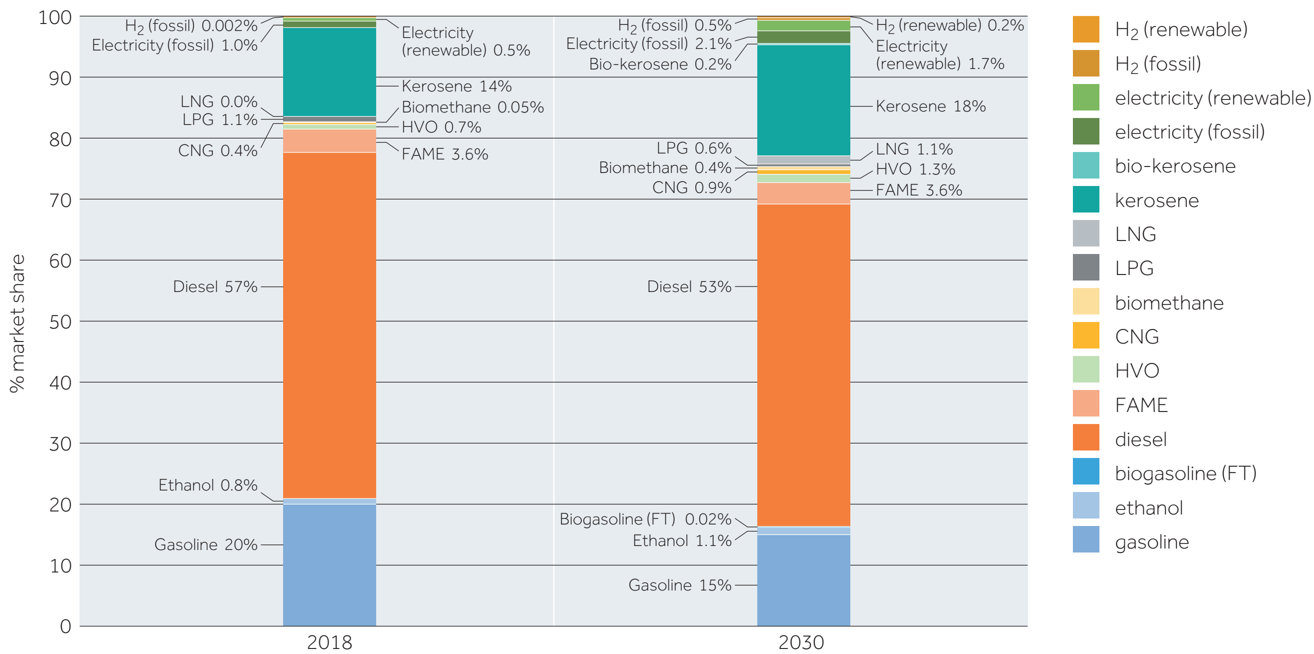


Figure 5: Percentage of market share per type of fuel (2018 vs 2030)



