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CREDITING SYSTEM FOR RENEWABLE FUELS IN EU EMISSION STANDARDS FOR ROAD TRANSPORT

Report for the German Federal Ministry for Economic Affairs and Energy (BMWi)

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EXECUTIVE SUMMARY

Main Objective – Amending the EU fleet regulation to establish a level playing field to reduce road transport sector emissions effectively and efficiently

The EU legislative framework on fleet targets for new road vehicles focuses on tailpipe emissions in a so-called "tank-to-wheel" approach, which does not differentiate between fossil fuels and synthetic and advanced alternative fuels (SAAF). For SAAF, the CO_2 tailpipe emissions are bound during the production of the fuels – in an extended "well-to-wheel" cycle view, this fuel would therefore be climate-neutral.

The European Commission (EC) is therefore asked in Article 15 to review scope to credit the climate-neutrality of SAAF in EU emissions performance standards for new vehicles.[1] Our study targets an SAAF-crediting system capable of serving as a template for the EC. This proposal is based on an economic evaluation of potential alternatives, aiming to establish a level playing field among wide-ranging emission-reduction technologies to reduce road transport sector emissions effectively and efficiently.

Main principles for the proposed crediting model

The proposed crediting system is based on the following main principles:

- **Building on the existing sustainability certification scheme for transport fuels under RED/RED II** – Accounting SAAF against fleet targets requires some form of certification system, which ensures sustainability criteria are met and double counting is prevented. We align the SAAF crediting model approach as closely as possible with existing fuel sector regulations (RED and RED II)[2] to avoid two parallel systems with different standards and additional administrative costs for a separate SAAF certification scheme.
- **Level playing field among emission-reduction options for road transport** – The SAAF-crediting system aims to broaden the scope for car manufacturers (OEMs) and establish a level playing field among emission-reduction options (i.e. rather than displacing alternative avoidance options, offering a wider set of options).
- **Effective climate change contribution in the transport sector** – Any admissible crediting system must contribute to additional CO_2 reductions in the transport sector, i.e. renewable fuel credits[3] counted toward fleet targets may

[1] See Art. 15 of EU Regulations 2019/631 (light duty vehicles, LDV) and 2019/1242 (heavy duty vehicles, HVD).

[2] RED (Directive 2009/28/EC) establishes national databases and a certification scheme based on common principles (sustainability criteria, mass balance system). This is further developed by RED II (Directive (EU) 2018/2001) and delegated acts (sustainability criteria for synthetical fuels (RFNBOs), Union database to ensure instant data transfers and harmonisation, see Recital 84).

[3] In this report, the terms "renewable fuel credit" and "sustainability credit" are used synonymously with 'proof of sustainability' or 'sustainability declaration' for fuels. The term 'certificate' is already used to accredit

not have been used elsewhere already (no double counting). The crediting of SAAF offers an alternative for OEMs to reduce emissions that would otherwise exceed their fleet target and pay a penalty ("excess emissions premium") – these resources would be lost for climate protection.

- **Maintaining affordable individual mobility** – Broadening the scope of emission-reduction options for OEMs will reduce costs to achieve fleet targets, which ultimately leads to lower-priced new vehicles. It also offers a low-emission option for customers and use cases with limited other alternatives.

Based on these principles, we establish the main building blocks of the proposed crediting system.

Main building blocks of the proposed SAAF-crediting system

Table 1 Proposed SAAF crediting system (LDV, HDV) – overview

	Aspect	Design proposal
General features	Participation conditions	Voluntary participation for OEMs (no minimum quota for SAAF)
	Geographical scope	EU-wide harmonised crediting system and sustainability criteria for SAAF
	Volumetric scope	Optional cap on max. reduction (in g/km for LDV and g/tkm for HDV per fleet and year)
	Admissible fuels	All RED II compatible transport fuels (option for Member States to restrict to sub-set)
	Tradability	Yes – sustainability credits for transport fuels transferable
	Banking	Yes – within the valid scope of sustainability proofs according to RED II
	Borrowing	No – no additional scope for borrowing
Origin side	Double counting	No – sustainability credits can only be credited once against a legal obligation
	Sustainability criteria	RED II sustainability criteria and delegated acts apply (regards renewable content and additionality)
	Country of origin	Worldwide (if tracked and comprised reliably in accordance with RED II)
	Blending	Blending with fossil fuels admissible
Use side	Link to transport sector	Yes – Either direct use or indirect use for fuels fed into cross-sectoral infrastructure
	Link country of use	No – admissible fuel can be supplied to final customers in all Member States
	Crediting options	Crediting to individual new vehicles (as 'low-emission vehicle') possible
	Link to OEM fleet	For crediting to individual new vehicles – only credits from fuels compatible with powertrain technology admissible
	Timeframe fulfilment	Front loading (credits for lifetime emissions to be surrendered at time of registration))

Source: Frontier Economics

Note: LDV = light duty vehicles (passenger cars and light commercial vehicles), HDV = heavy duty vehicles

economic operators along the fuel chain, issued by certification schemes that are recognised by the EC under RED II.

Table 1 outlines our proposal for the main building blocks of an SAAF-crediting system. The main building blocks apply both to LDV and HDV (a differentiation is only necessary to calculate the CO_2 reduction amount).

We explain the rationale behind our proposal in more detail below.

General design features

- **Voluntarily Participation for OEMs -**– Participation in the crediting of synthetic fuels should be voluntary for OEMs, i.e. there is no obligatory minimum SAAF quota for OEMs (as opposed to the renewable fuel obligation for suppliers under RED II). Crediting of SAAF offers OEMs an additional option to reduce emissions from their new vehicle fleet but not to create any specific incentives to displace alternative powertrain technologies (such as electrification).
- **Europe-wide harmonised crediting system and SAAF standards** – SAAF credits should apply uniformly to all OEMs, irrespective of the Member States in which new vehicles are registered. This is in line with current fleet regulation with a single EU-wide fleet target for each OEM (only differentiating car, vans and lorries). There should be common minimum SAAF standards to prevent an inefficient system with different unharmonized national SAAF standards. Member states may restrict the list of admissible fuels e.g. to reflect differences in the national potential of certain alternative fuels and boost political acceptance (see discussion on admissible fuels below).
- **Volumetric scope could be capped (upper limit for SAAF credit)** – SAAF should provide OEMs with an additional option as part of a level playing field of technology choices to reduce new-vehicle emissions. Limiting any of these options for OEMs can only make emission reductions costlier (less efficient). Since critics fear that crediting SAAF could jeopardise the penetration of new alternative powertrain solutions (particularly BEV), an appropriate upper limit can be imposed (in g/km for LDV and g/tkm for HDV on the level of an individual OEM). These limits should be reviewed regularly by the EC to avoid OEMs pay the penalty instead of using SAAF as an effective way to reduce transport sector emissions.
- **Wide range of admissible fuels** (though Member States may further restrict) – Liquid and gaseous transport fuels that fulfil the sustainability criteria of RED II should generally be admissible. Such a harmonized approach eliminates the need to establish a parallel system for OEMs (SAAF) and fuel suppliers (RED), which would generate significant additional administrative costs (static inefficiency) and hinder the penetration of innovative synthetic fuels (dynamic inefficiency).

  First-generation biofuels are subject to national caps under RED II (Art. 26 (1)).[4] These caps should also include all volumes that are used for crediting against fleet targets such that no additional first-generation biofuel volumes enter the transport sector. Member States can be accorded the option of excluding

[4] 7% of final energy consumption in the transport sector or the 2020-level plus 1%-point, whatever is lower. Member States may set lower limits.

certain fuels from crediting toward the fleet target to increase political acceptance.

Member States should be allowed to restrict the set of admissible fuels (to reflect national differences in the implementation of RED II and different national policy objectives and fuel potentials).[5]

- **Tradability of credits** – Sustainability credits for SAAF are transferable from fuel suppliers (who marketed these fuels) to OEMs. Otherwise, OEMs would have to enter the market for fuel supply to create the necessary credits. Tradability ensures sustainability credits are distributed efficiently and SAAF are supplied to the market to a sufficient extent to reduce emissions effectively.
- **Banking of credits admissible** – Banking of sustainability credits should be possible throughout the period these credits are valid under the national implementation of RED II. This ensure compatibility between RED II and fleet target regulation and that climate protection measures are implemented earlier.
- **Borrowing of credits inadmissible** – Borrowing, i.e. submission of SAAF credits in later years[6], should not be permitted beyond existing fleet target provisions (HDV emissions debts). Borrowing is not necessary since OEMs can either buy additional credits (tradability) or use banked certifications (banking) for unexpected developments in their average fleet emissions at year end. Borrowing would delay the reduction in transport sector emissions from SAAF.

Origin side – generating credits by supplying SAAF

- **Double counting strictly ruled out** – Sustainability credits from SAAF may only be credited once against a climate protection obligation system (RED renewable share, fleet targets). Double crediting would undermine effective climate protection policy in the transport sector. The process design (see below) for SAAF-crediting must ensure that double counting is prevented.
- **Sustainability criteria (renewable share, additionality) applied from RED II** – here the guidelines are based on the legal acts of RED II and delegates, which are still being implemented. This is a basic prerequisite to avoid a new, independent verification system operated alongside the RED II regime. This would involve considerable administrative work and transaction costs for market players. In addition, two parallel systems with differing renewable fuel standards would endanger or hinder market development (dynamic inefficiency).
- **Global country of origin admissible** – Worldwide imports are permitted provided they meet the RED II sustainability criteria. This is to ensure that renewable fuels are sufficiently available on the market and that production costs are minimized.

[5] RED II, Recital 90 for example gives Member States the option not to consider recycled carbon fuels in fuel supplier obligations.

[6] Fleet targets for OEMs are determined annually for all new vehicles registered in that year.

- **Blending and pre-products possible** – Blending is permitted, as within the framework of the RED II specifications. A separate distribution infrastructure for synthetic fuels would generate significant additional costs (inefficiency).

Use side – accounting for credits in fleet targets

- **Only fuels brought into the transport sector are admissible** – We propose a link to the transport sector (either directly through market placement and consumption in the transport sector or indirectly in the case of cross-sectoral infrastructure, e.g. hydrogen or methane). This ensures compatibility with fuel supplier requirements under RED II and carbon emission reductions in the transport sector.
- **Supply of fuel and credits can fall into different countries** – No link required between the country where SAAF are sold to final customers and the country where new vehicles are registered. This results directly from the logic of fleet regulation, which sets a single European-wide emission target for OEMs. Requiring a direct link would make an SAAF crediting system needlessly costlier and have no bearing on the achievable emission reductions in the transport sector.
- **Credits can be assigned to individual vehicles** – The emission reduction through the crediting of SAAF can be attributed to individual vehicles. OEMs also have the option of attributing low-emission properties in registration documents. This is intended to increase the willingness-to-pay of customers for low-emission vehicles and thus finance effective climate protection. It also enables Member States to establish a level playing field on other regulations (e.g. tax incentives for low-emission vehicles).
- **Only fuels compatible to the OEM's individual vehicles admissible** – A direct link is to be established between the powertrain technology of the new vehicle where credits are attributed to individual vehicles. Such a restriction leads to higher costs and does not lead to more CO_2 reductions but increases the credibility of the system since there is a link between new vehicles sold as low-emission and the type of additional renewable fuel brought on the market. For a collective crediting against fleet targets, there is no direct link to individual vehicles and therefore no such benefit from imposing restrictions on the types of renewable fuels. Such a requirement would lead to significant additional cost without more effective climate protection.
- **Frontloading of credits to ensure lifetime carbon neutrality at first registration** – We recommend front loading, i.e. the proof of sustainability must be provided at the time of registration for accumulative emissions throughout the entire life cycle of new vehicles. Front loading significantly accelerates emission reductions in the transport sector since emission reductions occur (negative net effect, as emissions are already bound up in the production of synthetic fuels over their lifetime of several years) before they occur at the tailpipe (over a lifetime of more than ten years for new vehicles).

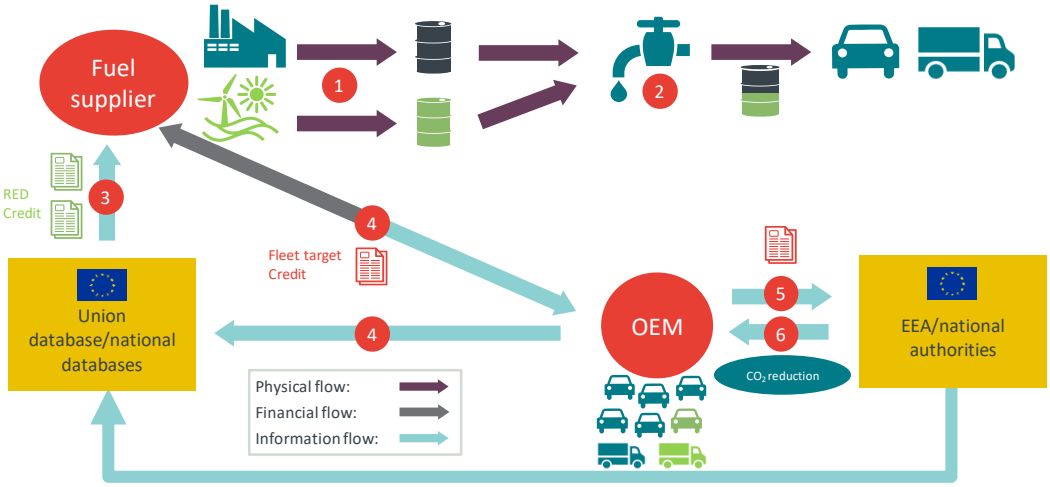
  Front loading is also a prerequisite for allowing assignment to individual (low-emission) vehicles since this provides a fair balance between an additional

burden for OEM (from frontloading) and higher willingness-to-pay for customers (for certified low-emission vehicles).

Process design for SAAF crediting

Figure 1 provides the institutional details behind the crediting process for SAAF which applies to both LDV and HDV.

Figure 1 Flow chart of accounting SAAF in fleet targets (LDV, HDV)



1. Production of SAAF
2. SAAF are supplied to customers at the fuelling station (typically as blend)
3. Sustainable fuel credits are issued and entered into the Union database
4. OEM buys credits from the fuel supplier and reports them to the Union database – accounting separation between credits counted towards RED II obligation and fleet targets to avoid double counting
5. OEM requests crediting against fleet targets – authorities verify the amount of credits bought by OEM
6. Equivalent reduction amount of CO_2 saved by SAAF is deducted from the original fleet target for OEM

Source: Frontier Economics

Note: Union database for renewable transport fuels to be set up in accordance with RED II, Recital 84.

The basic principles are:

- Fuel suppliers are responsible for supplying SAAF, which generates credits that OEMs can buy to credit against their fleet targets. In principle, the same certification and verification process as for RED renewable fuel targets can be used to credit SAAF against fleet targets.
- Authorities ensure that sustainability criteria are met and that credits are only used once. This involves national and EU authorities which are responsible for implementing RED/RED II (particularly the Union database for renewable transport fuels) and authorities involved in fleet target regulation.
- Authorities need to ensure that fuel suppliers continue to fulfil their renewable fuel obligations before supplying additional credits to OEMs.

Calculation of the equivalent CO_2 reduction amount

Fleet targets are expressed in average CO_2 emissions (in grams) per kilometre of mileage (for LDV) or per tonne-kilometre of transport performance (for HDV). The

contributions to emission reduction from credited SAAF quantities (in MJ) must therefore be converted into the same unit as the fleet targets.

Credits used in a period by OEMs must be **split** between credits counted against **average fleet emissions** and those assigned to **individual vehicles**. This is necessary to prevent double counting since credits assigned to individual vehicles lower the vehicles' specific emissions which in turn are the basis to calculate the average fleet emissions. The total impact on fleet emissions is the same, irrespective of which option the OEM chooses.

Light duty vehicles

Figure 2 shows how the reduction amount for crediting SAAF (in grams per kilometre) can be determined for an OEM.

Figure 2 Calculation of the CO_2 reduction amount for LDV

Origin of credits by OEM

$$(1)\ \text{credit}_{\text{total,t}} = \sum_k \left(\text{fuel}_{\text{k,t}} \times \text{CO2}_{\text{ref}} \times \text{CO2saving}_k\right) + \text{banking}_{\text{t-1}}$$

Use of credits by OEM

$$(2)\ \text{credit}_{\text{total,t}} = \text{credit}_{\text{fleet,t}} + \sum_j \text{credit}_{\text{vehicle,j,t}} + \text{banking}_{\text{t}}$$

Crediting option 1 ("$\text{credit}_{\text{fleet}}$") – Fleet emissions

$$(3a)\ \text{reduction amount}_{\text{fleet,t}} = \frac{\text{credit}_{\text{fleet,t}}}{\text{mileage} \times \text{vehicles}_{\text{t}}}$$

Crediting option 2 ("$\text{credit}_{\text{vehicle}}$") – Individual vehicles

$$(3b)\ \text{reduction amount}_{\text{vehicle,j,t}} = \frac{\text{credit}_{\text{vehicle,j,t}}}{\text{mileage}}$$

With:

1. $\sum_k(.)$: sum over all SAAF fuel types
2. $\sum_j(.)$: sum over individual vehicles
3. $\text{fuel}_{\text{k,t}}$: amount of fuel type k credited by OEM in year t [MJ]
4. CO2_{ref}: fossil fuel comparator (see RED II, Annex V) [g CO_2/MJ]
5. $\text{CO2saving}_{\text{k}}$: emission saving factor for fuel k (see RED II and delegated acts) [%]
6. $\text{banking}_{\text{t}}$: banked SAAF credits from period t
7. $\text{credit}_{\text{fleet,t}}$: total SAAF credits counted towards fleet targets in year t [g CO_2]
8. $\text{credit}_{\text{vehicle,j,t}}$: SAAF credits counted towards vehicle j in year t [g CO_2] (note: impact on fleet emissions via attribution to the WLTP value)
9. mileage: mileage over lifetime (**NEW**) [km]
10. $\text{vehicles}_{\text{t}}$: new registered vehicles of OEM in year t

Source: Frontier Economics

Most parameters are either taken from RED II or information reported by OEMs and verified by authorities. The main additional parameter to be introduced to Regulation (EU) 2019/631 is **mileage** of new vehicles **over their entire lifetime**. We propose to use a single standard fleet-wide value, consistent with the approach in the Regulation[7]:

[7] The Regulation aggregates individual CO_2 performances with equal weighting, i.e. a simple arithmetic average of individual vehicle WLTP values.

