

DECISIONS

COMMISSION IMPLEMENTING DECISION (EU) 2020/1232

of 27 August 2020

on the approval of the efficient generator function used in 12 Volt motor-generators for use in passenger cars and light commercial vehicles, including certain hybrid electric vehicles and vehicles capable of running on alternative fuels, as an innovative technology pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 ⁽¹⁾, and in particular Article 11(4) thereof,

Whereas:

- (1) On 27 November 2019, the manufacturers Bayerische Motoren Werke AG, Daimler AG, FCA Italy S.p.A, Ford-Werke GmbH, Honda Motor Europe Ltd, Hyundai Motor Europe Technical Center GmbH, Jaguar Land Rover Ltd., Opel Automobile GmbH-PSA, Automobiles Citroën, Automobiles Peugeot, PSA Automobiles SA, Renault, Volkswagen AG, Volkswagen AG Nutzfahrzeuge and the suppliers SEG Automotive Germany GmbH and Valeo Electrification Systems, jointly made a request ('the request'), as provided for by Article 12a of Commission Implementing Regulation (EU) No 725/2011 ⁽²⁾, to amend Commission Implementing Decision (EU) 2017/785 ⁽³⁾ in order to extend its validity to cover the conditions referred to in the Worldwide Harmonised Light Vehicles Test Procedure (WLTP) as set out in Commission Regulation (EU) 2017/1151 ⁽⁴⁾ and to include in its scope the use of the innovative technology in certain not-off vehicle charging hybrid electric passenger cars (NOVC-HEV) as well as in certain NOVC-HEVs and internal combustion engine powered passenger cars capable of running on certain alternative fuels.
- (2) On 27 November 2019, the manufacturers Daimler AG, FCA Italy S.p.A, Hyundai Motor Europe Technical Center GmbH, Jaguar Land Rover Ltd., Opel Automobile GmbH-PSA, Automobiles Citroën, Automobiles Peugeot, PSA Automobiles SA, Renault, Volkswagen AG, Volkswagen AG Nutzfahrzeuge and the suppliers SEG Automotive Germany GmbH, Mitsubishi Electric Corporation and Valeo Electrification Systems submitted a joint application ('the application') for the approval, in accordance with Article 11 of Regulation (EU) 2019/631, as an innovative technology, of the efficient generator function of 12 Volt motor-generators for use in light commercial vehicles powered by internal combustion engines capable of running on petrol, diesel or certain alternative fuels as well as in certain NOVC-HEVs of category N₁ capable of running on those fuels.

⁽¹⁾ OJ L 111, 25.4.2019, p. 13.

⁽²⁾ Commission Implementing Regulation (EU) No 725/2011 of 25 July 2011 establishing a procedure for the approval and certification of innovative technologies for reducing CO₂ emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (OJ L 194, 26.7.2011, p. 19).

⁽³⁾ Commission Implementing Decision (EU) 2017/785 of 5 May 2017 on the approval of efficient 12 V motor-generators for use in conventional combustion engine powered passenger cars as innovative technology for reducing CO₂ emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (OJ L 118, 6.5.2017, p. 20).

⁽⁴⁾ 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 (OJ L 175, 7.7.2017, p. 1).