Energy supply and alternative fuel availability

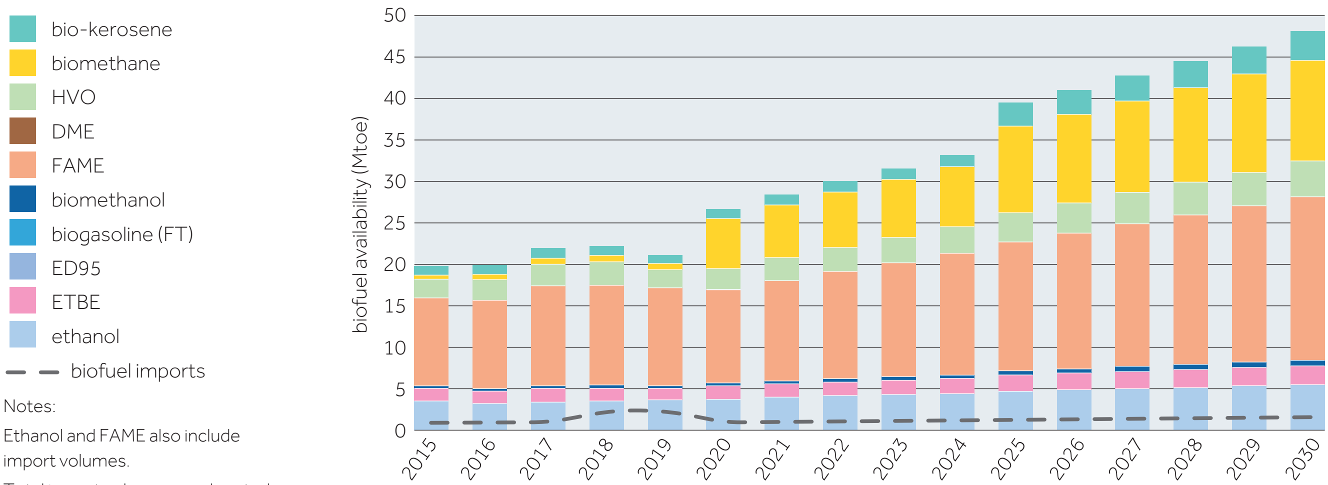
For the purposes of this fuel outlook, alternative fuels (according to Directive 2014/94/EU, Article 2) are defined as *'Fuels or power sources which serve, at least partly, as a substitute for fossil oil sources in the energy supply to transport and which have the potential to contribute to its decarbonisation and enhance the environmental performance of the transport sector. Liquid, gaseous and electricity are included in this categorisation'*. The penetration of alternative fuels in transport could be either unlimited (drop-in fuels) or constrained by certain blending walls regardless of their potential availability.

The updated baseline scenario includes the currently standardised grades for biofuel blends (B7, E5 and E10) that are widely used as road fuels in Europe, and considers the future availability of a number of different alternative fuels that will progressively become available in Europe during the 2020–2030 time frame. This availability has been assessed following a market-based approach, extracting aggregated data from the STRATAS[5] proprietary database, purchased for the purpose of this study and updated with recent developments. This database maps the status of alternative fuel production facilities in Europe (including those in operation and under construction, and planned installations already announced). The market-oriented baseline considers the following:

Liquid and gaseous (excluding H_2) fuels

The baseline is founded on an updated outlook for production plants currently in operation, under construction, and recently announced in Europe (based on the STRATAS 2017 database mapping facilities worldwide, updated with recent announcements in Europe), maximising the current utilisation rate of existing plants towards 2030. New types of fuels like dimethyl ether and ED95, and a small proportion of power-to-fuel plants (currently at demonstration scale) are also included in the scope of the study. The volumes of these fuels produced are also complemented by imports, keeping the same ratio of domestically-produced vs imported fuel volumes in 2030 as it is today (Figure 6).

Figure 6: Estimated availability of various biofuel types in Europe



Notes:
Ethanol and FAME also include import volumes.
Total import volumes are denoted by the dashed line on the figure.

[5] https://www.stratasadvisors.com

As a conclusion to this update on alternative fuels, it is worth noting the following:

- The current (installed) capacity for alternative fuel production is still very much based on food crop biofuels and, despite recent announcements about newly built plants in Europe, including facilities for the production of second-generation biofuels, the market-based signals seem to show only a modest ramp-up, at least regarding those projects announced in the public domain.
- Fully utilising the existing (installed) capacities in 2018 would be able to deliver an additional volume of ~11 Mtoe/year (100% utilisation is considered at the end of the 2030 period). This evaluation is based on the technical production potential and may not result in actual production outputs for a certain year as market conditions affect the real outputs of plants.
- When all existing and new facilities are considered, the 2030 baseline reports a maximum technical availability of ~47 Mtoe/year (based on the maximum installed capacity), of which only ~21 Mtoe/year are deemed to be used in transport as a result of the energy demand modelled. This is due to the fact that the energy demand for alternative fuels is determined by factors such as the demand for different powertrains, constrained by the existing blending walls in case of oxygenate-derived fuels, or the competition with other sectors in the case of biomethane availability.