- **160,000 km** based on *Regulation (EC) No 692/2008 Annex VII (1.2)*. This is a conservative proxy for lifetime mileage since it is used to verify the durability of pollution control devices.
- Alternatively, average historical values can be used suggesting a range of **175,000 – 185,000 km**.[8]
- In future, the mileage value might be calibrated with data from on-board fuel consumption metering (but no retrospective changes[9]).

Heavy duty vehicles

Figure 3 shows how the reduction amount for crediting SAAF (in grams per tonne-kilometre) can be determined for an OEM. The formula is slightly more complex than for LDV since the HDV Regulation considers 9 vehicle subgroups making differing contributions to the fleet target.

Figure 3 Calculation of the CO_2 reduction amount for HDV

Origin of credits by OEM

$$(1)\ \mathrm{credit}_{\mathrm{total,t}} = \sum_{\mathrm{k}}\left(\mathrm{fuel}_{\mathrm{k,t}} \times \mathrm{CO2}_{\mathrm{ref}} \times \mathrm{CO2saving}_{k}\right) + \mathrm{banking}_{\mathrm{t-1}}$$

Use of credits by OEM

$$(2)\ \mathrm{credit}_{\mathrm{total,t}} = \mathrm{credit}_{\mathrm{fleet,t}} + \sum_{\mathrm{j}} \mathrm{credit}_{\mathrm{vehicle,j,t}} + \mathrm{banking}_{\mathrm{t}}$$

Crediting option 1 ("$\mathrm{credit}_{\mathrm{fleet}}$") – Fleet emissions

$$(3a)\ \mathrm{reduction\ amount}_{\mathrm{fleet,t}} = \frac{\mathrm{credit}_{\mathrm{fleet,t}}}{\sum_{\mathrm{sg}} \mathrm{lifetime}_{\mathrm{sg}} \times \mathrm{tkm}_{\mathrm{sg}} \times \mathrm{vehicles}_{\mathrm{sg,t}} \times \frac{1}{\mathrm{MPW}_{\mathrm{sg}}}}$$

Crediting option 2 ("$\mathrm{credit}_{\mathrm{vehicle}}$") – Individual vehicles

$$(3b)\ \mathrm{reduction\ amount}_{\mathrm{vehicle,j,t}} = \frac{\mathrm{credit}_{\mathrm{vehicle,j,t}}}{\mathrm{lifetime}_{\mathrm{sg}} \times \mathrm{tkm}_{\mathrm{sg}}}$$

With:

1. $\sum_{\mathrm{k}}(.)$: sum over all SAAF fuel types
2. $\sum_{\mathrm{j}}(.)$: sum over individual vehicles
3. $\sum_{\mathrm{sg}}(.)$: sum over all nine vehicle subgroups
4. $\mathrm{fuel}_{\mathrm{k,t}}$: amount of fuel type k credited by OEM in year t [MJ]
5. $\mathrm{CO2}_{\mathrm{ref}}$: fossil fuel comparator (see RED II, Annex V) [g CO_2/MJ]
6. $\mathrm{CO2saving}_{\mathrm{k}}$: emission saving factor for fuel k (see RED II and delegated acts) [%]
7. $\mathrm{banking}_{\mathrm{t}}$: banked SAAF credits from period t
8. $\mathrm{credit}_{\mathrm{fleet,t}}$: total SAAF credits counted towards fleet targets in year t [g CO_2]
9. $\mathrm{credit}_{\mathrm{vehicle,j,t}}$: SAAF credits counted towards vehicle j in year t [g CO_2] (note: impact on specific vehicle emissions)
10. $\mathrm{lifetime}_{\mathrm{sg}}$: lifetime per subgroup, see table (**NEW**) [a]
11. $\mathrm{tkm}_{\mathrm{sg}}$: Annual transport performance by subgroup (Regulation (EU) 2019/1242, Annex I) [tkm/a]
12. $\mathrm{vehicles}_{\mathrm{sg,t}}$: new registered vehicles from subgroup sg of OEM in period t
13. $\mathrm{MPW}_{\mathrm{sg}}$: mileage and payload factor for subgroup sg (Regulation (EU) 2019/1242, Annex I)

Source: Frontier Economics

[8] According to the Report for the European Commission by Ricardo-AEA (Ref: Ares (2014)2298698) the average diesel car lifetime mileage is approximately 208,000 km while petrol lifetime mileages fluctuate between 160,000 and 170,000 km. Diesel cars accounted for approx. 35% of new passenger cars in 2018, see https://www.acea.be/statistics/article/Share-of-diesel-in-new-passenger-cars.

[9] Changes in the mileage value should only apply to the SAAF reduction amount for future fleet targets. Retrospective changes would impose a significant volume risk on OEMs.

Most parameters are either taken from regulations (RED II, HDV Regulation) or information reported by OEMs and verified by authorities. The main additional set of parameters to be introduced to Regulation (EU) 2019/1242 is **lifetime by subgroup** of new vehicles (in years, since the annual transport performance is given by the Regulation). We propose using a separate value for each subgroup, in line with the general approach in the Regulation:

- Lifetimes of requirements (total km or years) from Regulation (EC) No. 595/2009, Article 4, for heavy-duty vehicles in N_2 and N_3 categories and with a permissible mass above 16 tonnes (current scope of fleet targets) of 700,000 km or seven years (whatever is reached sooner).
- Alternatively, average historical values can be used from available studies.[10]

[10] For example, TNO (2018), Support to prepare the impact assessment for CO_2 emission standards for Heavy Duty Vehicles, Final report for 'SR9 Heavy Duty Vehicles CO_2', Table 24.

1 INTRODUCTION

In this section, we provide the background (Section 1.1) and scope (Section 1.2) of this report. In Section 1.3, we set out its structure.

1.1 Background

The transport sector is key to achieving the GHG reduction targets of Germany and the EU

Global greenhouse gas (GHG) emissions must be reduced significantly to meet the long-term goal of the 2015 Paris agreement: keeping global temperature increase well below 2 degrees Celsius (preferably below 1.5 degrees Celsius). To contribute to this goal, EU member states have agreed to reduce EU-wide CO_2 emissions by 40% by 2030 compared to 1990 levels. In addition, Germany has set itself the target of reducing national CO_2 emissions by 55% by 2030, 70% by 2040 and 80 to 95% by 2050. For the transport sector, the Federal Environment Ministry's (BMU) climate protection plan envisages a 40 to 42% reduction in emissions by 2030 compared to 1990. In its 'European Green Deal', the European Commission (EC) proposes even stricter targets to at least 50% by 2030.[11]

In achieving these ambitious goals, the transport sector, particularly road transport, will play a central role: while CO_2 emissions elsewhere, such as EU household, energy and industrial sectors, have already been reduced since 1990 and the transport sector is the only one with even higher emissions.[12] In 2017, the transport sector generated about 22% of EU-wide GHG emissions, namely 946 million tonnes of CO_2 equivalent. In Germany, it comprised around 18% of emissions in 2018, about 160 million tonnes.

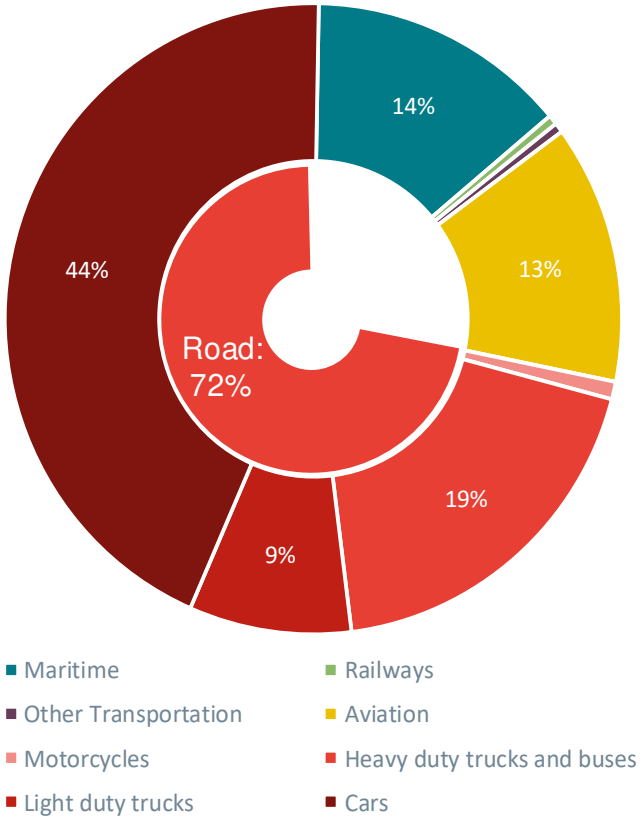
The main driver behind transport sector emissions is an increase in services, both passenger and freight[13]. At over 70%, most transport sector emissions occur in road transport. 60% of emissions within road transport (~ 40% of all transport sector emissions) being attributable to passenger transport and around 40% (~ 30% of all transport sector emissions) to light or heavy-duty vehicles (**Figure 4**).

[11] EC, COM(2019) 640 final, p. 4.

[12] Source: EEA (2018).

[13] For example, passenger car sector emissions in Germany increased by 0.5% between 1995 and 2017, but emissions per traffic volume fell by around 15%. Source: BMVI 2019, UBA 2019.

Figure 4 Distribution of CO_2 transport sector emissions in the EU28 (as of 2018)



Source: Frontier Economics based on https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-11

Current EU regulations target fuel suppliers and car manufacturers separately which may hinder coordination – this is to be reviewed by the EC

The EU legal framework for reducing CO_2 emissions in the road transport sector separates the responsibility along the supply chain:

- **Fuel suppliers ("well-to-tank")** – Fuel suppliers are responsible for emissions from transport fuels from the original energy source ("well") to the vehicle ("tank"). Regulations such as the revised Renewable Energy Directive[14] ("RED II") and further regulatory requirements[15] essentially focus on the quantities of fuel consumed.
- **Automotive industry ("tank-to-wheel")** – Vehicle manufacturers (often referred to as Original Equipment Manufacturer, "OEM") are responsible for direct emissions from the vehicle, i.e. on the way from the tank to the wheels. The main element regulating emission reductions are the set of emission performance standards for new vehicles[16] (also referred to as "fleet targets"),

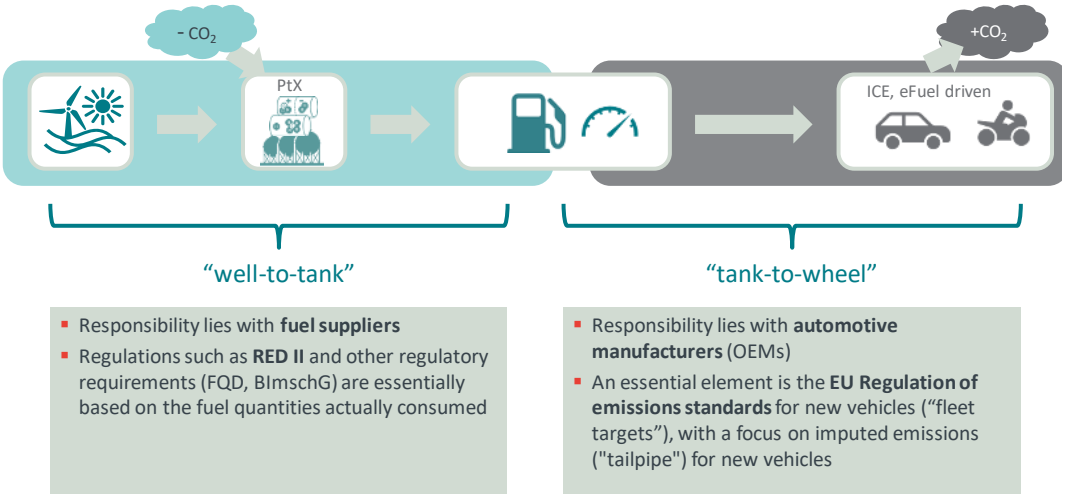
[14] Directive (EU) 2018/2001.

[15] Such as Directive 2009/30/EC (Fuel Quality Directive) and the German Federal Pollution Control Act (BImSchG).

[16] Regulation (EU) 2019/631 (passenger cars and for new light commercial vehicles) and Regulation (EU) 2019/1242 (heavy-duty vehicles).

which focuses on imputed emissions ("tailpipe") based on fleet values for new vehicles.

Figure 5 Schematic overview of the regulatory separation along an exemplary e-fuel supply chain



Source: Frontier Economics

Figure 5 illustrates (simplified for e-Fuels) the delimitation of the current regulation, most of which is now separate. This clear separation offers many advantages, including a clear assignment of responsibility and a pragmatic delimitation of the addressees of measures.

However, with sector-specific CO_2 targets in mind, this may result in a **coordination problem** which can spawn **economic inefficiencies** (i.e. higher CO_2 avoidance would be possible with the same effort). CO_2 abatement costs may differ substantially along the value chain. If CO_2 abatement costs (and thus willingness to pay for emission reductions) are higher in automotive manufacturing than in upstream supply chains, efficient coordination would shift more abatement efforts upstream.[17] Crediting SAAF in the fleet target context could potentially improve coordination, since it links fuel and automotive sectors.

The regulations on EU emission performance standards instruct the European Commission (EC) to review the effectiveness of these regulations and report to the European Parliament and Council. These reports shall also include proposed legislative amendments.

The review includes evaluating whether and to what extent the contribution of the use of synthetic and advanced alternative fuels (SAAF) from renewable energy sources to reduce emissions can be taken into account:

- Regulation (EU) 2019/631 (passenger cars and for new light commercial vehicles), Art. 15 para 2: [The Commission shall, in 2023, thoroughly review] "*the potential contribution of the use of synthetic and advanced alternative fuels produced with renewable energy to emission reductions*"; and
- Regulation (EU) 2019/1242 (heavy-duty vehicles), Art. 15 para 2 lit g: "*possibility of developing a specific methodology to include the potential*

[17] For example, if certain use cases for road transports of goods can only be electrified at very high cost, emissions can be reduced by renewable fuels in the fuel sector (i.e. further upstream).

contribution to CO_2 emission reductions of the use of synthetic and advanced alternative liquid and gaseous renewable fuels, including e-fuels, produced with renewable energy and meeting the sustainability and greenhouse gas emissions saving criteria referred to in Directive (EU) 2018/2001 [RED II]".

The scope of this report (see Section 1.2) falls into the context of this review by the EC.

The **key question** we are answering in this report is **how** such an SAAF-crediting system can be designed to unlock the potential benefits.

1.2 Scope of the report

The Federal Ministry of Economics and Energy (BMWi) has asked Frontier Economics Ltd. ("Frontier") to develop options for considering CO_2 reductions from SAAF in the EU fleet targets ("SAAF-crediting system").

The BMWi has specified the following tasks:

- Analysis of **possible systems for crediting** the CO_2 reduction contribution of SAAF in passenger cars, light and heavy-duty vehicles within the framework of the CO_2 emission performance regulation for road transport. This shall include an evaluation of the approaches already proposed. The result of this task involves proposing a concrete and workable crediting model.
- Developing a methodology to calculate the **equivalent reduction amount** using SAAF in passenger cars, light and heavy-duty vehicles, which is meaningful and environmentally sound.
- **Preparation of a draft text** for legislative implementation within the framework of the EC review in 2022/23.

More fundamental options to reform emission regulation in the transport sector, such as inclusion in the European Emission Trading Scheme (EU ETS) or the inclusion of rail, ship and air traffic are beyond the scope of this report. We also make no predictions on the future penetration of SAAF in the transport sector.

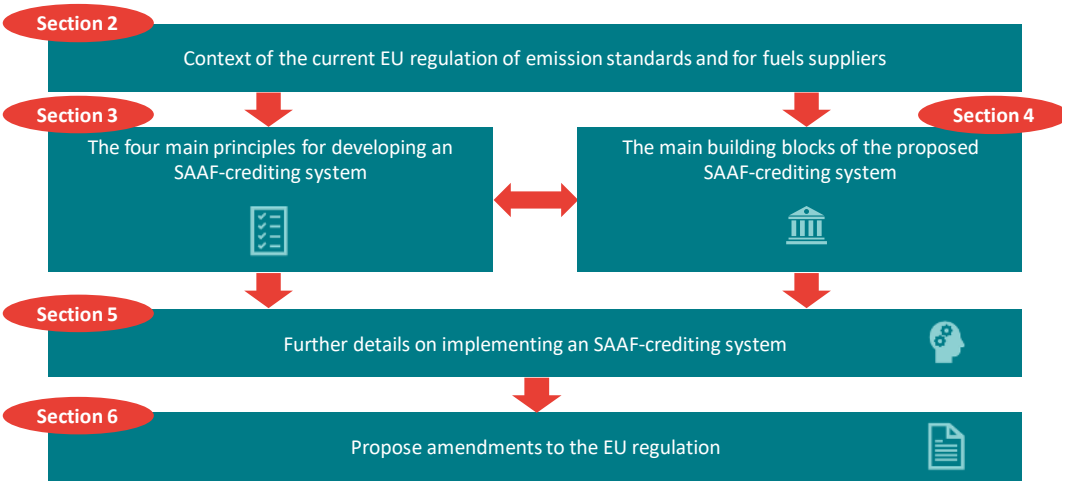
1.3 Structure of this report

Figure 6 sets out the structure of this report:

- In **Section 2**, we provide the context of the current EU regulation of emission standards for new road vehicles and fuel suppliers (RED II). **ANNEX A** provides further details.
- **Section 3** sets out four main principles for developing an SAAF-crediting system as derived from economic evaluation criteria;
- In **Section 4**, we describe the main building blocks of the proposed SAAF-crediting system;
- In **Section 5**, we provide details of how to implement an SAAF-crediting system (how to design the process and calculate the CO_2 reduction amount from SAAF on average fleet emissions); and

- In **Section 6**, we propose corresponding EU regulatory amendments. Further detailed amendments are relegated to **ANNEX B**.