- (3) The request and the application have been assessed in accordance with Article 11 of Regulation (EU) 2019/631, Implementing Regulation (EU) No 725/2011 and Commission Implementing Regulation (EU) No 427/2014 ⁽⁵⁾ as well as the Technical Guidelines for the preparation of applications for the approval of innovative technologies pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council ⁽⁶⁾ (July 2018 version) ⁽⁷⁾.
- (4) Considering that the request and the application refer to the same innovative technology and that the same conditions apply for its use in the vehicle categories concerned, it is appropriate to address both the request and the application in one single decision.
- (5) A 12 Volt motor-generator may operate as either an electric motor converting electrical energy into mechanical energy, or a generator converting mechanical energy into electrical energy, i.e. similarly as a standard alternator. The technology subject to the request and the application concerns an efficient generator function of 12 Volt motor-generator.
- (6) The efficient generator function of a 12 Volt motor-generator has already been approved by Implementing Decision (EU) 2017/785 and Commission Implementing Decision (EU) 2020/728 ⁽⁸⁾ as an innovative technology for use in internal combustion engine powered passenger cars and light commercial vehicles as well as in certain NOVC-HEVs of the same vehicle categories. The innovative technology has also been approved for use in passenger cars and light commercial vehicles capable of running on certain alternative fuels. According to those Implementing Decisions, the innovative technology is capable of reducing CO₂ emissions in a way that is only partially covered by the measurements performed as part of the emission test under the NEDC.
- (7) The request and the application refer, however, to the WLTP, and it is demonstrated that also the measurements performed as part of the emissions test under the WLTP only partially cover the CO₂ savings resulting from the technology used in 12 Volt efficient motor-generators.
- (8) Based on the experience gained from the assessment of the applications approved by Implementing Decisions (EU) 2017/785 and (EU) 2020/728, and taking into account the information provided with the present request and application, it has been satisfactorily and conclusively demonstrated that the efficient generator function of a 12 Volt motor-generator meets the criteria referred to in Article 11(2) of Regulation (EU) 2019/631 and the eligibility criteria specified in Article 9(1)(b) of Implementing Regulations (EU) No 725/2011 and (EU) No 427/2014.
- (9) The request and the application concern the use of the efficient generator function of a 12 Volt motor-generator in passenger cars, respectively light commercial vehicles, powered by internal combustion engines capable of running on petrol, diesel, liquefied petroleum gas (LPG), compressed natural gas (CNG) or E85, or in NOVC-HEVs of category M₁ or N₁ capable of running on those fuels and for which uncorrected measured fuel consumption and CO₂ emission values may be used in accordance with paragraph 1.1.4 of Appendix 2 to Sub-annex 8 to Annex XXI to Regulation (EU) 2017/1151.
- (10) Both the request and the application refer to the methodology for determining the CO₂ savings from the use of the 12 Volt efficient motor-generators set out in the Annex to Implementing Decision (EU) 2017/785, except for the proposals to modify the average speed from the one of the NEDC (33,58 km/h) to the one of the WLTP (46,6 km/h) and to introduce a run-in procedure.
- (11) As the conditions of the WLTP should be taken into account, it is appropriate to set the average speed equal to 46,6 km/h.

⁽⁵⁾ Commission Implementing Regulation (EU) No 427/2014 of 25 April 2014 establishing a procedure for the approval and certification of innovative technologies for reducing CO₂ emissions from light commercial vehicles pursuant to Regulation (EU) No 510/2011 of the European Parliament and of the Council (OJ L 125, 26.4.2014, p. 57).

⁽⁶⁾ Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO₂ emissions from light-duty vehicles (OJ L 140, 5.6.2009, p. 1).

⁽⁷⁾ <https://circabc.europa.eu/sd/a/a19b42c8-8e87-4b24-a78b-9b70760f82a9/july%202018%20Technical%20Guidelines.pdf>

⁽⁸⁾ Commission Implementing Decision (EU) 2020/728 of 29 May 2020 on the approval of the efficient generator function used in 12 volt motor-generators for use in certain passenger cars and light commercial vehicles as an innovative technology pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council (OJ L 170, 2.6.2020, p. 21).