Therefore, the total fuel use in transport is lower than the maximum technical availability reported by the installed capacity, and some surplus volumes may exist which will either be diverted to other sectors or exported out of Europe. This 'excess' concept (volumes not used in road transport to meet the modelled demand) would become especially relevant in the case of biomethane (as detailed in the related sensitivity case).

Electricity and hydrogen (as final fuels)

The projections for renewable electricity in the European mix are defined according to the IEA projections (45% in 2030), extensively detailed in the JEC WTT v5 report (Section 3.4), and the energy requirements would be defined by the fleet composition. Due to the foreseen electricity demand in transport in the 2030 baseline (~12 Mtoe/year of electricity, mainly in road and rail modes, representing about 4% of the current gross generation capacity in the EU27 + UK, Norway and Switzerland), as a simplification, no limitations on the EU electricity generation capacity have been assumed at this stage. A deep analysis on the feasibility of the integration of this electricity demand in transport within the whole EU economy (including other sectors such as domestic households, industrial sites, etc.) is part of a holistic energy system modelling process, and is beyond the scope of the present analysis.

Regarding the demand for hydrogen (as final fuel) modelled in the 2030 baseline, assuming a mix between natural gas and electrolytic hydrogen production in 2030, no assumptions on potential availability limits are considered. Hydrogen production for transport applications is limited in the 2030 baseline (2.1 Mtoe/year of total demand), where the majority stems from road transport (2.0 Mtoe/year) and the remainder from rail. Based on the current pace of development of renewable hydrogen in Europe, an increase in renewable hydrogen was assumed for road and rail applications (25% in 2030).

RED II targets (baseline and sensitivity analysis)

Baseline

As the RED II 'framework on additionality in the transport sector' (Article 27, point 3) is in the process of being fully defined by the Commission, this study explores the impact of two different interpretations when this concept of renewable electricity is applied to the transport sector. The results of the baseline, in terms of the percentage of equivalent renewable energy versus the RED II 14% minimum sub-target in road and rail transport by 2030, are presented below:

1. Interpretation 1 (Additionality criteria on renewable electricity in transport): RES-T 15.6%
2. Interpretation 2 (Additionality criteria on total renewable installed capacity): RES-T 17.0%

Note that the difference between both interpretations is mainly due to the current electricity consumption in rail transport, which helps to meet the RED II target. In both cases, all the sub-targets are met with the exception of Annex IX part A (min 3.5%) which, with the current market trends/ announcements, is deemed unlikely to be accomplished. When the compliance with RED II regulation is explored (for the detailed assumption see Section 5.3 of the Concawe report), the 2030 baseline shows the following:

- The multipliers boost the contribution of electrically-driven powertrains and the role of biofuels in transport in compliance with RED II up to a total of 15.6% (Interpretation 1) and 17.0% (Interpretation 2) in the baseline.
- The impact of these multipliers is significant and deemed to represent ~5–6% of renewable energy content within the current baseline (without multipliers, the absolute renewable energy share would represent 10.3% (Interpretation 1) and 11.1% (Interpretation 2)).
- Renewable electricity use in transport represents 3.9% (Interpretation 1) and 5.4% (Interpretation 2) of the total renewable energy in transport (RES-T) target (with multipliers) while the contribution of biofuels is ~11.5% (5.3% of which corresponds to advanced biofuels).
- Based on both the expected availability and blending walls, the share of first-generation (crop-based) biofuels remains below the imposed cap (max 7%).
- Regarding advanced biofuels, while the physical cap in Annex IX part B of RED II is respected (1.7%), the minimum requirement in part A is not reached (2.2% vs the 3.5% minimum defined in RED II).
- Based on these results, additional investments/support for alternative fuels (including liquid, gaseous and electricity) will be required to realise their potential towards 2030, versus current trends/publicly announced projects.
- The penetration of biomethane in the different transport sectors is deemed to have a significant impact when meeting the 2030 targets. The baseline assumes a higher biomethane content in all transport sectors (20%) versus the natural gas grid which would need to be confirmed, meeting the additionally criteria, to realise the potential GHG savings across the whole economy (instead of shifting emission reductions from one sector to another).