Figure 6 Structure of this report



Source: Frontier Economics

2 CONTEXT – CURRENT ROAD TRANSPORT SECTOR REGULATIONS

In this section we provide a brief overview of the relevant EU regulations for the transport fuel and vehicle sector:

- EU new-vehicle emission standards ('fleet targets') (Section 2.1);
- Recast of the renewable energy directive ('RED II') (Section 2.2); and
- Different legal definitions of renewable transport fuels (Section 2.3).

2.1 EU emission standards for new road vehicles

Since 2009, passenger cars and light commercial vehicles have been subject to emission performance regulations in the EU. The EU has decided to tighten regulations governing CO_2 fleet limits for passenger cars and light commercial vehicles throughout Europe (December 2018) and, for the first time, also for heavy commercial vehicles (February 2019). The basic idea is that all OEMs should lower the Europe-wide average CO_2 emissions of their new vehicles each year below a fleet limit value that is becoming increasingly stringent or face comparatively high penalties of around EUR 600 per tonne of CO_2 that exceed the fleet target.

Table 2 provides an overview of the key element of the EU regulation on new-vehicle emission standards.

Table 2 Key element of the EU regulation on new-vehicle emission standards

	Light duty vehicles (Regulation 2019/631)	Heavy duty vehicles (Regulation 2019/1242)
Addressee	Original Equipment Manufacturers (OEM)	
Granularity	Newly registered vehicles in the EU in a year	
Geographical coverage	EU-wide (single OEM fleet)	
Fuel chain coverage	Tank-to-wheel (tailpipe emissions)	
Scope of vehicles	▪ New passenger cars and light commercial vehicles (groups M_1 and N_1)	▪ New large lorries (groups N_2 and N_3)
Current target (2020)	▪ Cars: 95 g/km ▪ Vans: 147 g/km	▪ As yet unspecified (reference period 1 July 2019–30 June 2020)
Target path (compared to 2020)	▪ -15% from 2025, ▪ -37.5% (cars)/-31% (vans) from 2030 onward	▪ -15% from 2025 ▪ -30% from 2030
Dimension of target	▪ Mileage (gram CO_2 per kilometre, g/km)	▪ Transport performance (gram CO_2 per tonne-kilometre, g/tkm)
Adjustment of targets to specific OEM fleet	▪ According to the average mass in the fleet	▪ According to mix of vehicle groups within their portfolio
Penalty (per vehicle)	▪ 95 EUR/g/km	▪ 4,250 EUR/g/tkm in 2025 ▪ 6,800 EUR/g/tkm in 2030
Special provisions	▪ ZLEV ▪ OEMs can form 'pool'	▪ ZLEV ▪ Banking and borrowing
Review of Regulation	▪ 2023 /2021*	▪ 2022

Source: Frontier Economics

*Note: *) Earlier revision of Regulation according to the Green Deal, ZLEV = zero/low-emission vehicles.*

We provide further details below.

Common features for LDV and HDV

Both regulations share the following features:

- **Addressees of the regulation are OEMs** – The regulation addresses Original Equipment Manufacturers (OEM)[18] of vehicles.
- The fleet targets are set **annually** and comprise all **new vehicles** registered in the same year.

[18] Exemptions are granted for manufacturers responsible for less than 300,000 cars registered per year. Manufacturers responsible for fewer than 1,000 cars are fully exempted from the regulation. The exemptions run out after the year 2028.

- For each OEM, a single EU-wide fleet target applies for each of the segments (cars, vans and heavy-duty vehicles).
- **Tank-to-wheel approach regarding coverage of fuel chain** – Therefore, only the vehicle tailpipe emissions are relevant in the current context, regardless of the origin and CO_2 intensity of the fuel used.

Scope of vehicles

The scope of emission standards is defined in Article 2 of the respective LDV and HDV Regulation. The scope differs between LDV and HDV: while in the LDV regulation, all new vehicles registered in the EU are subject to emission targets, HDV regulation only covers large lorries which account for 65 to 70% of all emissions.[19] In more detail:

- **New vehicles** – A vehicle is considered 'new' when it is registered in the Union for the first time and has not previously been registered outside the Union.
- **LDV** – all new vehicles registered in the EU are included in fleet targets. There is an exemption (*de minimis* rule) for small OEMs:
  - **'Passenger cars'** and '**light commercial vehicles**' – Vehicles of category M_1 and N_1[20]; and
  - ***De minimis* rule***:* OEMs (together with all affiliated companies) with fewer than 1000 new vehicles are exempt.
- **HDV** – At first, only large lorries (categories N_2 and N_3)[21] will be covered by the emission targets (from 2025 onwards). This includes:
  - **Rigid lorries** with an axle configuration of 4×2 and a maximum laden mass exceeding 16 tonnes or with an axle configuration of 6×2; and
  - **Tractors** with an axle configuration of 4x2 and a maximum laden mass exceeding 16 tonnes or an axle configuration of 6x2.

  In the regulation, vehicles are split into 9 sub-groups (see ANNEX A for further details). In 2022, the EC will review whether to also include buses and smaller lorries.

Emission Targets

The EU emission regulations set separate long-term targets for the emissions standards of new cars, vans and heavy-duty vehicles:

- For **cars**, from 2020 onward, a fleet-wide average emission target[22] of 95 g CO_2/km will be phased in for passenger cars – in 2020, the targets will apply for the 95% least-emitting new cars in the fleet, from 2021 onward, average emissions of all registered new cars will be taken into account. For **vans** ('light commercial vehicles'), the 2020 target is set to 147 g/km (vans). Going forward,

[19] https://ec.europa.eu/clima/policies/transport/vehicles/heavy_en

[20] As defined in Annex II to Directive 2007/46/EC.

[21] Ibid.

[22] This emission level is equivalent to a fuel mileage of 4.1l/100 km petrol and 3.6 l/100 km diesel.

percentage reduction targets for each manufacturer will be defined with 2021 starting points taken as benchmarks. The reduction targets are

  - 15% reduction from 2025 onward, 37.5% reduction from 2030 onward for **cars**: and
  - 15% reduction from 2025 onward, 31% reduction from 2030 onward for **vans**.

- From 2025, **heavy-duty vehicles** will also be subject to fleet regulation. Target levels for CO_2 emission reduction will be set relative to a reference period (July 1, 2019 – June 30, 2020):
  - 15% reduction from 2025 onward; and
  - 30% reduction from 2030 onward.

Penalty for excess emissions

OEMs must pay a penalty per vehicles if their average emissions exceed the fleet target:

- For **LDVs**, OEMs must pay a 'premium' of 95 EUR/g/km times the number of new vehicles, which corresponds to a CO_2 price of ca. 475-600 EUR per tonne CO_2, depending on the assumed lifetime mileage.[23]
- For **HDVs**, failure to comply with the specific emission target will result in a penalty of €4,250 per g CO_2/tkm in 2025 and €6,800 per g CO_2/tkm in 2030. The penalty in 2030 corresponds to a CO_2 price of ca. 280-600 EUR per tonne CO_2, depending on the assumed lifetime.[24]

Special provisions and incentives for ZLEV

Manufacturers receive additional benefits (beyond the impact of lower average fleet emissions) when registering zero or low-emission vehicles (ZLEVs):

- A **car or van** is regarded as a ZLEV if it emits less than 50 g CO_2/km. When calculating an OEM's specific average emissions, one ZLEV is multiplied with a factor of 2 in 2020; 1.67 in 2021; 1.33 in 2022 and 1 from 2023 onward. Each manufacturer can be credited with up to 7.5 g CO_2/km before a cap is set.
- OEMs of **heavy-duty vehicles** can also use super credits to comply with the 2025 relative reduction targets. From 2019 to 2024,
  - Lorries without any tailpipe emissions at all count as zero-emission vehicles (ZEV) and are multiplied by a factor of 2 in the average fleet emission calculation.
  - Lorries with a technical permissible maximum mass exceeding 16 tons and that emit less than half of all average CO_2 emissions in their group count as

[23] 95 EUR/g/km divided by an average lifetime mileage of 160,000 – 200,000 km multiplied by 10^6 (g/tonne). Assuming a longer lifetime mileage would result in a lower CO_2 price and vice versa.

[24] €6,800 per g CO_2/tkm divided by 1,605,672 (annual tonne-kilometre for 5-LH, see ANNEX A) and divided by an assumed lifetime of 7-15 years, multiplied by 10^6 (g/tonne). Assuming a longer lifetime in years would result in a lower CO_2 price and vice versa.

low-emission vehicles (LEV) and are credited with a multiplier between 1 and 2, depending on their specific emissions.

Further ZLEV incentives will be introduced in 2025 for passenger cars and heavy-duty vehicles.

Transferring emissions – CO_2 pools, banking and borrowing (HDV only)

The fleet regulations provide options to transfer emissions, either between OEMs (by forming a so-called 'pool') or over different years ('banking'/'borrowing').

- **Pooling for LDV**: OEMs can group together and act jointly to meet their emissions target. A pool can relate to one of several years but may not exceed five years. Pooling between car and van manufacturers is not possible, nor is pooling for HDV possible under current regulations. This will be reviewed by the EC in 2022.
- **Banking/borrowing for HDV**: During the period 2025 to 2029, OEMs can bank an outperformance of their fleet target ('emissions credit') and carry these emissions over to be counted against the target in later years. OEMs can also borrow up to 5% of their 2025 target ('debt limit') in a single year if falling short of their emissions target. This enables them to avoid the penalty in earlier years if they can compensate for this with lower emissions in later years. Both measures are introduced to account for the long production cycles and reward early emission reductions.[25] Banking and borrowing is not allowed for OEMs of cars and vans.

Review of emission standards in 2021 and 2022

In the recently adopted regulations, however, the EU Commission is commissioned to assess whether and to what extent the contribution of the use of synthetic and advanced alternative fuels (SAAF) from renewable energy sources can be taken into account to reduce emissions.[26]

This assessment comes within the scope of a review of the effectiveness of these regulations planned for 2022 (heavy duty commercial vehicles) and 2023 (passenger cars and light commercial vehicles). In the Green Deal, the EC has proposed an earlier review of the fleet targets for cars and vans by June 2021.[27]

2.2 Renewable Energy Directive II

The revised renewable energy directive 2018/2001/EU (RED II) came into force in December 2018. Member States must transpose the RED II provisions into national law by the end of June 2021.

RED II contains the following key provisions with relevance for transport fuels:

- **Binding Union-wide 2030 renewable target** – RED II, sets an overall binding EU target for Renewable Energy Sources consumption by 2030 of 32%.

[25] https://ec.europa.eu/clima/policies/transport/vehicles/heavy_en

[26] Regulation (EU) 2019/631 and 2019/1242 , Art. 15 para. 2.

[27] EC, COM(2019) 640 final, p. 11.

Member States must set national contributions to collectively meet this binding overall Union target.

- **Sub-target for the transport sector** – Member States must require fuel suppliers to supply at least 14% of the final energy consumed in road and rail transport by 2030 as renewable energy.
- **Union-wide database for renewable transport fuels** – The European Commission will set up a Union database for liquid and gaseous transport fuels, into which all transactions and the sustainability properties of these fuels must be entered. This information includes the life-cycle GHG emissions, starting from their production location to the fuel supplier.
- **Sustainability criteria** – RED II defines sustainability criteria and minimum GHG savings with which transport biofuels must comply to be counted toward the renewable target. Annexes V provide default GHG emission values and calculation rules are provided in Annexes V (for liquid biofuels) and VI (for solid and gaseous biomass for power and heat production) of the RED II.
- **Further details for synthetics fuels by delegates acts** – Since synthetic fuels from renewable energy sources constitute a new category, RED II does not yet provide detailed provisions. By 31 December 2021, the European Commission must supplement the Directive by establishing a Union methodology to verify the renewable content of synthetic fuels.
- **Cap on biofuels from food and feed crops (first-generation biofuels)** – RED II sets national caps[28] (upper limit expressed as a % of final energy consumption in the transport sector) on first-generation biofuels produced from food and feed crops.

2.3 Different definitions for sustainable transport fuels in EU regulations

In the EU legislation, various definitions exist for sustainable transport fuels:

- **First-generation biofuels** are "*biofuels and bioliquids, as well as biomass fuels consumed in transport, where produced from food and feed crops*".[29] First-generation biofuels are often based on vegetable oils derived from food plants.
- **Advanced biofuels** are those "*produced from the feedstock*", such as bio waste, straw, bagasse and other cellulosic non-food material.[30]
- **Renewable fuels of non-biological origin (RFNBO)** are "*liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass*".[31]

[28] The share of first-generation biofuels must not exceed 7% or the 2020-level plus 1 %-point of the final energy consumption in road and rail transport of a Member State, whatever is lower. Where that share is below 1% in a Member State, it may be increased to a maximum of 2%. Member State may also set a lower limit. See RED II, Art. 26 (1).

[29] Directive (EU) 2018/2001, Art. 26 (1).

[30] Ibid, Art. 2 (34) in combination with Part A of Annex IX.

[31] Ibid, Art. 2 (36).

- **Recycled carbon fuels (RCF)** are liquid and gaseous fuels produced from "*liquid or solid waste streams of non-renewable origin which are not suitable for material recovery (…) or from waste processing gas and exhaust gas of non-renewable origin which are produced as an unavoidable and unintentional consequence of the production process in industrial installations*".[32]
- **Synthetic and alternative advanced fuels (SAAF)** are mentioned in articles reviewing and reporting on regulations to set CO_2 emission performance standards for new passenger cars and light commercial vehicles and for new heavy-duty vehicles.[33] Both regulations foresee a review of scope to include synthetic and advanced alternative fuels produced with renewable energy to reduce emissions. The regulation on heavy-duty vehicles specifically mentions e-fuels and the need to adhere to sustainability criteria laid out in the Renewable Energy Directive II.[34] However, no dedicated definition of synthetic and alternative advanced fuels is provided in any European regulation.

[32] Ibid, Art. 2 (35).

[33] Regulation (EU) 2019/631, Art. 15 (2) and Regulation (EU) 2019/1242, Art. 15 (2) lit. g.

[34] Regulation (EU) 2019/1242, Art. 15 (2) lit. g.

3 PRINCIPLES FOR DEVELOPING AN SAAF-CREDITING SYSTEM

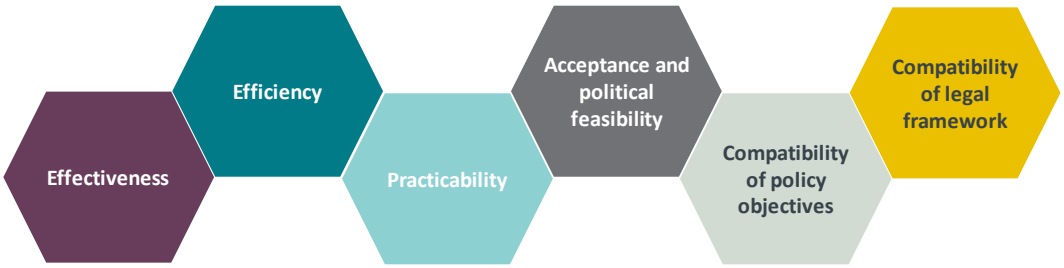
There is a broad spectrum of options to design an SAAF-crediting system. To define a coherent and consistent crediting system, we first introduce evaluation criteria (Section 3.1) and derive main principles a crediting system should fulfil (Section 3.2).

These principles form the basis for our design proposals in sections 4 and 5.

3.1 Evaluation criteria

Figure 7 provides an overview of the evaluation criteria we consider for deriving the main principles for developing an SAAF-crediting system.

Figure 7 Overview of filter and ranking criteria for the implementation models



Source: Frontier Economics

- **Effectiveness** – The instrument must effectively guarantee the achievement of additional reductions of greenhouse gas emissions in road transport. The incentives from the SAAF-crediting scheme need to be understood by market players to trigger the intended behaviour and be effective. Loopholes must be avoided.

  Effectiveness means that double counting of efforts ("fictive reductions") is prevented. In the longer term, the effectivity of achieving climate change in the transport sector and elsewhere requires an extended life-cycle view, e.g. ensuring that emissions are truly eliminated rather than simply "shifted" to another sector or geography.

  Effectiveness is a prerequisite for our proposed design – instruments or parameterisations that will clearly not effectively trigger emission reductions to the intended level are discarded.

- **Efficiency** – The implementation model should spawn economically efficient results and incentives, meaning the set emission reduction goals can be achieved as cost-effectively as possible for society. In other words: for any given amount spent, the maximum amount of GHG emissions is avoided. A suitable measure of this could, for example, be the emissions per capital input avoided or the average long-run abatement costs for emissions. It is important to note, that through creating new options (e.g. by allowing SAAF to count for fleet target) the overall costs to society can only decrease.