- (12) With regard to the addition to the testing methodology of a run-in procedure for the motor-generator, neither the application nor the request set out with sufficient precision the details for how such run-ins should be performed nor how the run-in effect should be taken into account. Moreover, it is already integral to the testing methodology set out in Implementing Decision (EU) 2017/785 that such effects may be taken into account, where necessary, by the requirement that the efficiency of the generator function of the motor-generator must be measured at least five times. As the efficiency of the generator function of the motor-generator is determined on the basis of the average of the measurement results, any run-in effects, positive or negative, may therefore be adequately taken into account in the final efficiency determination, where necessary by increasing the number of measurements. Against that background, it is not appropriate to complement the testing methodology with an additional specific run-in procedure such as that proposed in the application and the request.
- (13) In order to take into account the use of alternative fuels, it is proposed in the request and the application to include in the testing methodology additional factors for the consumption of the effective power and the fuel consumption conversion coefficients as well as additional extra mass coefficients corresponding to those fuels.
- (14) With regard to the proposed factors for the consumption of the effective power and the fuel consumption conversion coefficients, it is appropriate to include them in the testing methodology, taking into account that they are taken from the Technical Guidelines. With regard to the proposed extra mass coefficients, no clear justification for using the proposed values were provided, and in the absence of such justifications, it is appropriate to determine the extra mass coefficients using the reference values already included in the Technical Guidelines.
- (15) Considering the limited availability of E85 on the Union market as a whole, it is not appropriate to distinguish this fuel from petrol for the purpose of the testing methodology. As such, the values referring to the consumption of the effective power, the fuel consumption conversion and the extra mass coefficient to be used for E85 shall be the ones used for petrol.
- (16) Both in the request and the application new minimum efficiency rates for the generator function of the 12 Volt motor-generator are proposed. However, it is considered appropriate to maintain the minimum efficiency rates set out in Implementing Decision (EU) 2020/728 as no evidence has been provided that motor-generators with a lower efficiency rate would meet the market penetration requirement set out in Article 2(2)(a) of Implementing Regulations (EU) No 725/2011 and (EU) No 427/2014.
- (17) Manufacturers should have the possibility to apply to a type-approval authority for the certification of CO₂ savings from the use of the innovative technology where the conditions laid down in this Decision are met. Manufacturers should for that purpose ensure that the application for certification is accompanied by a verification report from an independent and certified body confirming that the innovative technology complies with the conditions laid down in this Decision and that the savings have been determined in accordance with the testing methodology set out in this Decision.
- (18) In order to facilitate a wider deployment of the innovative technology in new vehicles, a manufacturer should also have the possibility to submit a single application for the certification of the CO₂ savings from the efficient generator functions used in several types of 12 Volt motor generators. It is, however, appropriate to ensure that, where that possibility is used, a mechanism is applied that incentivises the deployment of only those motor-generators that offer the highest efficiency.
- (19) It is the responsibility of the type-approval authority to verify thoroughly that the conditions for certifying the CO₂ savings from the use of an innovative technology as specified in this Decision are met. Where the certification is issued, the responsible type-approval authority should ensure that all elements considered for the certification are recorded in a test report and kept together with the verification report and that this information is made available to the Commission on request.
- (20) For the purpose of determining the general eco-innovation code to be used in the relevant type-approval documents in accordance with Annexes I, VIII and IX to Directive 2007/46/EC of the European Parliament and of the Council ⁽⁹⁾, it is necessary to attribute an individual code to the innovative technology,

⁽⁹⁾ Directive 2007/46/EC of the European Parliament and the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (Framework Directive) (OJ L 263, 9.10.2007, p. 1).

HAS ADOPTED THIS DECISION:

Article 1

Innovative technology

The efficient generator function of a 12 Volt motor-generator is approved as an innovative technology within the meaning of Article 11 of Regulation (EU) 2019/631, taking into account that it is only partially covered by the standard test procedure set out in Regulation (EU) 2017/1151, and provided that the technology conforms to the following:

- (a) it is fitted in passenger cars and light commercial vehicles powered by internal combustion engines capable of running on petrol, diesel, liquefied petroleum gas (LPG), compressed natural gas (CNG) or E85, or in not-off-vehicle charging hybrid electric vehicles (NOVC-HEVs) of the category M₁ or N₁ that comply with paragraph 1.1.4 of Appendix 2 to Sub-annex 8 to Annex XXI to Regulation (EU) 2017/1151 and that are capable of running on those fuels;
- (b) the efficiency of the generator function, determined in accordance with the methodology set out in the Annex, is at least:
 - (i) 73,8 % for petrol- or E85-fuelled vehicles, other than turbo-charged;
 - (ii) 73,4 % for turbo-charged petrol- or E85-fuelled vehicles;
 - (iii) 74,2 % for diesel-fuelled vehicles;
 - (iv) 74,6 % for LPG-fuelled vehicles other than turbo-charged;
 - (v) 74,1 % for turbo-charged LPG-fuelled vehicles;
 - (vi) 76,3 % for CNG-fuelled vehicles other than turbo-charged;
 - (vii) 75,7 % for turbo-charged CNG-fuelled vehicles.

