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CREDITING SYSTEM FOR RENEWABLE FUELS – BENEFITS FOR TRUCKS OEMS REVISITED

Note prepared for Neste

Frontier Economics Ltd. ("Frontier") has produced a report on behalf of Neste Oyj ("Neste") on the functionality and benefits from a crediting system for renewable fuels.[1] In this report we have described the potential benefits for different stakeholders and the environment. Neste has asked Frontier to provide an addendum to the report with a focus on potential benefits for trucks OEMs. In this note we extend the analysis by (i) differentiating potential business cases over time, (ii) include biomethane as another possible renewable fuel and (iii) discuss the counterfactual in more detail. This note summarises our findings.

Renewable fuel credit prices will evolve over time with expected cost reductions

The proposed crediting system is voluntary and provides OEMs with an additional option to meet their fleet targets. Whether and how OEMs use this option will depend – among other things – on the future price of credits.

In our report we have determined a broad range of possible credit prices. In this note we amend our analysis in the initial report by

- Adding biomethane as another possible renewable fuel; and
- Differentiating between a short term perspective (2025) and longer term perspective (2030) to reflect the future cost reduction potential.

This allows us to narrow down the expected credit price range (Figure 1) compared to our main report where we did not differentiate between different points in time:

- Already today, there are established, mature renewable fuel technologies such as biodiesel and HVO. We expect that in the **short term**, credits will mainly be generated from these types of renewable fuel, which results in an expected credit price[2] range of approx. 0.4-0.7 €/l in 2025.
- In the **longer term**, additional renewable fuels, such as e-fuels might become cost-competitive and available at industrial scale (either from indigenous production or imports) while production cost for established renewable fuels are

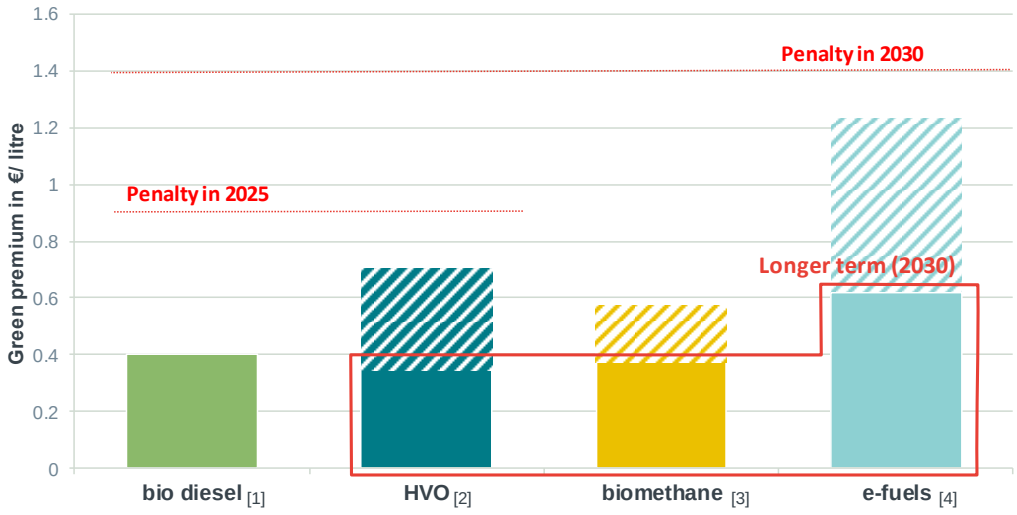
[1] Available online: https://www.frontier-economics.com/media/4347/crediting-system-for-renewable-fuels.pdf

[2] Renewable fuels are typically costlier to produce than conventional fuels (as reflected in higher wholesale prices). The credit price equals this cost difference (reflecting the green property of the fuel).

expected to decline further (e.g. due to scale effects).[3] This results in an expected credit price range of approx. 0.3-0.6 €/l by 2030 .

Penalties for excess emissions significantly exceed expected credit prices, irrespective of the underlying renewable fuel (see table below Figure 1).

Figure 1 Short term and long term credit price as different renewable fuel options become available



RE fuel credit price (long term)	bio diesel	HVO	biomethane	e-fuels	OEM pentalty (2025)	OEM penalty (2030)
€/l	0.4	0.3	0.4	0.6	0.9	1.4
g/tkm (HDV)	1,957	1,690	1,830	3,036	4,250	6,800

Source: Frontier Economics based on [1] https://www.ufop.de/biodiesel-und-co/biodiesel-preis; [2] Current price derived from publicly available financial statements from Neste Oyj (2019); cost reduction potential IEA Bioenergy (2020): "Advanced Biofuels – Potential for Cost Reduction", Table 3 (medium case); [3] Average range based on an extensive literature review; biomethane price estimates vary widely due to scale effects and different feedstocks; conventional long-term CNG wholesale price from IEA WEO (2020); energy density 36 MJ/l. [4] E-fuels produced in MENA region and transported to the EU, Source: Frontier Economics (2020).