- **Practicability** – Implementing the instrument should be as practicable as possible for market participants and authorities, which means that transaction costs, overheads and risks for manufacturers and consumers should be minimised.
- **Compatibility with the existing legal framework** – The instrument should be legally compliant and compatible with the current national and European legal framework. Double subsidies should be avoided, for example, with efficiency as well as compliance with State Aid Law in mind. It is also important to take into account the extent to which existing definitions and standards (e.g. in RED II for determining possible CO_2 intensities) can be used (creating synergies) or that to which new regulations would have to be created. Legal constraints related to investor protection (no "ex post" intervention) should also be considered.
- **Incentive compatibility to existing policy objectives** – Another criterion is the degree to which different instruments can deliver on other (related) policy objectives, e.g. ensuring affordability of mobility for all or allowing for a wider range of vehicles.
- **Acceptancy and political feasibility** – Another criterion will be the degree to which instruments contribute to public acceptance of climate policy and help avoid or mitigate adverse distributional effects.

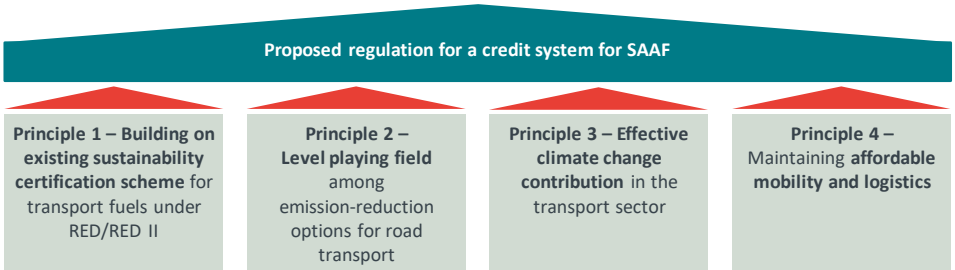
Based on these criteria, we have developed the following main principles for the proposed crediting model:

3.2 Four principles for developing an SAAF-crediting system

The overarching goal of the proposed SAAF-crediting model is to reduce GHG emissions in the transport sector. This should be done in a way that avoids imposing any unnecessary burden on citizens or industry but instead paves the way for easier /greater reductions. The instrument is not intended to lower or increase reduction goals nor to help one technological solution prevail over the other. The instrument should open "another optional pathway" in a level playing field of competing CO_2 reduction options for OEMs to meet their obligatory targets.

The proposed crediting system is based on the following four main principles (Figure 8):

Figure 8 Four principles for developing an SAAF-crediting system



Source: Frontier Economics

- **Principle 1 – Building on existing sustainability certification scheme for transport fuels under RED/RED II** – Accounting SAAF against fleet targets requires some form of certification system which ensures sustainability criteria are met and double counting is prevented. We align the SAAF crediting model approach as closely as possible with existing fuel sector regulations (RED and RED II)[35] to avoid two parallel systems with different standards and additional administrative costs for a separate SAAF certification scheme.
- **Principle 2 – Level playing field among emission-reduction options for road transport** – The aim of the SAAF crediting system is to broaden the scope for car manufacturers (OEMs) and establish a level playing field among emission-reduction options (i.e. rather than displacing alternative avoidance options, creating a wider set of options).
- **Principle 3 – Effective climate change contribution in the transport sector** – Any admissible crediting system must contribute to CO_2 additional reductions in the transport sector, i.e. credits counted toward fleet targets may not have been used elsewhere already (no double counting). Crediting of SAAF should offer an alternative for OEMs to reduce emissions that would otherwise exceed their fleet target and pay a penalty ("excess emissions premium") – these resources would be lost for climate protection. A crediting system for road transport may also facilitate the market ramp-up of synthetic fuels, which can create cross-sector synergies and - for instance - support emission reductions for other modes of transport (such as shipping and aviation) and other sectors.
- **Principle 4 – Maintaining affordable mobility and logistics** – Broadening the scope of emission-reduction options for OEMs will reduce costs to achieve fleet targets which ultimately drives new-vehicle prices down (LDV and HDV). It also offers low-emission options for customers and use cases with limited other alternatives.

These key principles are used to propose the main building blocks of an SAAF-crediting system (Section 4) and further implementation aspects (Section 5).

[35] RED (Directive 2009/28/EC) establishes national databases and a certification scheme based on common principles (sustainability criteria, mass balance system). This is further developed by RED II (Directive (EU) 2018/2001) and delegated acts (sustainability criteria for synthetical fuels (RFNBOs), Union database to ensure instant data transfers and harmonisation, see Recital 84).

4 MAIN BUILDING BLOCKS OF THE PROPOSED SAAF-CREDITING SYSTEM

In this section, we develop the main building blocks of our proposed SAAF-crediting system.

- Section 4.1 illustrates the **basic concept** of a crediting system;
- In Section 4.2, we describe the **general design features** of the crediting system applicable to both the origin and use of sustainability credits for SAAF, such as the geographical coverage of the crediting system and participation conditions for OEMs;
- Section 4.3 addresses the **origin side**, i.e. which fuels are admissible as SAAF and how credits are generated; and
- Section 4.4 concerns the **use side**, i.e. how credits from SAAF can be used by OEMs and credited against their fleet targets.

Table 3 summarises the proposed design, with identical building blocks for LDV and HDV. Further details on implementation, where LDV and HDV have to be differentiated, are presented in Section 5.

Table 3 Proposed SAAF crediting system (LDV, HDV) – overview

	Aspect	Design proposal
General features	Participation conditions	Voluntary participation for OEMs (no minimum quota for SAAF)
	Geographical scope	EU-wide harmonised crediting system and sustainability criteria for SAAF
	Volumetric scope	Optional cap on max. reduction (in g/km for LDV and g/tkm for HDV per fleet and year)
	Admissible fuels	All RED II compatible transport fuels (option for Member States to restrict to sub-set)
	Tradability	Yes – sustainability credits for transport fuels transferable
	Banking	Yes – within the valid scope of sustainability proofs according to RED II
	Borrowing	No – no additional scope for borrowing
Origin side	Double counting	No – sustainability credits can only be credited once against a legal obligation
	Sustainability criteria	RED II sustainability criteria and delegated acts apply (regards renewable content and additionality)
	Country of origin	Worldwide (if tracked and comprised reliably in accordance with RED II)
	Blending	Blending with fossil fuels admissible
Use side	Link to transport sector	Yes – Either direct use or indirect use for fuels fed into cross-sectoral infrastructure
	Link country of use	No – admissible fuel can be supplied to final customers in all Member States
	Crediting options	Crediting to individual new vehicles (as 'low-emission vehicle') possible
	Link to OEM fleet	For crediting to individual new vehicles – only credit fuels compatible with powertrain technology admissible
	Timeframe fulfilment	Front loading (credits for lifetime emissions to be surrendered at time of registration)

Source: Frontier Economics

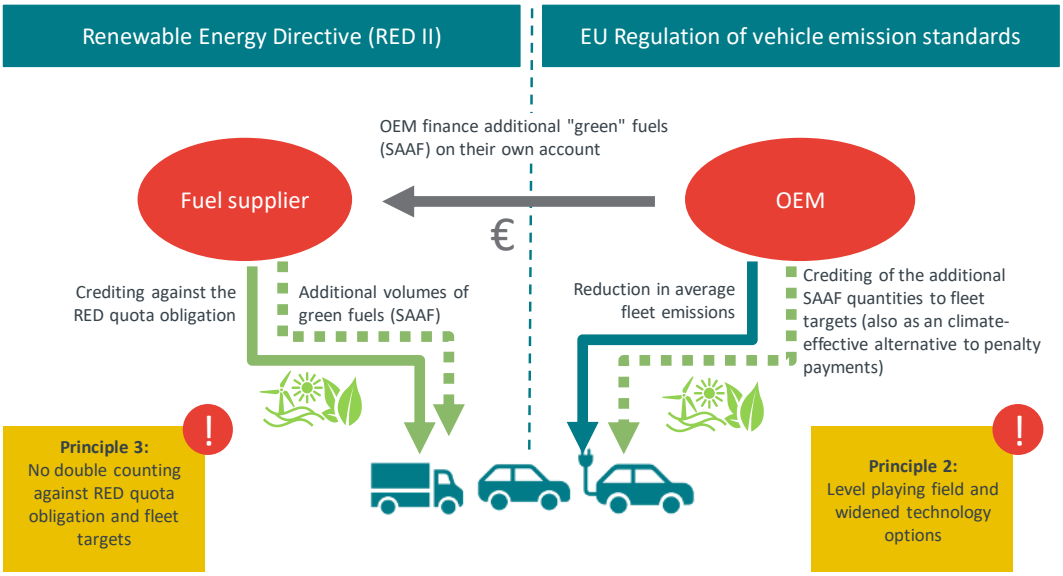
Note: LDV = light duty vehicles (passenger cars and light commercial vehicles), HDV = heavy duty vehicles

4.1 Basic concept

Figure 9 illustrates the basis concept of an SAAF-crediting system:

- **Fuels suppliers** sell renewable transport fuels into the market, which are then credited against their renewable fuel quota.
- **Fuels suppliers** sell additional renewable transport fuel volumes (which qualify as 'SAAF') beyond their own renewable fuel quota. These volumes are purchased by **OEMs**, which receive credits in return. The crediting system must be designed to prevent double counting against the renewable fuel quota (of the fuel supplier) and the fleet target (of the OEM).
- **OEMs** use these credits from additional renewable fuel (SAAF) volumes – which would otherwise not have been supplied to the market – for counting toward the average emissions of new vehicles in their fleet. The crediting system should be designed to provide a level playing field and widen technology options (Principle 2). It also provides a climate-effective alternative to penalty payments if fleet targets are not met by an OEM.

Figure 9 Basic concept of the SAAF-crediting system



Source: Frontier Economics

In the next subsections, we set out our design proposal for an SAAF-crediting system in detail.

4.2 General design features

Participation conditions – Voluntary Participation for OEMs

The EU Fleet target regulations apply to all OEMs selling more than 1,000 new vehicles per year and registered in the EU. OEMs are free to choose whichever technology option they like to reach their emission targets.[36]

A crediting system must specify the conditions for participation, with two key options:

- Mandatory participation – OEMs must apply a certain amount of SAAF, for example through a minimum quota; or
- Voluntary participation – OEMs can freely choose whether they want to use SAAF to reduce average emissions from their fleet, depending on the cost of different options and the preferences of their customers.

To establish a level playing field (Principle 2), participation in the crediting of SAAF should be **voluntary for OEMs**, i.e. there should be no obligatory minimum SAAF quota for OEMs. Crediting of SAAF should offer OEMs an additional option to reduce emissions from their new vehicle fleet but not create any specific incentives to displace alternative powertrain technologies (such as electrification). Such constraints on technology choices would make achieving emission targets costlier (contradicting principle 4).

[36] Either through powertrain solutions such as BEV/ FCEV, hybrids or through highly-efficient combustion engines with low fuel consumption.

Geographical scope – Europe-wide harmonised crediting system and SAAF standards

Regulation of fuel suppliers (RED II) is based on an EU directive which must be implemented in national law, providing member states with certainty degrees of freedom. Regulations on vehicle emission standards, conversely, come into force directly in all member states.

An SAAF-crediting system that builds on RED sustainability criteria and certification schemes (Principle 1) must connect these two areas of EU legislation, considering national legislation and authorities from the implementation of RED II that is still underway.[37]

- **Uniform crediting** – SAAF credits should apply uniformly to all OEMs, irrespective of the Member States in which new vehicles are registered. This is in line with current regulations governing vehicle emission standards with a single EU-wide fleet target for each OEM (only differentiating car, vans and lorries). This requires a single methodology to calculate the reduction amount from SAAF (see Section 5.2).
- **Uniform sustainability criteria** – There should be an EU-wide common standard for SAAF. Unharmonized national SAAF standards would increase transaction cost for fuel suppliers and OEMs (static inefficiency) and impede the market ramp-up for new synthetic fuels (dynamic inefficiency).

  This is consistent with RED II that sets out the sustainability requirements for biofuels. The EC will establish a Union methodology for sustainability requirements that apply to synthetic fuels in further delegated acts (RED II, Article 27).
- **List of admissible fuels might vary between Member States** – The SAAF definition (see Section 2.3) potentially includes a wide set of established and new biofuels and synthetic fuels which can be liquid or gaseous. Member states may restrict the list of admissible fuels e.g. to reflect differences in the national potential of certain alternative fuels and increase political acceptance (see discussion on admissible fuels below).

Volumetric scope – could be capped (upper limit for SAAF credit)

According to principle 2, the SAAF-crediting system should create a level playing field among emission-reduction options. With such a level playing field, OEMs should be able to select freely among a broad set of equivalent emission-reduction technologies. This technology choice should be made according to minimal cost and preferences of their customers (see principle 4). Explicitly limiting any of these options would only make emission reductions costlier (inefficient).

On this level playing field, SAAF are only a further, additional option to reduce new-vehicle emissions. If fuel suppliers and OEMs comply with the sustainability regulatory requirements, there is no economic reason to set a limit.

In the discussion, some concerns have been raised that the use of SAAF might jeopardise incentives to introduce new alternative powertrain solutions into the

[37] Member States have to transpose RED II into national law by the end of June 2021.

market. To address such political concerns, appropriate upper limits could potentially be imposed on the use of SAAF to reduce average fleet emissions:

- Separate limits for LDV (in g/km) and HDV (in g/tkm); and
- Equal limits for each OEM from the same vehicle segment to avoid distortions among manufacturers.

These limits should be regularly reviewed to avoid OEMs having to pay the penalty instead of using SAAF as an effective means to reduce transport sector emissions (Principle 3).

Admissible fuels – allowing for wide-ranging fuels (though Member States may further restrict)

The definition of the term "SAAF" is left open when regulating vehicle emission standards (see Section 2.3). For a crediting system, the regulations must specify which types of transport fuels can be credited against fleet targets.

In principle, OEMs should be able to use all synthetic and biological liquid and gaseous transport fuels produced with renewable energy that meet the sustainability and greenhouse gas emissions saving criteria in RED II (in line with the SAAF definition in Article 15 (2) of the HDV Fleet Regulation).

- This kind of harmonized approach avoids the need to establish a parallel system for OEMs (SAAF) and fuel suppliers (RED), which would increase administrative cost (static inefficiency) and hinder the penetration of innovative synthetic fuels (dynamic inefficiency) (see principle 1).
- A wide range helps unlock sufficient potential for SAAF to be effective against climate change (Principle 3) – restrictions to a narrow subset, for example only selected synthetic fuels, could mean significant supply constraints, since these fuels remain in the market ramp-up phase.
- A wide range also makes the instrument more cost-efficient and hence helps maintain affordable individual mobility (Principle 4).

Member states may nevertheless restrict the list of admissible fuels, for example e.g. to reflect differences in the national potential of certain alternative fuels and increase political acceptance:[38]

- **Excluding first-generation biofuels** – First-generation biofuels from food and feed crops are subject to national caps under RED II (Art. 26 (1)).[39] These caps should also include all volumes used for crediting against fleet targets such that no additional first-generation biofuel volumes enter the transport sector. Member States might want to restrict the use of first-generation biofuels still further if not consistent with their national policies. Member States should therefore be given the option to exclude fuels from the list of admissible fuels ("blacklisting").

[38] RED II, Recital 90 for example gives Member States the option not to consider recycles carbon fuels in fuel supplier obligations.

[39] The share of first-generation biofuels must not exceed 7% or the 2020-level plus 1 %-point of the final energy consumption in road and rail transport of a Member State, whatever is lower. Where that share is below 1% in a Member State, it may be increased to a maximum of 2%. Member State may also set a limit lower than 7%. See RED II, Art. 26 (1).

- **Focus on synthetic fuels (RFNBO, RCF)** – Some Member States might want to only allow specific renewable fuels of non-biological origin ("whitelisting"). Synthetic fuels (e.g. based on "Power-to-X" technologies) are part of the cross-sectoral defossilisation strategy of many Member States and Member States might want to focus on them to meet additional objectives (e.g. industrial policy) to climate protection.

It is important to stress that even though the set of admissible fuels should be defined as widely as possible, the OEM decides which additional renewable fuels to finance for crediting against fleet targets. OEMs might focus (based on intrinsic preferences) on fuels that are seen as innovative and sustainable given the positive impact on their reputation.

Restricting the set of admissible fuels would mean that sustainability credits from fuels in a Member State which have been excluded by this country cannot be credited against the fleet targets (see Section 5.1 for the process and the authorities involved).

Tradability of credits

Sustainability credits for SAAF need to be tradeable between fuel suppliers (who places them on the market) and OEMs (who want to count them against their fleet targets) – and potentially additional intermediaries (brokers, exchanges).

Otherwise, OEMs would have to become directly active on the market for fuel supply to create the necessary credits. This would obviously result in huge hindrances and go against the intention of the new crediting system to provide an additional technological option to lower vehicle emissions as part of a level playing field (Principle 2) and not change the business models of different players in the fuel chain. Furthermore, tradability is compatible with the system for fuel suppliers under RED II (Principle 1), which allows for trades of sustainable fuels between different players active in the fuel chain (e.g. from a foreign producer of biofuels to importers and final delivery by a fuel supplier at a fuelling station).

Tradability ensures an efficient production of renewable fuels by specialised fuel suppliers, distribute sustainability credits and supply sufficient SAAF to the market for effective emission reductions (Principle 3).

Banking of credits admissible

Banking of credits means that emission reductions from SAAF can be carried over from the period (year) a renewable fuel was initially sold into the market and sustainability credits were created to a later period (year) when the credits are used and counted toward fleet targets of this period.

Banking of credits should be allowed since it provides the following benefits:

- Banking is a measure to enhance price stability over time and to **increase the efficiency** of a credit/certificate system since it allows the distribution of credits to be optimised over time without the need to store the underlying product (renewable fuel). This reduces the overall cost from the crediting system (Principle 4).

- Banking incentivises climate protection measure **earlier** than in a system without banking. This leads to premature emission reductions which enhances the **effectiveness** of an SAAF-crediting system for the road transport sector (Principle 3).