Article 2

Application for certification of CO₂ savings

1. A manufacturer may apply to a type-approval authority for certification of the CO₂ savings from the use of the technology approved in accordance with Article 1 ('the innovative technology') in one or several 12 Volt motor-generators by reference to this Decision.
2. The manufacturer shall ensure that the application for the certification is accompanied by a verification report from an independent and certified body confirming that the conditions set out in Article 1 have been met.
3. Where savings have been certified in accordance with Article 3, the manufacturer shall ensure that the certified CO₂ savings and the eco-innovation code referred to in Article 4(1) are recorded in the certificate of conformity of the vehicles concerned.

Article 3

Certification of CO₂ savings

1. The type-approval authority shall ensure that CO₂ savings achieved from the use of the innovative technology have been determined using the methodology set out in the Annex.
2. Where a manufacturer applies for the certification of the CO₂ savings from the use of the innovative technology in more than one type of 12 Volt motor-generator in relation to one vehicle version, the type-approval authority shall determine which type of the 12 Volt motor-generators tested delivers the lowest CO₂ savings. That value shall be used for the purpose of paragraph 4.
3. Where the innovative technology is fitted in a bi-fuel or flex-fuel vehicle, the approval authority shall record the CO₂ savings as follows:
 - (a) for bi-fuel vehicles using petrol and gaseous fuels, the CO₂ savings value with regard to LPG or CNG fuels;
 - (b) for flex-fuel vehicles using petrol and E85, the CO₂ savings value with regard to petrol.

4. The type approval authority shall record the certified CO₂ savings determined in accordance with paragraph 1 and 2, and the eco-innovation code referred to in Article 4(1) in the relevant type-approval documentation.
5. The type-approval authority shall record all the elements considered for the certification in a test report and keep that together with the verification report referred to in Article 2(2), and shall make that information available to the Commission on request.
6. The type-approval authority shall only certify CO₂ savings, if it finds that the innovative technology complies with the conditions set out in Article 1, and if the CO₂ savings determined in accordance with point 3.5 of the Annex are 0,5 g CO₂/km or higher, as specified in Article 9(1)(b) of Implementing Regulation (EU) No 725/2011 in the case of passenger cars, or in Article 9(1)(b) of Implementing Regulation (EU) No 427/2014 in the case of light commercial vehicles.

Article 4

Eco-innovation code

1. The innovative technology approved by this Decision is attributed with the eco-innovation code 33.
2. The certified CO₂ savings recorded by reference to that eco-innovation code may be taken into account for the calculation of the average specific emissions of manufacturers starting from the calendar year 2021.

Article 5

Entry into force

This Decision shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

Done at Brussels, 27 August 2020.

For the Commission
The President
Ursula VON DER LEYEN

ANNEX

Methodology to determine the CO₂ savings of the technology used in a 12 Volt efficient motor-generator for conventional combustion engine and certain hybrid electric passenger cars and light commercial vehicles

1. INTRODUCTION

This Annex sets out the methodology to determine the CO₂ (carbon dioxide) emission savings from the use of the efficient generator function of a 12 Volt motor-generator ('12V motor-generator') in an M₁ or N₁ vehicle as specified in Article 1.

2. DETERMINATION OF THE EFFICIENCY OF THE 12V MOTOR GENERATOR

The efficiency of the 12V motor-generator shall be determined in accordance with ISO 8854:2012, with the following precisions.

The manufacturer shall provide evidence to the type-approval authority that the frequency ranges of the 12V motor-generator are the same as or equivalent to those set out in Table 1.

The efficiency of the 12V motor-generator shall be determined on the basis of measurements at each of the operating points listed in Table 1.

The current intensity of the 12V motor-generator at each operating point shall be half the rated current. For each operating point, the voltage and the output current of the 12V motor-generator shall be kept constant during the measurement, with the voltage at 14,3 V.

Table 1

Operating point i	Holding time [s]	Rotational frequency n _i [min ⁻¹]	Frequency of operating points h _i
1	1 200	1 800	0,25
2	1 200	3 000	0,40
3	600	6 000	0,25
4	300	10 000	0,10

The efficiency of the 12V motor-generator at each operating point i (η_{MG_i}) [%] shall be calculated in accordance with Formula 1.