Note: Green premium = green fuel production cost (wholesale price) – conventional fuel wholesale price. The reduction in green premium is therefore higher than the corresponding cost reduction. The price calculations are made independently by Frontier Economics based on publicly available information. Neste does not suggest that this would be the future nor correct pricing.

In the remainder of this note we present the short term and longer term business case, relying on the most cost-efficient renewable fuel technology respectively.

The proposed voluntary crediting system provides two attractive options which create alternative business cases for OEMs

We have proposed two ways how credits from additional renewable fuels can be used by OEMs. This creates the following potential business cases:

- **Option 1 – Reduction of average fleet emissions**: greenhouse gas reductions from additional renewable fuels are subtracted from the average fleet emissions of an OEM. Under this option, an OEM realises a benefit from either **achieving the target at lower cost or avoiding much higher penalty**

[3] See The European Commission's impact assessment on Stepping up Europe's 2030 climate ambition part 2, pages 74 (evolution of stock of heavy duty vehicles) and 75 (share of alternative fuels over time); available online: https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_2&format=PDF.

payment if it would otherwise exceed its fleet target. The final customers who buy the vehicles nevertheless experience no difference between an OEM using renewable fuels to meet its targets or not. A broad set of admissible fuels ensures wide-ranging biofuels and synthetic fuels that can be used to generate credits since there is no link required between the drivetrain technologies in the new vehicle fleet and the type of renewable fuel used to generate credits.

- **Option 2 – Crediting against individual vehicles (optional for OEM)**: The emission reduction through crediting renewable fuels can be attributed to individual vehicles (by amending the European type-approval regulation[4]). This enables OEMs to **offer their customers carbon-neutral internal combustion engine (ICE) trucks**[5] while at the same time **avoiding significant penalties and contributing to climate protection** (which will enhance the reputation of the OEM brands).

  This option may appeal to customers for whom combustion engine vehicles is the most or only suitable option, in particular if such carbon-neutral vehicles are granted the same tax/toll exemptions as electric vehicles.

  Option 2 requires a direct link between the drivetrain technology of a specific new carbon-neutral vehicle and the corresponding fuel used to generate the necessary credits (e.g. a CNG/LNG truck can only use biomethane).

Both options can generate attractive business cases for OEMs as we illustrate in the following.

OEMs can ensure they achieve fleet targets more efficiently and gain almost 90,000 € per vehicle from crediting (Option 1)

We analyse the following example to illustrate the benefits from choosing option 1:

- OEM fleet is **at target** – through a mix of electric / hybrid trucks and fuel efficiency improvements;
- OEM is selling an **additional ICE vehicle** which without additional measure would lift the OEM above the fleet target;
- OEM can use credits from a wide range of renewable fuels to avoid a penalty from the additional ICE vehicle sold.

Note that the size of the OEM fleet does not matter for this example since the OEM does not pay any penalties (zero excess emissions) before selling the additional ICE vehicle.

Figure 2 presents the results of the exemplary business case of crediting against the fleet average:

- Without a crediting system, this would imply a **penalty of 36-117 thousand euros** for that vehicle.

[4] We have drafted amendments in Frontier Economics / FGS (2020): "Crediting System for renewable fuels in EU emission standards for road transport", report for the German Federal Ministry for Economic Affairs and Energy (BMWi).

[5] OEMs can attribute the low-carbon properties in registration documents, which makes the emission reduction visible (and transferable) for final customers.

- With crediting, the penalty could be avoid at credit cost of 17-31 thousand euros for that additional vehicle, generating a **net benefit of 20-88 thousand euros** (values do not add up due to rounding).

Figure 2 Business case of crediting against the fleet average (Option 1)

Long haul truck (5-LH)	Unit	Short term (2025)	Longer term (2030)		Source / Comment
Reference renewable fuel		Bio diesel	Biomethane	HVO	
Average fleet emission before crediting	g/tkm	54	51	51	Preliminary baseline ACEA for 5-LH, 1% p.a. fuel efficiency
Emission target	g/tkm	45	34	34	Tighter targets (-40% instead of -30% in 2030)
Annual transport	tkm/a	1,605,672	1,605,672	1,605,672	for 5-LH, see ANNEX A of HDV Fleet Regulation
Annual mileage	km/a	116,000	116,000	116,000	see ANNEX A of HDV Fleet Regulation
Lifetime	a	9	9	9	New parameter; 9 a ~ 1,000,000 km total mileage
Total excess emissions	t CO2	123	249	249	Imputed excess CO2 emissions
Penalty	€/g/tkm	4,250	6,800	6,800	HDV Fleet Regulation
Avoided penalty	**€/ vehicle**	**36,256**	**116,944**	**116,944**	Penalty avoided to achieve fleet target
CO2 savings RES fuel	gCO2e/l	2,953	2,953	2,953	based on renewable fuel with ~85% CO2e savings
RES fuel credits required	l	41,746	84,157	84,157	
RES fuel credit cost	€/l	0.4	0.4	0.3	See Figure 1
RES fuel credit cost	**€/ vehicle**	**16,698**	**31,477**	**29,062**	
OEM benefits	**€/vehicle**	**19,558**	**85,467**	**87,882**	Avoided penalty - credit cost
	€/g/tkm	2,293	4,970	5,110	