Banking can be limited (for example for one reporting period, as in the HDV Regulation[40]) or unlimited (as in the EU ETS). For compatibility reason with RED II (Principle 1), banking of sustainability credits should be possible for the duration that these credits are valid under the national implementation of RED II.

Borrowing of credits not required

Fleet targets for OEMs are determined annually for all new vehicles registered in that year. Borrowing would imply that more credits are used in a year than credits surrendered for the same period. The difference ('emission debt' = used credits – surrendered credits) would have to be submitted in later years (possibly against a fee to account for interest).[41]

Borrowing might have the following benefits:

- Borrowing (as the counterpart to banking) could enhance price stability and **efficiency** of a credit/certificate system since it allows CO_2 abatement measures to be postponed if they can be implemented more economically in future (Principle 4). This is particularly relevant for products with long production cycles, such as new HDV powertrain solutions, which is why limited borrowing of emission credits is currently allowed.[42]
- Borrowing could also help mitigate **risk**, since it protects OEMs against unexpected increases in average fleet emissions toward the end of a year when they might not be able to react in time to buy and surrender additional SAAF credits.

Borrowing appears no longer necessary if OEMs can either buy additional credits (tradability) or use banked certifications (banking) for unexpected developments in their average fleet emissions at the end of the year. The main disadvantage of borrowing is that climate protection measures are implemented **later** than in a system without borrowing, which weakens the **effectiveness** of an SAAF-crediting system for the road transport sector (contradicting principle 3).

Borrowing should therefore **not be permitted** beyond existing fleet target provisions (emissions debts for HDV).

[40] See Regulation (EU) 2019/1242, Art. 7 (1). Banked credits ('emission credits') can be carried over into the next reporting period for the years 2025-2028. This excludes credits acquired before 2025, which can be carried over into 2025, the first year when the emission targets apply.

[41] In the EU ETS, banking is technically permitted since the surrender of allowances for the previous year takes place in April of the following year, such that installations can use new allowances for the current year (which are allocated in February) to surrender against the previous year's obligation. However, borrowing not permitted across trading periods (covering several years). See ETS Handbook, p. 133, available online https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf.

[42] Regulation (EU) 2019/1242, Art. 7 (1).

4.3 Origin side – generating credits by supplying SAAF

Double counting strictly ruled out

We propose to build on the sustainability credits for transport fuels from RED II (Principle 1). Without further measures, this might increase the risk of the same amount of renewable fuels (and corresponding credits) being counted twice; once against the fuel supplier obligation under RED II and once against the OEM fleet targets.

Such double crediting would seriously undermine the effectiveness of climate protection policy in the transport sector since new-vehicle emissions would virtually decline while now additional renewable fuels are brought onto the market (contradicting principle 3).

To prevent fraud and double counting, RED II sets out the following requirements for all economic operators in the fuel chain:

- The use of a mass balance system to ensure that each consignment is counted only once. A strict chain of custody allows the physical mixing (blending) of batches while the bookkeeping (for batches with different sustainability characteristics) must be separated.
- Auditors shall verify that the systems used by economic operators are accurate, reliable and protected against fraud. This includes ensuring that materials are not intentionally modified or discarded.

The amendments to the fleet regulation and process design (see Section 5.1) need to ensure that such double counting continues to be prevented. This requires a strict separation of credits in national and future union database for transport fuels and for national authorities and the EC to verify that OEMs surrender only credits from truly additional renewable fuel volumes.

Sustainability criteria (renewable share, additionality) applied from RED II

According to Principle 3, we propose aligning the sustainability criteria for SAAF with renewable transport fuels from RED II (see Section 2.2). This is already in the HDV Regulation where the EC should consider SAAF in their review, "*meeting the sustainability and greenhouse gas emissions saving criteria referred to in Directive (EU) 2018/2001*".[43]

This is a basic prerequisite to avoid a new, independent verification system in parallel to the RED II regime. Such a parallel system would involve considerable administrative work and transaction costs for market players. In addition, two parallel systems with different standards for renewable fuels might endanger or hinder market development (dynamic inefficiency).

[43] Ibid, Art. 15 (2) lit. g.

Global country of origin admissible

RED II allows for imports of renewable fuels (and pre-products) from outside the EU if they adhere to the sustainability and GHG saving standards of the RED II.[44]

Since we propose building on the RED II provisions for renewable transport fuels (Principle 1), global imports that fulfil these provisions should also be creditable against fleet targets. A global market ensures renewable fuels are sufficiently available on the market and helps minimize production costs (Principle 4).

Blending and pre-products possible

Blending should be permitted, as within the framework of the RED II specifications (see above). The mass balance system (see "double counting") prevents blending of different batches changing the sustainability characteristics of the original consignments or renewable fuels. The same applies when considering pre-products in the fuel value chain.

Prohibiting blending and/or pre-products would require a separate distribution infrastructure for SAAF, which would generate significant additional costs (inefficiency) and make mobility costlier (contradicting principle 4).

4.4 Use side – accounting for credits in fleet targets

Only fuels brought into the transport sector admissible

RED II sets a renewable target for the transport sector of at least 14% of final energy consumption by 2030.[45] This target requires a link between an energy carrier (such as methane or diesel which are usable in multiple sectors) to the transport sector to track the achievement of the sector target.[46]

Such a link to the transport sector can be established in two ways:

- **Direct** – by placing a renewable fuel on the market and consumption in the transport sector. This typically applies for bio/synthetic diesel or petrol which is blended with fossil fuels and distributed in the same fuelling station.
- **Indirect** – in the case of cross-sectoral infrastructure, e.g. hydrogen or methane. There is no dedicated infrastructure for methane used in the transport sector (in CNG[47] vehicles) and the heating sector. For example, in Germany fuel suppliers can fulfil their renewable fuel obligation by injecting the corresponding volume of biomethane into the gas grid.[48]

Where the required link is not already specified by RED II (in delegated acts and the transposition into national law), we propose also considering an **indirect link to the transport sector** for fuels that are fed into cross-sectoral infrastructure, e.g. hydrogen or methane. This ensures compatibility with requirements for fuel

[44] RED II, Article 30 (3).

[45] Ibid, Article 25 (1).

[46] RED II distinguished between 'biofuels' (liquid fuel for transport produced from biomass) and 'bioliquids' (liquid fuel for energy purposes other than for transport produced from biomass), see Art. 2 (32) – (33).

[47] CNG = Compressed natural gas.

[48] See Section 37b BImschG.

suppliers under RED II (Principle 1) and effective carbon emission reductions in the transport sector (Principle 3).

Supply of fuel and credits can fall into different countries

No link is required between country where SAAF are sold to final customers and the country where new vehicles are registered. This results directly from the logic of fleet regulation, which sets a single European-wide emission target for OEMs. Requiring a direct link would increase costs for an SAAF crediting system unnecessarily (contradicting principle 4) and have no bearing on the achievable emission reductions in the transport sector.

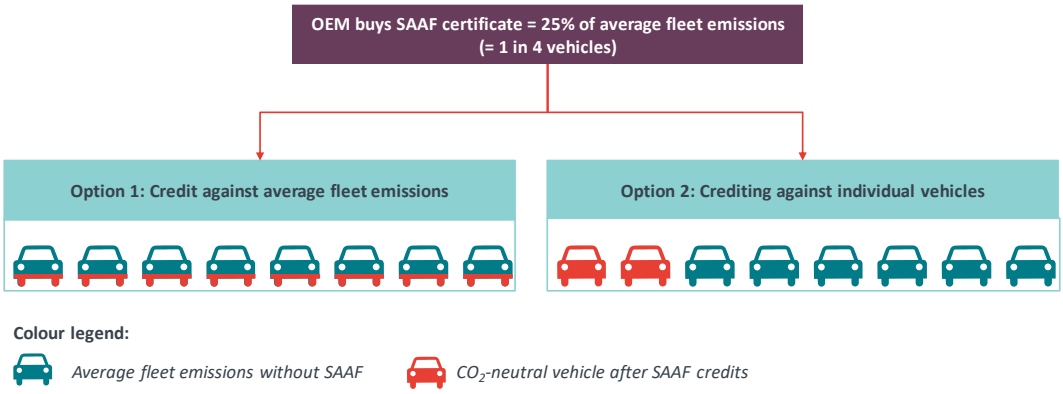
Credits assignable to individual vehicles

Under a crediting system, OEMs buy and surrender a certain volume of sustainability declarations equivalent to a certain CO_2 reduction in tonnes. There are two options for how these absolute CO_2 reductions can be credited against vehicles (Figure 10):

- **Option 1 – Reduction of average fleet emissions**: The CO_2 reduction amount is subtracted from the average fleet emissions of an OEM (see Section 5.2 for a calculation formula). Under this option, the OEM realises a benefit from avoiding a penalty payment if it would otherwise exceed its fleet target. The final customers who buy the vehicles nevertheless experience no difference between an OEM using SAAF to meet its targets or not.
- **Option 2 – Crediting against individual vehicles (optional for OEM)**: The emission reduction through the crediting of SAAF can be attributed to individual vehicles. OEMs have the option to attribute the low-emission properties in registration documents, which makes the emission reduction visible (and transferable) for final customers. The credibility of such systems depends on new vehicles only being sold as low-emission vehicles after the submission of the corresponding credits was verified. Depending how the verification process is organised, only credits from the previous period (year) might be used (introducing a time lag of a year). See Section 5.1 (steps 5 and 6) for further details.

We recommend optionally **crediting against individual cars** (option 2) since it increases the willingness-to-pay of customers for low-emission vehicles and thus helps finance effective climate protection (Principle 3). It also enables Member States to establish a level playing field on other regulations (e.g. tax incentives for low-emission vehicles) (Principle 1).

Figure 10 Different crediting options



Source: Frontier Economics

Note: Vehicles can be partly (low-emission vehicle) or fully (zero-emission vehicle) set CO_2 neutral in Option 2. Note that this is a simplified example based on a 25% assumption. See section 5.2 for a more realistic calculation of the SAAF contribution to fleet targets.

For crediting to individual new vehicles, only credits from SAAF compatible with the powertrain technology are admissible

Wide-ranging biofuels and synthetic fuels can be used to generate sustainability credits. However, not every OEM fleet has the same powertrain solution and is thus able to consume all such fuels.

There are two options whether a link is required between fuels and the fleet of an OEM:

- **Option 1 – No link** between OEM fleet and admissible renewable fuels. This means that OEMs can chose the most cost-efficient type of SAAF to reduce their average fleet emissions for cheaper mobility (Principle 4).
- **Option 2 –** A **direct link** must be established between the powertrain technology of new vehicles in the year in which the crediting takes place. There are two variants, depending on whether credits are assigned to the overall fleet or to individual new vehicles (see above):
  - Option 2a (**individual low-emission vehicles**) – An OEM can only attribute credits from SAAF to individual new vehicles that are technically usable in these vehicles.
  - Option 2b (**overall OEM fleet**) – An OEM can only use credits from fuels that are technically usable in the overall fleet of newly registered vehicles in the same year.

Any restriction, such as option 2a and 2b, drives up costs (contradicting principle 4) and does not lead to more effective CO_2 reductions in road transport. However, a link between new vehicles sold as 'low-emission' and the type of additional renewable fuel brought on the market (option 2a) might increase the political credibility of the SAAF crediting system since OEMs are solely accountable for the choice of powertrain technologies.

For collective crediting against fleet targets (option 2b), there is no direct link to individual vehicles and therefore no such benefit from imposing restrictions on the types of renewable fuels. However, requiring a link would make the implementation of a crediting system costlier and less efficient.[49]

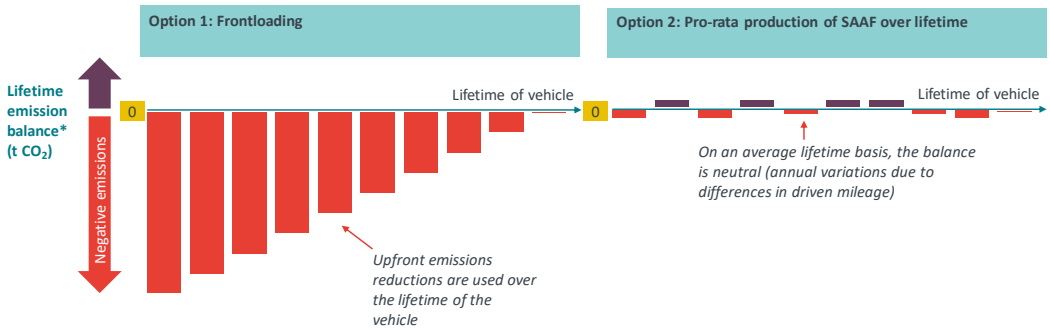
We therefore recommend **option 2a**, i.e. a link between admissible fuels for crediting to individual new vehicles, only where credits are assigned to individual vehicles (see above).

Frontloading of credits to ensure lifetime carbon neutrality at first registration

There are two options for how OEMs can surrender SAAF credits to reduce new-vehicle emissions, impacting differently on the CO_2 balance in the transport sector (Figure 11):

- **Option 1 – Frontloading**: OEMs surrender SAAF credits in year 1 covering the full lifetime emissions of a new vehicle. This means that a new vehicle has a **negative**[50] **CO_2 balance** (on a "well-to-wheel" basis[51]) until it reaches its expected average end of life. We examine how lifetime fuel-related emissions can be calculated in Section 5.2.
- **Option 2 – Pro-rata** over a vehicle lifetime: OEMs surrender SAAF credits equal to the average mileage of a new vehicle per year. The net balance in a single year can be slightly above or below zero, depending on the actual drive pattern compared to the typical average. The average difference becomes zero over the full lifetime of the car provided the lifetime is determined correctly. An annual pro-rata purchase of SAAF would generate a steady long-term cash flow for investments in new renewable fuel plants.

Figure 11 Impact of front loading vs. pro-rata on emissions over time



Source: Frontier Economics

*Note: Illustrative graph with simplifications. *) Lifetime emissions = emission reductions for production of SAAF – tailpipe emissions of vehicle over lifetime*

[49] For example, information on the fuel mix are only available after the end of the year of crediting against average fleet emissions, national differences in fuel specifications would restrict the tradability of SAAF credits across Member States, tracking of blended fuels and pre-products differentiated by different renewable fuel type is not practicable.

[50] Renewable fuels require a non-fossil CO_2 source for their production. Only when the renewable fuel is burnt in a combustion engines over the lifetime of a vehicle is the CO_2 released into the atmosphere.

[51] This abstracts from the CO_2 emissions generated during production of a vehicle and the end-of-life emissions for recycling.

We recommend **front loading** since it significantly accelerates emission reductions in the transport sector and supports effective climate change contributions for the transport sector (Principle 3). Under front loading, there is a negative net effect on emissions as emissions already bound up in the production of synthetic fuels are released back into the atmosphere over their lifetime of several years.

Front loading is also a prerequisite for allowing assignment to individual (low-emission) vehicles since this provides a fair balance between an additional burden for OEM (from frontloading) and higher willingness-to-pay for customers (for certified low-emission vehicles).

5 IMPLEMENTATION OF THE SAAF-CREDITING SYSTEM

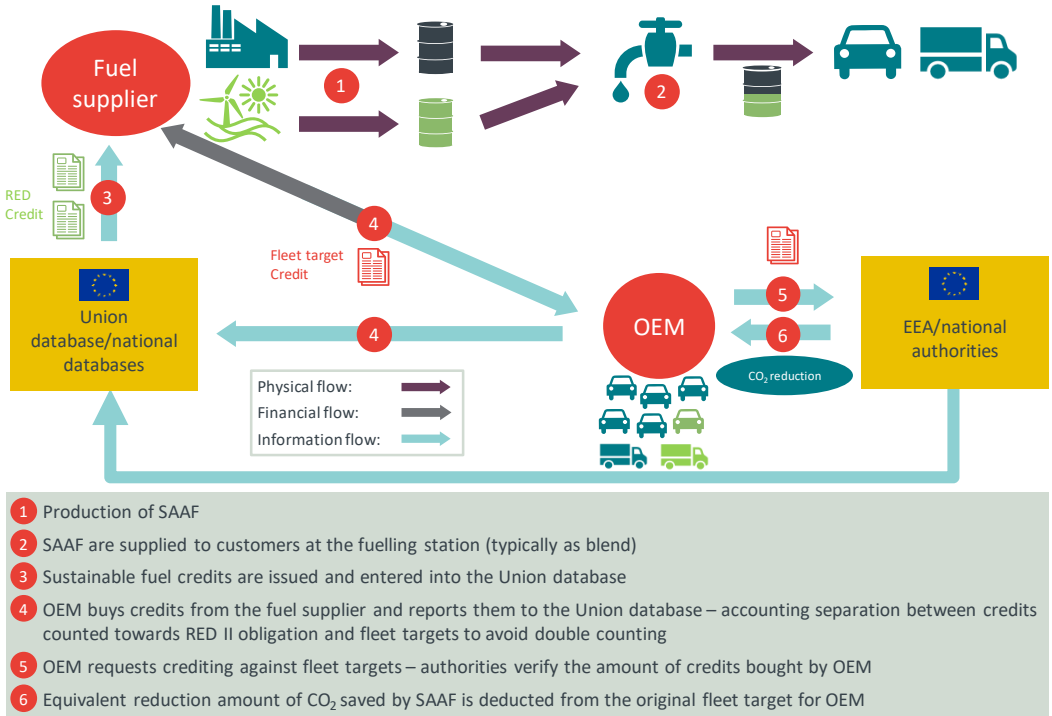
In Section 4, we developed the main building blocks for the proposed SAAF-crediting system in the EU new-vehicle emission standards. In this section, we provide further details of how such a crediting model can be practically implemented:

- **Process design** (Section 5.1) – In this section we describe the process and the parties and institutions involved along the fuel chain step-by-step, from production of SAAF to crediting against OEM fleet targets. The process must ensure climate targets are effectively reached and administrative costs are minimised.
- **Calculation of the equivalent CO_2 reduction amount** (Section 5.2) – Fleet targets and CO_2 reduction from supplying renewable fuels need to be aligned, despite the different underlying units. This requires converting the CO_2 savings from the provision of renewable fuels into a reduction on the average fleet value.