Formula 1

$$\eta_{MG_i} = \frac{60 \cdot U_i \cdot I_i}{2\pi \cdot M_i \cdot n_i} \cdot 100$$

where, for each operating point i,

U_i is the voltage [V];

I_i is the current intensity [A];

M_i is the torque [Nm];

n_i is the rotational frequency [min⁻¹].

For each operating point, the measurements shall be performed at least five times consecutively and the efficiency shall be calculated for each of those measurements ($\eta_{MG_{i,j}}$) with j being the index referring to one set of measurements.

For each operating point, the average of those efficiencies ($\overline{\eta_{MG_i}}$) shall be calculated.

The efficiency of the 12V motor-generator (η_{MG}) [%] shall be calculated in accordance with Formula 2.

Formula 2

$$\eta_{MG} = \sum_{i=1}^4 h_i \cdot \overline{\eta_{MG_i}}$$

where,

$\overline{\eta_{MG_i}}$ is the average efficiency of the 12V motor-generator determined for operating point i [%]

h_i is the frequency of operating point i, as set out in Table 1.

3. CALCULATION OF THE CO₂ SAVINGS AND THEIR UNCERTAINTY

3.1. Saved mechanical power

The difference (ΔP_m) [W] between the saved mechanical power when using the 12V motor generator under real-world conditions (ΔP_{mRW}) and the saved mechanical power when using the 12V motor under type-approval conditions (ΔP_{mTA}) shall be calculated in accordance with Formula 3.

Formula 3

$$\Delta P_m = \Delta P_{mRW} - \Delta P_{mTA}$$

where,

ΔP_{mRW} shall be calculated in accordance with Formula 4 and ΔP_{mTA} in accordance with Formula 5.

Formula 4

$$\Delta P_{mRW} = \frac{P_{RW}}{\eta_B} - \frac{P_{RW}}{\eta_{MG}}$$

Formula 5

$$\Delta P_{mTA} = \frac{P_{TA}}{\eta_B} - \frac{P_{TA}}{\eta_{MG}}$$

where,

η_{MG} is the efficiency of the 12V motor-generator as determined in point 2 [%]

P_{RW} is the power requirement under 'real-world' conditions, which is 750 W

P_{TA} is the power requirement under 'type-approval' conditions, which is 350 W

η_B is the efficiency of the baseline alternator, which is 67 %

3.2. Calculation of the CO₂ savings

The CO₂ savings of the 12V motor-generator (C_{CO_2}) [gCO₂/km] shall be calculated in accordance with Formula 6.

Formula 6

$$C_{CO_2} = \Delta P_m \cdot \frac{V_{Pe} \cdot CF}{v}$$

where,

ΔP_m	is the difference between the saved mechanical power under real-world conditions and the saved mechanical power under type-approval conditions, as determined in point 3.1
v	is the mean driving speed of the WLTP, which is 46,6 km/h
V_{pe}	is the consumption of effective power as specified in Table 2 [l/kWh]
CF	is the conversion factor as set out in Table 3 [gCO ₂ /l]

Table 2

Type of engine	Consumption of effective power (V_{pe}) [l/kWh]
Petrol- or E85-fuelled other than turbo-charged	0,264
Turbo-charged petrol- or E85-fuelled	0,280
Diesel-fuelled	0,220
LPG fuelled	0,342
Turbo-charged LPG-fuelled	0,363
	Consumption of effective power (V_{pe}) [m ³ /kWh]
CNG (G20) other than turbo-charged	0,259
Turbo-charged CNG (G20)	0,275

Table 3

Type of fuel	Conversion factor (CF) [gCO ₂ /l]
Petrol/E85	2 330
Diesel	2 640
LPG	1 629
	Conversion factor (CF) [gCO ₂ /m ³]
CNG (G20)	1 795

3.3. Calculation of the uncertainty of the CO₂ savings

The uncertainty of the CO₂ savings calculated in accordance with point 3.2 shall be quantified as follows.

First, the standard deviation of the efficiency of the 12V motor-generator at each operating point ($S_{\overline{\eta_{MG_i}}}$) [%] shall be calculated in accordance with Formula 7.