Source: Frontier Economics

Note: Excess emissions based the preliminary baseline published by ACEA (57 g/tkm for 5-LH, by far the largest subgroup accounting for ~63% of all heavy duty vehicles that are subject to fleet targets.[6]

The example above also extends to an OEM which is above target on its entire fleet.[7]

Note that Option 1 could be used relatively **short-term and opportunistically** by an OEM

- in **unforeseen event** it misses its fleet target due to an unexpected drop in sales figures for electric trucks (fall-back option in case of unexpected consumer behaviour or loss of market shares); or
- to **achieve targets more efficiently**, replacing another low-carbon options that is more expensive than the credit cost.

OEMs can offer their customers carbon-neutral combustion engine trucks alongside new electric solutions at credit cost of ~100,000 € per truck (Option 2)

We analyse the following example to illustrate the possible benefits from alternatively choosing option 2:

6 https://www.acea.be/uploads/publications/ACEA_preliminary_CO2_baseline_heavy-duty_vehicles.pdf

7 For example, if an OEM has a fleet of 50,000 5-LH trucks which is on average only 1 g/tkm above target, total benefits from crediting (2030, HVO) would amount to € 256 million (=50,000 *1 [g/tkm] * 5,110 [€/g/tkm, see last row in Figure 2]).

- OEM fleet is **above target**, e.g. due to an unexpectedly low number of electric trucks sold or unexpectedly high demand for ICE vehicles;
- OEM sells an **additional carbon-neutral ICE vehicle** which not only avoids a penalty on this vehicle (without crediting, the ICE vehicle would be above target) but also reduces the average emissions of the rest of the fleet.
- OEM can only use credits from renewable fuels that are compatible with the drivetrain technology (e.g. biodiesel/HVO in a diesel engine truck).

Note that the size of the OEM fleet does not matter for this example as long as total excess emission in the entire fleet are larger than the savings from a single additional carbon-neutral ICE vehicle (which would usually be the case).

For some consumer groups combustion engine vehicles are the most suitable – or possibly the only – option for sustainable mobility, in particular for long haul trucks. Reasons why some consumers might be hesitant to pick up electric drivetrain solutions could be:

- (**Perceived) lack of available charging infrastructure** – Charging infrastructure is still developing in many areas in Europe (in particular in sparsely populated areas). Logistics companies depend on access to a network of fast chargers to minimise charging times.
- **Limitation of the maximum payload** – The weight of the battery might limit maximum payload such that other options (hydrogen, renewable fuels) might be more economical.[8]
- **Driving range** – Long-haul trucks require driving ranges of at least 300 km (distance which trucks can cover during the 4.5 h driving period before the compulsory rest) and then would need access to fast charging during rest periods for the driver not to lose any time.

Selling carbon-neutral ICE trucks through individual vehicle crediting might therefore be the best available option. Under the proposed crediting system, OEMs can sell carbon-neutral truck (in our example a diesel engine in 2025/30 or a CNG[9] truck in 2030) at **credit costs of around 100 k€/truck** (Figure 3).

[8] The 500 kWh stationary battery container by Tesvolt weighs about 10t. The 40t Freightliner electric truck would need a 550 kWh battery for 400 km range.

See Heikki Liimatainen et (2019) : The potential of electric trucks – An international commodity-level analysis and https://www.zerohomebills.com/product/tesvolt-lithium-battery-storage-500-kwh-tlc500/

[9] LNG would incur additional liquification costs of ~7€/MWh, see table 9 of Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018): The Future Cost of Electricity-Based Synthetic Fuels, Table 9.