5.1 Process design

Figure 5 provides an overview of the institutions involved and the steps along the fuel chain, starting from the production of renewable fuels until the crediting against fleet targets. The upper part of the flow charts represents the physical world where fuels are produced, transported and distributed to final customers. The lower half shows the financial and data flow involved in crediting SAAF against fleet targets.

Figure 12 Flow chart of process for crediting SAAF against fleet targets



Source: Frontier Economics

Note: "Renewable fuel credit" or "RED credit" means 'proof of sustainability' / 'sustainability declaration' since the term 'certificate' refers to the accreditation by certification schemes that is recognised by the EC under RED II.

In the following, we provide further details for each of the six steps:

Step 1 – SAAF produced by fuel supplier

At the beginning of the fuel chain, fuel suppliers produce renewable fuels, which may originate from a broad range of technically available renewable fuel sources and be produced in the EU or imported (as end- or pre-products) from outside the Union. For example:

- Biodiesel can be produced *inter alia* from crops (first-generation biofuels) or waste and residual materials (second-generation biofuels), such as waste cooking oil or animal fats imported into the EU.
- Synthetic diesel or petrol can be produced with renewable electricity in Member States via various chemical processes (e.g. Fischer-Tropsch process or methanol synthesis). The share of synthetic fuels is currently negligible and most fuel plants are still in the demonstration phase.

The fuel production chain may involve several production steps and different economic operators until the fuel is ready for distribution and consumption. For simplification, in this report we focus on the interface between the fuels supplier to end customers and OEMs.

Step 2 – SAAF are supplied to customers (typically as blend)

Renewable fuels can reach final customers via a range of pathways:

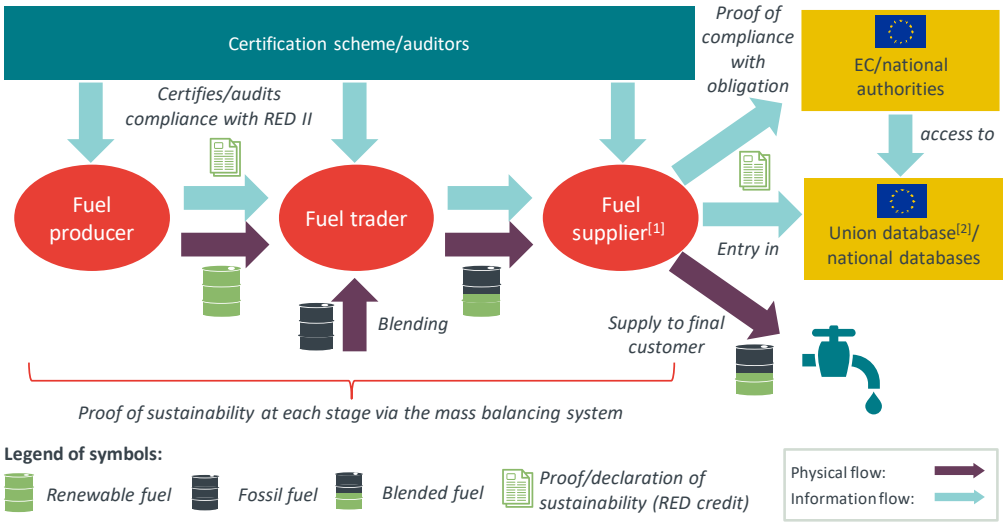
- **Usage of the traditional fuel infrastructure**, such as tankers, fuel bunkers, tank trucks and fuelling stations. The use of this infrastructure can be dedicated to new fuels[52] or simultaneously via blending[53] with fossil fuels.
- **Grid-based fuel provision**, for example transport and distribution via pipelines for methane (existing natural gas infrastructure) and hydrogen (in future hydrogen grids).

The choice of which pathways are used depends on the future mix of renewable fuels for road transport.

Step 3 – Fuel supplier receives credit for renewable transport fuel (RED II)

Figure 13 illustrates how sustainability declarations ("RED credits") for renewable fuels are passed on along the fuel chain and the chain of custody that ensure that the sustainability requirements are fulfilled at each stage.

Figure 13 Chain of custody for renewable fuels and sustainability declarations under RED/RED II and national implementation



Source: Frontier Economics

Note: [1] Definition according to RED II, Art. 2 (38): "'fuel supplier' means an entity supplying fuel to the market that is responsible for passing fuel through an excise duty […]".
[2] RED II, Art. 28 (2): "The Commission shall ensure that a Union database is put in place to enable the tracing of liquid and gaseous transport fuels […]. A Member State may set up a national database that is linked to the Union database ensuring that information entered is instantly transferred between the databases."

Under RED II and the current national implementation (still under RED I), fuel suppliers acquire the necessary sustainability declarations as follows:

- The EC recognises voluntary **certification schemes** that demonstrate compliance with the sustainability criteria for renewable fuels.[54] To get recognised, certification schemes need robust verification and auditing

[52] Parallel distribution for specialised vehicles, e.g. methanol (M100), OME, DME and hydrogen.

[53] Within the specifications for fuels, e.g. EN 510 (diesel) and EN 228 (petrol).

[54] A list of certification schemes is published online: https://ec.europa.eu/energy/topics/renewable-energy/biofuels/voluntary-schemes_en?redir=1#list-of-approved-voluntary-schemes

procedures. The Commission assesses whether the schemes adequately cover the sustainability criteria.

- The use of a **mass balance system** allows the physical mix of sustainable and non-sustainable products as well as the mix of consignments with different sustainability characteristics at every stage of the value chain. A mass balance system along the fuel chain ensures the renewable content can be verified.
- The production of renewable fuels generates a **sustainability declaration ("credit")** which includes all essential information (inter alia: type of renewable fuel, energy content and the GHG savings). These declarations are passed on along the fuel chain.
- Fuel suppliers use sustainability declarations to **substantiate to the responsible national authorities** that they are complying with their national renewable fuel quota. The information on any declaration of sustainability is currently entered into national **databases** and the EC will set up a Union database to store all information centrally.

The same process should apply for generating credits usable for fleet targets.

Step 4 – OEM buys renewable transport fuel credits from the fuel supplier

An OEM can buy sustainability declarations ("credits") from the fuel supplier. This requires a written contract between the OEM and fuel supplier, which identifies the transacted credits unambiguously.

The OEM notifies the operator of the national database for sustainable fuels and submits a written contract:

- The transacted credits are deducted from the fuel supplier account (seller).
- The transacted credits are added to the OEM account (buyer).

In future, information will enter the Union database.

The database would have to be separated between renewable fuel credits used by fuel suppliers and OEMs. This can be implemented by adding a "final purpose" category to the dataset of renewable transport fuels.

Step 5 and 6 – OEM requests crediting against fleet targets which is verified by authorities

The process for OEMs requesting crediting against fleet targets includes the following steps:

- **By 28 February of each year**, national authorities (e.g. the KBA in Germany) must report emissions and new registration data for the preceding year to the Commission.[55] This timetable currently applies only to LDV since the process for HDV has not yet been determined.

[55] Regulation (EU) 2019/631, Art. 7.

- **By e.g. 15 April of each year**[56]**,** after reporting registration data to the Commission, OEMs must notify the designated national authorities for renewable fuels (for example, in Germany the Main Customs Office in Cottbus) about how many SAAF credits they intend to credit against their fleet emissions for the preceding year. The designated national authorities must verify that OEMs have procured sufficient SAAF credits and that the fuel suppliers having provided the credits have fulfilled their renewable fuel obligation from the preceding year (i.e. only excess credits transferable to OEMs).
- **By 30 June each year**, the Commission notifies OEMs of the average specific CO_2 emissions, target emissions and the credited reduction amount from SAAF for the preceding calendar year.

If an OEM wants to assign credits to individual vehicles (see Section 4.4), additional requirements are necessary to ensure that credits are supplied before a vehicle is sold to a customer with reduced emissions. There are two options for how verification and assignment to vehicles could be organised:

- An **ongoing verification procedure intra-year** where credits must be surrendered and verified year-round (and not the following year) when low/zero-emission vehicles are sold. This approach generates additional administrative efforts but lets the OEM offer low-emission vehicles immediately after credits have been verified.
- An **annual verification procedure** where only credits from the previous year can be used for assignments to individual vehicles. This approach would not require additional administrative effort since it is compatible with the current approach for fuel suppliers (see above) but involves a time lag of one year between the supply of credits and the ability to offer low-emission vehicles. Since credits can be banked (see Section 4.2), OEMs can acquire the necessary credits in the previous period and transfer any excess credits into the next period if they sell fewer low-emission vehicles than expected.

In Section 5.2, we set out a methodology for how the Commission can determine the equivalent CO_2 reduction amount based on the SAAF credits.

5.2 Calculation of the equivalent CO_2 reduction amount

In this section, we propose a methodology for how the CO_2 reduction from additional SAAF financed by OEMs can be credited against their fleet emissions:

- **Introduction of a new element "equivalent CO_2 reduction amount"** – The new element when calculating average emission standards is introduced as a so-called "reduction amount". This additional term is necessary due to different dimensions: Fleet targets and vehicle emissions are expressed in average CO_2 emissions (in grams) per kilometre of mileage (for LDVs) or per tonne-kilometre of transport performance (for HDVs). The contributions to emission reduction

[56] This is the date set in German law (BImSchG) by which quota trading contracts for the previous year must be submitted to the main customs office in Cottbus to be counted against the fuel supplier quota.

from credited SAAF quantities (in litres or MJ) must therefore be converted into the same unit as the fleet targets.

- **Split between credits counted against average fleet emissions and individual vehicles** – OEMs need to declare which share of credits in a year is counted toward average fleet emissions ("$credit_{fleet}$") and which share is assigned to individual vehicles ("$credit_{vehicle}$"). This is necessary to prevent double counting, since credits assigned to individual vehicles lower their specific emissions which, in turn, are the basis used to calculate average fleet emissions.[57] The total impact on fleet emissions remains unchanged, irrespective of which option the OEM chooses.
- **Different formulas for LDV and HDV** – Due to differences in the dimension of the fleet targets between LDV (gram of CO_2 per kilometre driving distance) and HDV (gram of CO_2 per tonne-kilometre transport performance), we analyse the required amendments to the formula separately.

The following subsections set out the calculation methodology and present an example of how this can be practically implemented.

5.2.1 Light duty vehicles

For light duty vehicles, fleet targets are expressed in average CO_2 emissions in grams per kilometre of mileage (g CO2/km). The contributions to emission reduction from credited SAAF quantities (in MJ) must therefore be converted into the same unit.

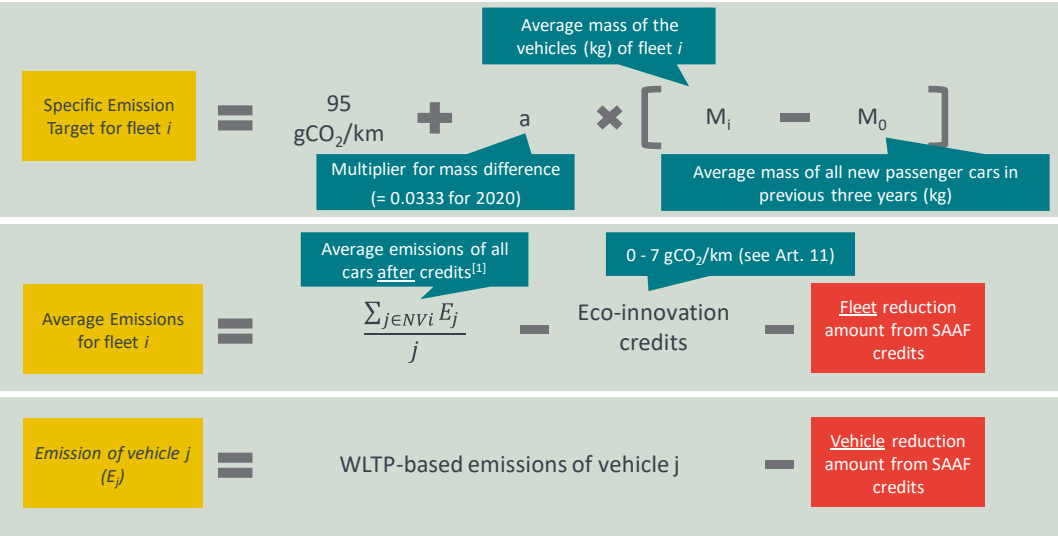
Figure 14 shows the relevant formula for calculating the specific emission target and the average emissions for light duty vehicles for fleet i:

- The upper part shows how **emission targets** for OEM i are calculated: the target of 95 g CO_2/km (applicable in 2020) is adjusted for the average mass of all vehicles in fleet i compared to the average mass of all new passenger cars in the past three years. If fleet i is heavier than the EU-wide average, the specific emission target is increased and vice versa.
- The lower part shows how **average emissions** for fleet i are determined: the average WLTP-based emissions per vehicle are reduced by credits for eco-innovations (up to 7 g CO_2/km) and the credits for SAAF (determined as equivalent **reduction amount** in g CO_2/km).

If average emissions (after credits) exceed the specific target, OEM i must pay a penalty for excess emissions (see Section 2.1).

[57] For example, if an OEM has acquired 100 credits in year t, it splits credits equally such that 40 are counted against the fleet emission of year t and the remaining 60 are assigned to individual vehicles, which are then sold as low-emission vehicles in year t. At the end of year t, fleet emissions are already reduced as some vehicles have reduced emission values (because of the credits assigned to the vehicle). Accordingly, only the remaining 40 credits have to be deducted from the fleet emissions.

Figure 14 Light duty vehicle emission formula



Source: Frontier Economics based on Regulation (EU) 2019/631.

Note: Multiplier "a" increases the specific emission target for a fleet if the average vehicle mass is higher than the industry-wide average and vice versa. For example, in 2020 (a = 0.0333), if fleet i is on average 100 kg heavier per vehicle, the specific emission target increases by 3.3 g/km.

Figure 15 shows how the reduction amount for crediting SAAF (in g CO_2/km) can be determined for OEM i.

Figure 15 Calculation of the CO_2 reduction amount for LDV

Origin of credits by OEM

$$(1)\ \text{credit}_{\text{total,t}} = \sum_{\text{k}}\left(\text{fuel}_{\text{k,t}} \times \text{CO2}_{\text{ref}} \times \text{CO2saving}_{k}\right) + \text{banking}_{\text{t-1}}$$

Use of credits by OEM

$$(2)\ \text{credit}_{\text{total,t}} = \text{credit}_{\text{fleet,t}} + \sum_{\text{j}} \text{credit}_{\text{vehicle,j,t}} + \text{banking}_{\text{t}}$$

Crediting option 1 ("$\text{credit}_{\text{fleet}}$") – Fleet emissions

$$(3a)\ \text{reduction amount}_{\text{fleet,t}} = \frac{\text{credit}_{\text{fleet,t}}}{\text{mileage} \times \text{vehicles}_{\text{t}}}$$

Crediting option 2 ("$\text{credit}_{\text{vehicle}}$") – Individual vehicles

$$(3b)\ \text{reduction amount}_{\text{vehicle,j,t}} = \frac{\text{credit}_{\text{vehicle,j,t}}}{\text{mileage}}$$

With:

1. $\sum_{\text{k}}(.)$: sum over all SAAF fuel types
2. $\sum_{\text{j}}(.)$: sum over individual vehicles
3. $\text{fuel}_{\text{k,t}}$: amount of fuel type k credited by OEM in year t [MJ]
4. CO2_{ref}: fossil fuel comparator (see RED II, Annex V) [g CO_2/MJ]
5. $\text{CO2saving}_{\text{k}}$: emission saving factor for fuel k (see RED II and delegated acts) [%]
6. $\text{banking}_{\text{t}}$: banked SAAF credits from period t
7. $\text{credit}_{\text{fleet,t}}$: total SAAF credits counted towards fleet targets in year t [g CO_2]
8. $\text{credit}_{\text{vehicle,j,t}}$: SAAF credits counted towards vehicle j in year t [g CO_2] (note: impact on fleet emissions via attribution to the WLTP value)
9. mileage: mileage over lifetime (**NEW**) [km]
10. $\text{vehicles}_{\text{t}}$: new registered vehicles of OEM in year t

Source: Frontier Economics

The CO_2 reduction amount for LDV is determined as follows:

- **Equation (1)** specifies the credits available to an OEM in period t as the sum of newly acquired credits (based on the quantity and type of renewable fuel) and banked credits from the previous period.
- **Equation (2)** shows the split between credits that are counted toward average fleet emissions ("$credit_{fleet}$") and assigned to individual vehicles ("$credit_{vehicle}$"). Any remaining credits are banked for the next period.
- **Equations (3a) and (3b)** specify how the reduction amount is determined; deducted from either the average fleet emissions or the specific emissions of individual vehicles.
- **Parameters**[58] – The equations in **Figure 15** distribute the total CO_2 savings (in g CO_2) over the lifetime mileage of all new vehicles in fleet i (in km):
  - **Parameters 3-8 and 10** are either taken from RED II or information reported by OEMs and verified by authorities.
  - **Parameter 9:** The main additional parameter to be introduced to Regulation (EU) 2019/631 is the **mileage** of new vehicles **over their entire lifetime**. We propose using a single standard value for the entire fleet, consistent with the approach in the Regulation[59]:
    - **160,000 km** based on *Regulation (EC) No 692/2008 Annex VII (1.2)*. This is a conservative proxy for lifetime mileage since it is used to verify the durability of pollution control devices.
    - Alternatively, average historical values can be used suggesting a range of **175,000 – 185,000 km**.[60]
    - In future, the mileage value might be calibrated with data from on-board fuel consumption metering (but no retrospective changes[61]).