Sensitivity analysis

Complementing the baseline, additional sensitivities on key individual parameters have been explored (Table 1). While these are not intended to represent alternative scenarios, they show interesting trends and conclusions which could help to identify areas for further research and development, and to boost the penetration of renewable energy in transport towards a higher 2030 RED II goal.

Table 1: Summary of the sensitivity analysis considering a change in model parameters

Case	RED II % interpretation 1	RED II % interpretation 2	Key outcome
Baseline	15.6%	17.0%	
30% BEV+PHEV in 2030 sales	16.4%	17.8%	Additional sales of 1.6 million new EVs in 2030 raises RED II by ~0.8%
5% bio-kerosene in 2030 aviation fuel	16.7%	18.1%	Raises RED II by 1.1%, but the realisation of feedstock potential gain could be at risk
Increased use of hydrotreated vegetable oil (HVO) to reach minimum 3.5% (RED Annex IX part A feedstock)	16.9%	18.4%	The use of feedstock detailed in Annex IX part A of RED II is about 60% higher than in the baseline
40% share of biomethane in total gas	16.8%	18.3%	Towards meeting all RES-T targets and biofuel feedstock sub-targets with Annex IX part A at risk (3.4%)
1.7% administrative cap on Annex IX part B feedstocks*	14.1%	15.6%	1.5% lower RED II compared to the baseline
E10 limited uptake (78% of fuel grades by 2030)	15.4%	16.9%	Slight reduction in RED II by 0.2%
Only E5 grade (theoretical assessment)	14.6%	16.1%	~1% reduction in RED II
Liquid biofuels in 2030: 20% in maritime and 10% in non-electric rail	16.0%	17.5%	Small increment of 0.5% in RED II
LNG trucks (>16 t segment) with dual-fuel high pressure direct injection (HPDI) technology in 2030	15.5%	17.0%	Very small decrease in RED II due to lower use of biomethane

* Case study exploring the potential impact of the current physical cap to an administrative one.

The sensitivities explored indicate the following:

- Increasing the share of EVs (BEVs+PHEVs) from 20% in the baseline to a higher level of 30% in 2030 sales raises the RES-T by ~0.8%. It calls for the registration of 4.8 million new EVs, one-third of which are expected to be PHEVs.
- The penetration of renewable fuels in aviation plays a key role when meeting the targets, especially due to their contribution in the numerator (not in the denominator) and the ad-hoc multipliers defined by RED II for the sector. A 5% share of renewable jet fuel in the total EU aviation pool (equivalent to multiplying the capacity defined in the baseline by five) increases the RES-T share by 1.1%. This sensitivity case assumes additional biofuel capacity without jeopardising the volume of advanced feedstocks dedicated to road transport. In the case of feedstocks and/or future installed capacity competition, the realisation of this potential gain could potentially be at risk.
- Reaching the administrative mandate of 3.5% on Annex IX part A feedstocks is estimated to require an increase from 0.8 to 2.4 Mtoe of Annex IX part A feedstocks being diverted to, for example, $HVO_{equivalent}$.[6] This volume is about three times that used in the baseline and would require new additional HVO capacity, well beyond the current installed capacity and public market plans/imports levels in Europe.
- By assuming a higher share of 40% for biomethane diverted from other sectors to transport (and replacing fossil CNG and LNG), an increment of 1.2% would be expected for RED II. With this assumption, the Annex IX part A[7] share reaches 3.4% with the use of multipliers in the numerator, approaching the minimum requirement of 3.5%. It is important to note that, beyond RED II, biomethane is mainly used as an energy source in non-transport sectors, so any increase in the use of biomethane in transport may not imply an additional GHG reduction versus the baseline unless the whole energy system is considered and new ad-hoc additional capacity is added for the specific purpose of meeting future transport demand (otherwise there may be a potential risk of shifting GHG emission reductions among sectors).
- Applying a 1.7% administrative mandate on Annex IX part B feedstocks reduces the RES-T share to 14.1% when multipliers are used in the numerator. In this case, the RES-T target of 14% and all biofuel feedstock sub-targets are met.
- Limiting ethanol penetration in the fleet by assuming a slow penetration of E10, modelled through the historical ramp-up of E10, leads to a slight decline of 0.2% in RES-T share, compared to the baseline.
- Limiting ethanol penetration through the extrapolation of historical E5 data and excluding E10 from gasoline fuel grades resulted in ~1% decline in RES-T share. This theoretical case shows the impact and importance of full E10 penetration in the fleet model.
- Assuming a higher share of liquid biofuels in rail (10% of non-electric in 2030) and maritime (20% of total fuel in 2030) raises the RES-T share by ~0.5%.
- Assuming a full penetration of dual-fuel LNG trucks by 2030 would slightly reduce the RES-T share by only 0.1% compared to baseline.The use of dual-fuel LNG trucks with HPDI technology reduces the demand for LNG and, thus, the room for additional biomethane uptake, compared to the baseline.