Figure 3 Business case of carbon-neutral ICE vehicle with crediting (Option 2)

Long haul truck (5-LH)	Unit	Short term (2025)	Longer term (2030)		Source / Comment
Reference renewable fuel		Bio diesel	Biomethane	HVO	
Emission new ICEV before crediting	g/tkm	54	51	51	Preliminary baseline ACEA for 5-LH, 1% p.a. fuel efficiency
Annual transport	tkm/a	1,605,672	1,605,672	1,605,672	for 5-LH, see ANNEX A of HDV Fleet Regulation
Annual mileage	km/a	116,000	116,000	116,000	see ANNEX A of HDV Fleet Regulation
Lifetime	a	9	9	9	New parameter; 9 a ~ 1,000,000 km total mileage
Total emissions	t CO2	776	738	738	Imputed lifetime CO2 emissions
Penalty	€/g/tkm	4,250	6,800	6,800	HDV Fleet Regulation
Avoided penalty	**€/ vehicle**	**228,356**	**347,464**	**347,464**	Including impact on rest of fleet if OEM is above target
CO2 savings RES fuel	gCO2e/l	2,953	2,953	2,953	based on renewable fuel with ~85% CO2e savings
RES fuel credits required	l	262,933	250,047	250,047	
RES fuel credit cost	€/l	0.4	0.4	0.3	See Figure 1
RES fuel credit cost	**€/ vehicle**	**105,173**	**93,523**	**86,349**	
OEM benefits	**€/vehicle**	**123,183**	**253,940**	**261,114**	Avoided penalty - credit cost

Source: Frontier Economics

Note: The benefit in €/g/tkm (last row) is the same as for Option 1 (Figure 2) since one credit leads to the same overall reduction in excess emissions under both options. The key difference is that consumers might enjoy additional benefits (such as tax/toll exemptions) which would increase their willingness-to-pay for a carbon-neutral ICE vehicle under Option 2.

This creates two possible business cases for OEMs, depending on the counterfactual:

- **Counterfactual ICE vehicle without crediting (and paying the penalty)** – Through crediting, an OEM would not only be able to avoid the penalties from selling a single ICE vehicle (which would amount to the difference between the ICE vehicle emission and the target, equivalent to a penalty of 36-117 thousand euros, see Figure 2) but also to lower the average emissions on the rest of the fleet (equal to the fleet target level for a single truck), which leads to **combined avoided penalties of 228-347 thousand euros**[10]. The **net benefits from this business ranges between 123-261 thousand euros per vehicle**, despite the significant credit costs.
- **Counterfactual electric/hydrogen truck** – Any zero-tailpipe emission vehicle would allow the OEM the realise the same savings in penalty. There is a business case for crediting if the additional costs from alternative drivetrain solutions exceed the credit cost (of around 100 thousand euros per carbon-neutral truck).

The best option will depend on a lot of different factors which are highly uncertain from today's perspective and largely out of control by OEMs. As we outline below, crediting can serve as an additional tool to manage these risks.

A voluntary crediting systems allows OEM to better manage significant future market and regulatory risks

Trucks OEMs face significant regulatory and market uncertainties:

- **Uncertainty regarding future regulation** – Fleet regulation for trucks will only take full effect in 2025. However, already from today's perspective future developments are possible: 2030 targets for heavy duty vehicle might be tightened in the 2022 review by the European Commission. This could be a very likely scenario if OEMs seem to meet the 2025 targets comfortably (OEMs can create early emission savings 2019-2024, so-called 'emission credits'

[10] Due to the increase in premium from 4,250 €/g/tkm in 2025 to 6,800 €/g/tkm in 2030.

(Fleet Regulation, Art. 7). The European Commission will also review a possible LCA methodology by 2023 which could change the way targets are set.

- **Uncertainty how demand for electric trucks will develop** – It is unclear how quickly charging infrastructure will be developed (overhead line systems on highways, public or private chargers) and what the future demand by customers will be (in particular in the 5-LH segment). A delayed uptake of electric vehicles would increase fleet emissions significantly. There is further uncertainty about the impact from COVID-19 on the baseline.[11]
- **Uncertainty of future market dynamics (possible disruptions)** – The focus on a single technology might also disrupt the "new vehicle" market, in particular in years when fleet targets are tightened (2025 and 2030). If OEMs expect to fail their targets, without a crediting system they basically only have two options: either pay a significant penalty or sell additional electric vehicles at a significant discount. If customers can anticipate this behaviour, they might delay the purchase of a new electric vehicle to benefit from significant future discounts.

A **voluntary crediting system** provides an additional tool to **manage these risks** and therefore acts as a safety belt for OEMs (even if they expect to achieve their targets from today's perspective). It **could avoid disruptions** since OEMs can buy renewable fuel credits (at lower costs than the penalty) as an alternative to meet their targets and achieve **effective emission savings**.

[11] ICCT reports that the composition of the fleet has changed due to Covid-19, seeing a decline in the share of 5-LH could make compliance and the accumulation of early credits harder for manufacturers if this trend continues, see https://theicct.org/publications/eu-heavy-duty-co2-standards-baseline-impact-Dec2020.