Below we provide a simplified example that shows how the CO_2 reduction amount (SAAF credit) can be calculated.

Calculation example

To calculate the value of the emission reduction for fleet i of a given amount of SAAF, we must first calculate the total CO_2 savings induced by the renewable fuel:

- For each type of SAAF, we first multiply the amount of fuel by the CO_2 reference value for the fossil fuel comparator (according to RED II[62]).

[58] Strictly speaking, this is a mix of variables (values that can change, for example the number of new vehicles (6.)) and parameters (values fixed by the Regulation).

[59] The Regulation aggregates individual CO_2 performances with equal weighting, i.e. a simple arithmetic average of individual vehicle WLTP values.

[60] According to the Report for the European Commission by Ricardo-AEA (Ref: Ares (2014)2298698) the average diesel car lifetime mileage is approximately 208,000 km while for petrol cars, lifetime mileages fluctuate between 160,000 and 170,000 km. Diesel cars comprised approx. 35% of new passenger cars in 2018, see https://www.acea.be/statistics/article/Share-of-diesel-in-new-passenger-cars.

[61] Changes in the mileages value should only apply to the SAAF reduction amount for future fleet targets. Retrospective changes would impose a significant volume risk on OEMs.

[62] Directive (EU) 2018/2001, *Annex V No. 19.* For biofuels, the fossil fuel comparator is set to 94 g CO_2/MJ. This value reflects the CO_2 content of petrol and diesel which is higher than for natural gas. RED II does not yet provide a separate fuel comparator for natural gas. We recommend adding a fuel comparator for natural gas to detemine the CO2 savings from biomethane accordingly. For example, in Germany the value has

- Subsequently, we multiply the CO_2 reference value for the fossil fuel comparator with the emissions saving factor of the respective renewable fuel, also specified in RED II[63], to get the total emission reduction that can be counted against the fleet target.

Table 4 shows this first step for one exemplary fuel type.

Table 4 LDV example – Total CO_2 savings from SAAF

Variable	Value [Example]
SAAF type	Fischer-Tropsch diesel
Quantity (in MJ)	1,000,000,000
CO_2 reference value (g CO_2/MJ)	94
CO_2 savings factor (%)	85%
Total CO_2 saved (in tonnes)	79,990

Source: Frontier Economics

An OEM that introduces 1,000,000,000 MJ (~27 million litres[64]) of Fischer-Tropsch diesel into the market would generate a total of 79,990 tonnes of CO_2 emissions savings, which can be credited against their fleet emission targets.

To determine the equivalent CO_2 reduction amount, next we divide the emission savings by the total expected mileage of the newly registered fleet, for which we multiply the number of newly registered vehicles of OEM i, with their assumed lifetime. **Table 5** shows this for an exemplary OEM.

Table 5 LDV example – CO_2 reduction amount

Variable	Value
Number of newly registered cars	100,000
Lifetime mileage per car (km)	175,000
Total CO_2 saved (g)	79,900,000,000
Contributions to emission reduction from credited SAAF (g CO_2/km)	4.57

Source: Frontier Economics

In the above example, we do not explicitly split credits counted toward fleet emissions or assigned to individual vehicles:

- **Fleet emissions**: The exemplary OEM registered 100,000 cars, which are assumed to run 175,000 km in their lifetime on average and created emission savings of 79,900,000,000 g CO_2, which yields a contribution to emission reduction from SAAF of 4.57 g CO_2/km.
- **Individual vehicles**: This is the equivalent of setting around 4,566 vehicles with WLTP emissions of 100 g CO_2/km carbon neutral[65].

been set to 69.3 g CO_2/MJ, see Annex 2 of 38th BImSchV, available online: https://www.gesetze-im-internet.de/bimschv_38_2017/BJNR389200017.html.

63 Ibid, Annex V.

64 This assumes an energy content of 44 MJ/kg and a density of 0.84 kg/litre for Fischer-Tropsch diesel, see also RED II, Annex III, "Fischer-Tropsch diesel" and https://www.bdbe.de/daten/umrechnung-und-formeln.

65 79,900,000,000 gCO_2 / (175,000 km/vehicle * 100 g CO_2/km) = 4,565.71 vehicles.

The net impact on average fleet emissions is the same under either option, since assigning to individual vehicles lowers WLTP-based emissions, which are an input variable to calculate average fleet emissions (see Figure 14).

5.2.2 Heavy duty vehicles

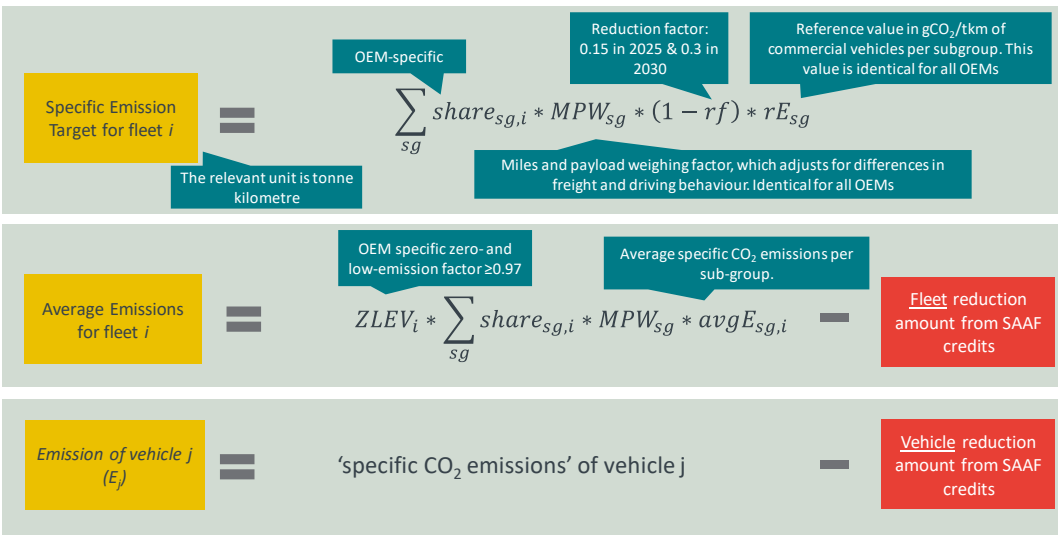
For heavy duty vehicles, fleet targets are expressed in average CO_2 emissions (in grams per tonne-kilometre (g CO_2/tkm) of transport performance. As above, the contributions to emission reduction from credited SAAF quantities (in MJ) must therefore be converted into the same unit.

Figure 16 shows the relevant formula for calculating the specific emission target and the average emissions for heavy duty vehicles for fleet i. The main difference to the calculation above is the inclusion of the sub-group specific 'miles and payload weighing factor' (MPW), used to reflect differences in freight and driving behaviour. A higher MPW weights CO_2 in this vehicle sub-group more highly.

- The upper part of **Figure 16** shows how the **specific emission targets** for OEM i are calculated: the emission target is determined by multiplying the share of each vehicle sub-group with the corresponding MPW, a factor that accounts for the emission reduction (15 percent in 2025) and the reference value in gram CO_2 per tonne-kilometres, which is identical for all OEMs.
- The lower part of **Figure 16** shows how **average emissions** for fleet i are determined: the emissions are calculated as the sum over all vehicle sub-groups of their respective share multiplied by their MPW and the average specific CO_2 emissions of the sub-group. This value is adjusted by the OEM-specific reduction factor for zero- and low-emissions vehicles (ZLEV) and the credits for SAAF (determined as the equivalent **reduction amount** in g CO_2/tkm).

If average emissions (after credits) exceed the specific target, OEM i must pay a penalty for excess emissions (see Section 2.1).

Figure 16 Heavy duty vehicle emission formula



Source: Frontier Economics, based on Regulation (EU) 2019/1242.

Figure 17 shows how the reduction amount for crediting SAAF (in grams per tonne-kilometre) can be determined for OEM i. The formula is slightly more complex than for LDV since the HDV Regulation considers nine vehicle subgroups making different contributions to the fleet target.

Figure 17 Calculation of the CO_2 reduction amount for HDV

Origin of credits by OEM

$$(1)\ \mathrm{credit}_{\mathrm{total,t}} = \sum_{\mathrm{k}}\left(\mathrm{fuel}_{\mathrm{k,t}} \times \mathrm{CO2}_{\mathrm{ref}} \times \mathrm{CO2saving}_{k}\right) + \mathrm{banking}_{\mathrm{t-1}}$$

Use of credits by OEM

$$(2)\ \mathrm{credit}_{\mathrm{total,t}} = \mathrm{credit}_{\mathrm{fleet,t}} + \sum_{\mathrm{j}} \mathrm{credit}_{\mathrm{vehicle,j,t}} + \mathrm{banking}_{\mathrm{t}}$$

Crediting option 1 ("$\mathrm{credit}_{\mathrm{fleet}}$") – Fleet emissions

$$(3a)\ \mathrm{reduction\ amount}_{\mathrm{fleet,t}} = \frac{\mathrm{credit}_{\mathrm{fleet,t}}}{\sum_{\mathrm{sg}} \mathrm{lifetime}_{\mathrm{sg}} \times \mathrm{tkm}_{\mathrm{sg}} \times \mathrm{vehicles}_{\mathrm{sg,t}} \times \frac{1}{\mathrm{MPW}_{\mathrm{sg}}}}$$

Crediting option 2 ("$\mathrm{credit}_{\mathrm{vehicle}}$") – Individual vehicles

$$(3b)\ \mathrm{reduction\ amount}_{\mathrm{vehicle,j,t}} = \frac{\mathrm{credit}_{\mathrm{vehicle,j,t}}}{\mathrm{lifetime}_{\mathrm{sg}} \times \mathrm{tkm}_{\mathrm{sg}}}$$

With:

1. $\sum_{\mathrm{k}}(.)$: sum over all SAAF fuel types
2. $\sum_{\mathrm{j}}(.)$: sum over individual vehicles
3. $\sum_{\mathrm{sg}}(.)$: sum over all nine vehicle subgroups
4. $\mathrm{fuel}_{\mathrm{k,t}}$: amount of fuel type k credited by OEM in year t [MJ]
5. $\mathrm{CO2}_{\mathrm{ref}}$: fossil fuel comparator (see RED II, Annex V) [g CO_2/MJ]
6. $\mathrm{CO2saving}_{\mathrm{k}}$: emission saving factor for fuel k (see RED II and delegated acts) [%]
7. $\mathrm{banking}_{\mathrm{t}}$: banked SAAF credits from period t
8. $\mathrm{credit}_{\mathrm{fleet,t}}$: total SAAF credits counted towards fleet targets in year t [g CO_2]
9. $\mathrm{credit}_{\mathrm{vehicle,j,t}}$: SAAF credits counted towards vehicle j in year t [g CO_2] (note: impact on specific vehicle emissions)
10. $\mathrm{lifetime}_{\mathrm{sg}}$: lifetime per subgroup, see table (**NEW**) [a]
11. $\mathrm{tkm}_{\mathrm{sg}}$: Annual transport performance by subgroup (Regulation (EU) 2019/1242, Annex I) [tkm/a]
12. $\mathrm{vehicles}_{\mathrm{sg,t}}$: new registered vehicles from subgroup sg of OEM in period t
13. $\mathrm{MPW}_{\mathrm{sg}}$: mileage and payload factor for subgroup sg (Regulation (EU) 2019/1242, Annex I)

Source: Frontier Economics

The equations for HDV follow the same structure as for LDV presented above:

- **Equation (1)** specifies the amount of credits available to an OEM in period t as the sum of newly acquired credits (based on the quantity and type of renewable fuel) and the banked credits from the previous period.
- **Equation (2)** shows the split between credits that are counted toward average fleet emissions ("$\mathrm{credit}_{\mathrm{fleet}}$") and assigned to individual vehicles ("$\mathrm{credit}_{\mathrm{vehicle}}$"). Any remaining credits are banked for the next period.
- **Equations (3a) and (3b)** specify how the reduction amount is determined, deducted from either the average fleet emissions or the specific emissions of individual vehicles.
- **Parameters** – The equations in **Figure 17** distribute the total CO_2 savings (in g CO_2) over the lifetime transport performance of all new vehicles in fleet i (in tkm):

- **Parameters 3-9 and 11-13** are either taken from RED II, the HDV fleet target Regulation or information reported by OEMs and verified by authorities.
- **Parameter 10:** The main additional parameter to be introduced to Regulation (EU) 2019/1242 is the **lifetime of each vehicle sub-group** (in years since the annual transport performance is given by the Regulation). We propose using a separate value for each subgroup, in line with the general approach in the Regulation:
  - Lifetimes of requirements (total km or years) from Regulation (EC) No. 595/2009, Article 4, for heavy-duty vehicles in N_2 and N_3 categories with a permissible mass above 16 tonnes (current scope of fleet targets) of 700,000 km or seven years (whatever is reached sooner). **Table 6** shows the annual mileage per sub-group, which is provided in the Regulation and the subsequent assumption on each groups' lifetime.
  - Alternatively, average historical values can be used from available studies.[66]

Table 6 HDV sub-group annual mileage and lifetime

Vehicle sub-group sg	Annual mileage per sub-group (in km)	km after 7 years	years until 700,000 km	Assumed lifetime of vehicle sub-group	km after assumed lifetime
4-UD	60,000	420,000	11.67	7	420,000
4-RD	78,000	546,000	8.97	7	546,000
4-LH	98,000	686,000	7.14	7	686,000
5-RD	78,000	546,000	8.97	7	546,000
5-LH	116,000	812,000	6.03	6.03	700,000
9-RD	73,000	511,000	9.59	7	511,000
9-LH	108,000	756,000	6.48	6.48	700,000
10-RD	68,000	476,000	10.29	7	476,000
10-LH	107,000	749,000	6.54	6.54	700,000

Source: Frontier Economics, based on Regulation (EU) 2019/1242 Annex I.

Calculation example

To calculate the value of the emission reduction for the HDV fleet i of a given amount of SAAF, we must recalculate the total CO_2 savings induced by the renewable fuel. We assume that the OEM introduces an equivalent amount of SAAF, as in our example above and generates total CO_2 savings of 79,990 tonnes.

Let us further assume that the OEM fleet comprises 30,000 5-LH and 10,000 10-RD vehicles. With this, we can calculate the denominator of the formula for the SAAF reduction amount in **Figure 17**. For each sub-group, we multiply the number of vehicles with their lifetime mileage and with the reciprocal of their MPW, which is 1 and 0.434 for 5-LH and 10-RD respectively. **Table 7** shows the relevant figures for an exemplary OEM. As a final step, we divide the total CO_2 savings by the total

[66] For example, TNO (2018), Support for preparation of the impact assessment for CO_2 emission standards for Heavy Duty Vehicles, Final report for 'SR9 Heavy Duty Vehicles CO2', table 24.

effective lifetime tkm of the newly registered fleet and reach a contribution to emission reduction from SAAF of 0.2g CO_2/tkm. This is equivalent to setting around 146 vehicles of the sub-group 5-LH carbon neutral[67].

Table 7 HDV example – CO_2 reduction amount

Variable	5-LH	10-RD
Number of newly registered cars	30,000	10,000
Lifetime mileage (km)	700,000	476,000
Average payload (tonnes)	13.8	10.3
MPW	1	0.434
Sum of total effective tkm for both sub-groups[1]	402,767,741,935	
Contributions to emission reduction from credited SAAF (g CO_2/tkm)	0.20	

Source: Frontier Economics, based on Regulation (EU) 2019/1242.

*Note: [1] 5-LH: 30,000*700,000*13.8*(1/1) = 289,800,000,000 tkm;*
*10-RD: 10,000*476,000*10.3*(1/0.434) = 112,967,741,935 tkm*

Unsurprisingly, the specific emission reduction for the same amount of SAAF is smaller for the HDV fleet than the LDV fleet, even if the HDV fleet has far fewer vehicles. This is mainly due to the higher assumed lifetime performance of each vehicle for the HDV fleet, for which more SAAF must be introduced to compensate for the emissions.

[67] 79,900,000,000 gCO_2 / ((700,000 km*13.8 tonnes)/vehicle * 56.5 g CO_2/tkm) = 146.39 vehicles. See https://www.acea.be/uploads/publications/ACEA_preliminary_CO2_baseline_heavy-duty_vehicles.pdf, p. 5.

6 PROPOSED AMENDMENTS TO EU LEGISLATION

In sections 4 and 5, we have developed the main building blocks and further implementation details from an economic perspective. In this section, we propose the corresponding amendments to EU legislation. Further detailed amendments are relegated to ANNEX B.

As outlined in previous sections, an SAAF-crediting system requires alignment with existing legislation in the fuel sector (RED and RED II) to avoid creating two parallel systems with different standards and additional administrative costs (Principle 1). At the same time, the goal must be to ensure that sustainability criteria are met and double counting is prevented (Principle 3).

Adjustments to EU fleet legislation should be as minor as possible and are based on the principle that additions should, at best, fit into the existing legal system. Accordingly, modifications should be kept to a minimum. The proposed fundamental changes are as follows:

- Regarding the **EU fleet legislation** (Section 6.1),
  - the basic rules of the crediting system could be inserted into **LDV** Regulation (EU) 2019/631[68]; and
  - a reference to the (new) basic rules of the crediting system in Regulation (EU) 2019/631 could be inserted into **HDV** Regulation (EU) 2019/1242[69], and only the necessary and HDV-related adjustments should be made in Regulation (EU) 2019/1242 itself.
- In the **type-approval legislation** (Section 6.2), namely in Regulation (EC) 715/2007[70] and Regulation (EC) 595/2009[71], additions are proposed to enable crediting to individual vehicles.