[6] As a simplification, this sensitivity case does not consider an increase in the use of Annex IX part A feedstocks used for FAME production as the B7 blending wall is reached (higher blends, B10, or a different repartition of feedstocks to different final and/or blending fuels may offer different alternatives to comply with this sub-target).

[7] According to the STRATAS database all biogas (and SNG) feedstocks are considered as Annex IX part A.

A look into GHG emissions

At the time of publication of this article, a revision of the FQD is being undertaken by the European Commission. The results of the assessment of GHG emission reductions in the road transport[8] baseline are explored in the Concawe report, and indicate the following (see also Table 2):

- In 2020: The total GHG emissions from the road sector (GHG_{road}) was estimated to be 1,097 Mt CO_2eq and the total energy consumption from both fossil and renewable energy sources was estimated at 297 Mtoe.
- In 2030: The GHG intensity calculations showed that the total road GHG emissions reached 857 Mt CO_2eq and the total energy from both fossil and renewable energy sources was 238 Mtoe. The results show an emission factor of 85.8 g CO_2eq/MJ.

  In absolute terms, derived from the composition of the fuels in transport and the fuel production pathways modelled in the JEC WTT v5 report, the total GHG emissions in the whole transport sector have been estimated in 1,146 Mt CO_2eq/year at the EU level in 2030 (~18% decline in the 2018–2030 period).
- Based on the above, the 2030 baseline estimates a reduction in the GHG intensity of road transport fuels in 2030 of 8.8% versus 2010. The results of the 2030 baseline are intended to be used to inform the ongoing revision of the FQD. As a result of this process, new criteria could be defined, impacting the present outcome of the analysis. If so, the present outlook will be updated accordingly in due course.

Table 2: Baseline results for GHG intensity reduction in road transport fuels

Year	GHG emissions (Mt CO_2eq)	Energy use (Mtoe)	Emission factor (g CO_2eq/MJ_{fuel})	GHG intensity reduction from 2010
2030	857	238	85.8	-8.8 %

Important note

The 2018 baseline does not represent any individual company's views and is the result of a consensus prior to the publication of the EU's 2030 Impact Assessment. The modification of various parameters (some of them already explored as sensitivities in this analysis) or any additional policy considerations (e.g. the use of renewable fuels of non-biological origin (RFNBO), electrolytic hydrogen, and e-fuels versus electricity) could have an impact, and could effectively enable a higher penetration of renewable energy in the transport sector.

Conclusion

A key conclusion that can be derived from the initial assessment using this baseline is that, since the composition of the fleet and fuel contribution is founded on market-based outlooks and expert judgment, it is considered the best starting point for understanding and exploring potential scenarios towards 2030. Concawe's outlook has not, therefore, been back-calculated from the RED II and FQD targets. It is intended to provide the reader and various stakeholders with an educated market and industry view on where the current trends could lead the sectors, and to help identify key parameters to be further enhanced when meeting the current 2030 objectives. (Note that the revision of the 2030 targets under the EU's current Impact Assessment is not included in the baseline and will be explored in future publications).

[8] This section is not intended to be used as a direct comparison with the FQD targets as it is only focused on road (e.g. gas oil used in non-road mobile machinery, which is included in the FQD, is not considered here) but gives a good indication of the potential GHG reductions based on the WTT intensity considered/described in the Appendixes of the Concawe report.