In contrast, RED II Directive (EU) 2018/2001 with its annexes should not be amended if possible because it does not address transport and vehicle-specific issues, although it deals with transport fuels. However, since the Directive is a central reference point of the EU fleet legislation, it will be necessary to amend its Annex V to adequately reflect all relevant SAAFs. This amendment could be implemented on the basis of delegated acts of the Commission in accordance with the existing Article 31 of the Directive. However, the core provisions of the Directive are not affected.

[68] Directive (EU) 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

[69] Regulation (EU) 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 No (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC

[70] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (Text with EEA relevance)

[71] Regulation (EC) No 595/2009 of the European Parliament and of the Council of 18 June 2009 on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI) and on access to vehicle repair and maintenance information and amending Regulation (EC) No 715/2007 and Directive 2007/46/EC and repealing Directives 80/1269/EEC, 2005/55/EC and 2005/78/EC

6.1 Amendments to Fleet Regulation (EU) 2019/631 and (EU) 2019/1242

6.1.1 Amendments to Regulation (EU) 2019/631

The fleet legislation for LDVs in Regulation (EU) 2019/631 will integrate the SAAF-crediting system's core procedure. To this end, a new article has been inserted, which is based on Article 11 (eco-innovation) as far as possible and, due to a similar mode of operation, will be systematically introduced immediately thereafter. In order not to affect internal and external references to the Regulation and to make it easier to follow, we have inserted the new provisions as Article 11a.

Other necessary amendments are made in the annex, including the specific formula for calculating reductions. The specific calculation formulae can be found in Annex B.1 of this report.

Article 11a

Use of synthetic and alternative fuels

(1) Upon application by a manufacturer, CO_2 savings achieved through the use of synthetic and advanced alternative fuels (hereinafter "alternative fuels") shall be considered in accordance with paragraphs 2 and 3 of this Article.

The total contribution of this use to reducing the average specific emissions of CO_2 of a manufacturer may be up to [●value to be added] g/km.

The Commission is empowered to adopt delegated acts in accordance with Article 17 in order to amend this Regulation by adjusting the cap referred to in the second subparagraph of this paragraph with effect from 2025 onwards to take into account technological developments while ensuring a balanced proportion of the level of that cap in relation to the average specific emissions of CO_2 of manufacturers.

(2) Instead of being included in a manufacturer's average specific CO_2 emissions as referred to in paragraph 1 of this Article, CO_2 savings achieved through the use of alternative fuels may be allocated to individual vehicles which are technically capable of using the credited alternative fuel in accordance with Regulation (EC) 715/2007.

(3) Each Member State shall record for each calendar year the quantities of alternative fuels placed on the market by a manufacturer, or the quantities of alternative fuels allocated to a manufacturer, and shall provide appropriate certification of these quantities and the resulting CO_2 savings by correspondingly applying the certification and documentation procedure laid down in Directive (EU) 2018/2001.

The Member States shall decide which of the fuels listed in Articles 2(27), (28) and (33) to (37) of Directive (EU) 2018/2001 may be allocated and for which of these fuels to issue credits. The Member States shall ensure that credits are issued only for quantities that meet the requirements of Directive (EU) 2018/2001 and where it is ensured that no simultaneous allocation takes place against the reduction targets set out in Article 25(1) of Directive (EU) 2018/2001.

The credits must indicate the issuing Member State, their period of validity, and the quantity and type of alternative fuel for which they were issued. The credits must be tradable.

With a view to minimising the risk of single quantities being claimed more than once in the Union, Member States and the Commission shall strengthen cooperation among national systems, including,

where appropriate, the exchange of data. Where the competent authority of one Member State suspects or detects a fraud, it shall, where appropriate, inform the other Member States.

(4) The amount of the savings referred to in paragraphs 1 and 2 shall be calculated in accordance with Annex I, Part C.

A Part C is added to Annex I (see Annex B.1 of this report). This part contains the formula for calculating the reductions. The Commission should use implementing acts to determine the relevant life-time mileage of newly registered vehicles since a uniform approach is essential for European fleet legislation to work. Implementing acts offer a certain flexibility that a rigid starting point in the legislation itself, which would then have to be amended by delegated acts, cannot provide.

Annex V to RED II for the CO_2saving parameter should be amended to apply to all relevant SAAFs. This would be the only necessary amendment to the RED II Directive, ensuring that the crediting system for SAAFs is standardized throughout the EU. Following an amendment to RED II, the SAAFs would also be creditable for the renewable energy obligations in the transport sector under Article 25 of RED II Directive, excluding double crediting.

6.1.2 Amendments to Regulation (EU) 2019/1242

The intended changes to the fleet legislation for HDVs in Regulation (EU) 2019/1242 are strongly oriented, via a reference, to the system to be created in the fleet legislation for passenger cars and light commercial vehicles. The required derogations relate primarily to the concrete calculation formula, which has also been shifted to the annex in this case (see Annex B.2 of this report).

As a core amendment, subparagraph (c) has been added to Article 4, and a consequential amendment has been added to the last sentence of the article, which now refers to Annex I, point 2.8, as the calculation formula is introduced as new point 2.7.

Article 4

Average specific CO_2 emissions of a manufacturer

Starting from 1 July 2020, and in each subsequent reporting period, the Commission shall determine for each manufacturer the average specific CO_2 emissions in g/tkm for the preceding reporting period, by taking the following into account:

a) the data reported pursuant to Regulation (EU) 2018/956 for the manufacturer's new heavy-duty vehicles registered in the preceding reporting period, excluding vocational vehicles; and

b) the zero- and low-emission factor determined in accordance with Article 5; and

c) *the CO_2 reductions achieved through the use of alternative fuels that are credited pursuant to Article 11a of Regulation (EU) 2019/631. The total contribution of this use to reducing the average specific emissions of CO_2 of a manufacturer may be up to [●value to be added] g/tkm. The crediting of CO_2 reductions pursuant to Article 11a(2) of Regulation (EU) 2019/631 shall be in accordance with Regulation (EC) 715/2007 and Regulation (EC) No 595/2009. The reductions pursuant to sentences 1 and 2 shall be determined in accordance with point 2.7 of Annex I.*

The average specific CO_2 emissions shall be determined in accordance with *point 2.8 of Annex I*.

6.2 Amendments to Type-Approval Regulation (EC) 715/2007 and (EC) 595/2009

In both type-approval Regulations (EC) 715/2007 for LDVs and (EC) 595/2009 for HDVs the attribution of contributed quantities to individual vehicles will be added to the list contained in Article 5. This will enable the Commission to determine the technical details of the assignment mechanism. The reductions thus become part of the type-approval under Regulation (EU) 2018/858 and are therefore also reflected in an individual vehicle's certificate of conformity.

The following amendment (in italics) is proposed to Regulation (EC) 715/2007:

Article 5

Requirements and tests

[…]

(3) The specific procedures, tests and requirements for type-approval set out in this paragraph, as well as requirements for the implementation of paragraph 2, which are designed to amend non-essential elements of this Regulation, by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 15(3). This shall include establishing the requirements relating to:

[…]

g) *the allocation of alternative fuels to individual vehicles pursuant to Article 11a(2) of Regulation (EU) 2019/631,*

[…]

The following amendment (in italics) is proposed to Regulation (EC) 595/2009:

Article 5

Requirements and tests

[…]

(4) The Commission shall take implementing measures on this Article; these implementing measures include:

[…]

b) the allocation of alternative fuels to individual vehicles pursuant to Article 4(c) sentence 2 of Regulation (EU) 2019/1242;

[…]

In addition to the changes mentioned here, some consequential amendments to other legislation are necessary or recommended. For example, Article 4 point 4b of the Clean Vehicles Directive (EU) 2019/1161 should be amended to update the definition of 'clean vehicles' by adding a reference to the new Article 11 paragraph 2 of Directive (EU) 2019/631. Moreover, further purely editorial amendments (such as adjustments of references to the amended provisions) are necessary. Finally, there is further legislation with detailed technical provisions implementing the type approval regulations which might need to be amended so that changes due to the

new SAAF-crediting system are fully reflected (e.g. technical provisions of Commission Regulation (EU) 2017/1151[72]).

[72] Commission Regulation (EU) 2017/1151 of 1 June 2017 supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and repealing Commission Regulation (EC) No 692/2008

ANNEX A PARAMETERS FOR HDV SUB-GROUPS

Figure 18 provides an overview of the main parameters for the nine vehicle sub-groups subject to the current HDV regulation of vehicle emission standards.

Figure 18 Relevant HDV vehicle groups, their sub-groups and other parameters

Four vehicle groups directly relevant* (dark grey background)

Axle configuration	Chassis	Permissible total mass in loaded condition (tons)	Vehicle group
4x2	Rigid	>3.5 - <7.5	0
	both	7.5 - 10	1
	both	>10 -12	2
	both	>12 - 16	3
	Rigid	>16	4
	Tractor	>16	5
4x4	Rigid	7.5 - 16	6
	Rigid	>16	7
	Tractor	>16	8
6x2	Rigid	all	9
	Tractor	all	10
6x4	Rigid	all	11
	Tractor	all	12
6x6	Rigid	all	13
	Tractor	all	14
8x2	Rigid	all	15
8x4	Rigid	all	16
8x6/8	Rigid	all	17

Above are the vehicle groups of vehicle class N (freight transport) with a permissible total mass of >3.5 tons.

A vehicle is called **rigid** if the "superstructure" is permanently attached. Conversely, it is a **tractor** unit if the trailers can be exchanged as required.

* The other vehicle groups are included when calculating the ZLEV factors, which are taken into account when calculating fleet emissions.

These four vehicle groups are divided into nine subgroups

Vehicle description	Vehicle group	Vehicle sub-group	Cabin type	Engine power	MPW factorr#	Average payload (tonnes)[1]	Annual mileage (km)[1]
Rigid, 4x2 axle configuration, permissable total mass in loaded condition > 16 t	4	4-UD	all	< 170 kW	0.099	2.650	60,000
		4-RD	normal cab	>= 170 kW	0.154	3.180	78,000
			Cab with berth	≥170 kW und < 265 kW			
		4-LH	Cab with berth	≥ 265 kW	0.453	7.420	98,000
Tractor, 4x2 axle configuration, permissable total mass in	5	5-RD	normal cab	all	0.498	10.258	78,000
			Cab with berth	< 265 kW			
		5-LH	Cab with berth	≥ 265 kW	1.000	13.842	116,000
Rigid, 6x2 axle	9	9-RD	normal cab	all	0.286	6.280	73,000
		9-LH	Cab with berth		0.901	13.400	108,000
Tractor, 6x2 axle	10	10-RD	normal cab	all	0.434	10.258	68,000
		10-LH	Cab with berth		0.922	13.842	107,000

MPW: Mileage and payload weighting (weighting factor for mileage and payload). The MPWs are used to reflect differences in freight and driving behaviour. A higher MPW means that CO_2 savings are more important in this vehicle class.

The weighting factor for mileage and payload is calculated as the product of the annual mileage, normalized to that of the product for subgroup 5-LH, which is responsible for the most emissions.

[1] Regulation (EU) 2019/1242 of the European Parliament and of the Council, Annex I

Source: Frontier Economics, based on (EU) 2019/1242.

ANNEX B FURTHER AMENDMENTS TO FLEET REGULATION

B.1 Amendments to Regulation (EU) 2019/631 (LDV)

A Part C is added to Annex I.

PART C

CALCULATION OF THE CO_2 SAVINGS ACHIEVED THROUGH THE USE OF ALTERNATIVE FUELS PURSUANT TO ART. 11A

The total (origin) of all CO_2 savings credits ($credit_{total}$) in g in year t pursuant to Art. 11a shall be calculated using the formula:

$$credit_{total,t} = \sum_k \left(fuel_{k,t} \times CO2_{ref} \times CO2saving_k\right) + banking_{t-1}$$

The total (usage) of all CO_2 savings credits is also calculated using the formula:

$$credit_{total,t} = credit_{fleet,t} + \sum_j credit_{vehicle,j,t} + banking_t$$

The CO_2 reduction amount in g credited in year t to the specific average emissions in accordance with Article 11a(1) ($reduction\ amount_{fleet}$) shall be calculated using the formula:

$$reduction\ amount_{fleet,t} = \frac{credit_{fleet,t}}{mileage \times vehicles_t}$$

The CO_2 reduction amount credited in year t to an individual vehicle "j" in accordance with Article 11a(2) ($reduction\ amount_{vehicle,j,t}$) shall be calculated using the formula:

$$reduction\ amount_{vehicle,j,t} = \frac{credit_{vehicle,j,t}}{mileage}$$

Where:

$\sum_k(.)$	*Total of all alternative fuels placed on the market across all fuel types*
$\sum_j(.)$	*Total of all CO_2 reductions credited to individual vehicles pursuant to Article 11a(2)*
$fuel_{k,t}$	*Contributed or allocated quantity in MJ of an alternative fuel k placed on the market in year t*
$CO2_{ref}$	*CO_2 emission comparator for fossil fuels in g/MJ pursuant to Annex V of Directive (EU) 2018/2001*
$CO2saving_k$	*Greenhouse gas emissions saving of each alternative fuel pursuant to Annex V of Directive (EU) 2018/2001 in comparison to fossil fuels in %*
$banking_t$	*SAAF credits not used and transferred by a manufacturer in year t*

$credit_{fleet,t}$	*Total emission reduction credits in g CO_2 credited in year t pursuant to Article 11a(1)*
$credit_{vehicle,j,t}$	*Emission reductions in g CO_2 credited to vehicle j in year t pursuant to Article 11a(2)*
mileage	*Average expected lifetime distance driven in km of a manufacturer's newly registered vehicles that can use the fuels placed on the market pursuant to Article 11a(2). The Commission shall adopt, by means of implementing acts, provisions for the calculation of the average lifetime mileage of new vehicles in accordance with the examination procedure referred to in Article 16(2).*
$vehicles_t$	*Number of vehicles registered by a manufacturer in year t*

B.2 Amendments to Regulation (EU) 2019/1242 (HDV)

The specific calculation formulae have been inserted into Annex I, point 2.7 as follows:

2.7 Total CO_2 emissions savings achieved through the use of alternative fuels pursuant to Article 4 c)

The total (origin) of all CO_2 savings credits ($credit_{total}$) in g pursuant to Art. 11a in year t for each manufacturer shall be calculated using the formula:

$$credit_{total,t} = \sum_k \left(fuel_{k,t} \times CO2_{ref} \times CO2saving_k\right) + banking_{t-1}$$

The total (usage) of all CO_2 savings credits is also calculated using the formula:

$$credit_{,total,t} = credit_{fleet,t} + \sum_j credit_{vehicle,j,t} + banking_t$$

The amount of CO_2 reductions allocated to each manufacturer in year t in accordance with Article 4 c) sentence 1 (reduction $amount_{fleet}$) in g shall be calculated using the formula:

$$reduction\ amount_{fleet,t} = \frac{credit_{fleet,t}}{\sum_{sg} lifetime_{sg} \times tkm_{sg} \times vehicles_{sg,t} \times \frac{1}{MPW_{sg}}}$$

The amount of CO_2 reductions allocated to an individual vehicle in year t in accordance with Article 4 c) sentence 2 (reduction $amount_{vehicle,j,t}$) shall be calculated using the formula:

$$reduction\ amount_{vehicle,j,t} = \frac{credit_{vehicle,j,t}}{lifetime_{sg} \times tkm_{sg}}$$

The total of all credits of a manufacturer $credit_{vehicle,j,t}$ may not exceed $credit_{fleet,t}$

Where:

$\sum_k(.)$	*Total of all alternative fuels placed on the market across all fuel types*
$\sum_j(.)$	*Total of all CO_2 reductions credited to individual vehicles j pursuant to Article 4(c) sentence 2*

$\sum_{sg}(.)$	*Total of all new vehicle subgroups in accordance with Table 1*
$fuel_{k,t}$	*Contributed or allocated quantity in MJ of an alternative fuel k placed on the market in year t*
$CO2_{ref}$	*CO_2 emission comparator for fossil fuels in g/MJ pursuant to Annex V of Directive (EU) 2018/2001*
$CO2saving_k$	*Greenhouse gas emissions saving of each alternative fuel pursuant to Annex V of Directive (EU) 2018/2001 in comparison to fossil fuels*
$banking_t$	*Certificates not credited and transferred by a manufacturer in year t*
$credit_{fleet,t}$	*Total emission reductions in g CO_2 credited in year t pursuant to Article 4(c) sentence 1*
$credit_{vehicle,j,t}$	*Emission reductions in g CO_2 credited to vehicle j in year t pursuant to Article 11a(2)*
$lifetime_{sg}$	*Average expected lifetime of newly registered vehicles in a vehicle subgroup in accordance with Table [●new, to be added];*
tkm_{sg}	*Annual mileage in tkm/a per vehicle subgroup in accordance with Table 4*
$vehicles_{sg,t}$	*Annual new vehicle registrations by a manufacturer per vehicle subgroup in year t*
MPW_{sg}	*Weighting factor for mileage payload determined in accordance with no. 2.6.*

The CO_2 saving parameter also refers to an Annex V attached to RED II, which should be amended as described in Section 6.1.1 to cover all relevant SAAFs.

The lifetime parameter should be defined in the annex to the Regulation by using a table differentiating between the relevant vehicle subgroups. This table should then also fall under the Commission's competence to revise by means of a delegated act on the basis of Article 14 of the Regulation (as for other parameters). The starting point for deriving such values could be Article 4 of Regulation (EU) 595/2009.

The alternative would be to leave the determination of the lifetime parameter to the Commission via implementing acts, in parallel to the solution chosen in Annex I Part C of the revised Regulation 2019/631 (see annex B.1 of this report).

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