Formula 7

$$S_{\overline{\eta_{MG_i}}} = \sqrt{\frac{\sum_{j=1}^m (\eta_{MG_{ij}} - \overline{\eta_{MG_i}})^2}{m(m-1)}}$$

where,

- m is the number of measurements j undertaken for determining the 12V motor-generator efficiency at each operating point i , as referred to in point 2
- η_{MGij} is the efficiency of the 12V motor-generator calculated for an individual measurement j at operating point i as referred to in point 2 [%]
- $\overline{\eta_{MGi}}$ is the average efficiency of the 12V motor-generator calculated for an operating point i , as determined in point 2 [%]

Next, the standard deviation of the efficiency of the 12V motor-generator ($s_{\eta_{MG}}$) [%] shall be calculated in accordance with Formula 8.

Formula 8

$$s_{\eta_{MG}} = \sqrt{\sum_{i=1}^4 (h_i \cdot s_{\overline{\eta_{MGi}}})^2}$$

where,

- $s_{\overline{\eta_{MGi}}}$ is as determined by Formula 7 [%]
- h_i is the frequency of operating point i , as set out in Table 1.

Finally, the uncertainty of the CO₂ savings ($s_{C_{CO_2}}$) [gCO₂/km] of the 12V motor-generator shall be calculated in accordance with Formula 9 and shall not exceed 30 % of the CO₂ savings.

Formula 9

$$s_{C_{CO_2}} = \frac{(P_{RW} - P_{TA})}{\eta_{MG}^2} \cdot \frac{V_{Pe} \cdot CF}{v} \cdot s_{\eta_{MG}}$$

where,

- P_{RW} is the power requirement under 'real-world' conditions, which is 750 W
- P_{TA} is the power requirement under type-approval conditions, which is 350 W
- η_{MG} is the efficiency of the 12V motor-generator, as determined in point 2 [%]
- V_{Pe} is the consumption of effective power as specified in Table 2 [l/kWh]
- CF is the fuel conversion factor as specified in Table 3 [gCO₂/l]
- v is the mean driving speed of the WLTP, which is 46,6 km/h
- $s_{\eta_{MG}}$ is standard deviation of the efficiency of the 12V motor-generator as determined in accordance with Formula 8 [%]
- η_{MG} is the efficiency of the 12V motor-generator, as determined in point 2 [%]

3.4. Rounding

The CO₂ savings (C_{CO_2}) calculated in accordance with point 3.2 and the uncertainty of the CO₂ savings ($s_{C_{CO_2}}$) calculated in accordance with point 3.3 shall be rounded to a maximum of two decimal places.

Each value used in the calculation of the CO₂ savings can be applied unrounded or must be rounded to the minimum number of decimal places which allows the maximum total impact (i.e. combined impact of all rounded values) on the savings to be lower than 0,25 gCO₂/km.

3.5. Check against the minimum CO₂ savings threshold

The type-approval authority shall ensure for each vehicle version fitted with the 12V motor-generator that the minimum threshold criterion as specified in Article 9(1)(b) of Implementing Regulations (EU) No 725/2011 and (EU) No 427/2014 is met.

When verifying whether the minimum threshold criterion is met, the type-approval authority shall take into account, in accordance with Formula 10, the CO₂ savings determined in point 3.2, the uncertainty determined in point 3.3 and, where applicable, a CO₂ correction, in the case of a positive mass difference (Δm) between the 12V motor-generator and the baseline alternator.

For the purpose of the positive mass correction, the mass of the baseline alternator shall be set to 7 kg.

The manufacturer shall provide to the type approval authority information on the mass of the 12V motor-generator as certified by the supplier.

Formula 10

$$(C_{CO_2} - s_{CO_2} - \Delta CO_{2m}) \geq MT$$

where,

MT is 0,5 gCO₂/km as specified in Article 9(1)(b) of Implementing Regulations (EU) No 725/2011 and (EU) No 427/2014

C_{CO₂} is the CO₂ savings as determined in point 3.2 [gCO₂/km]

s_{CO₂} uncertainty of the CO₂ savings as determined in point 3.3 [gCO₂/km]

ΔCO_{2m} CO₂ correction, in the case of a positive mass difference (Δm) [kg] between the 12V motor-generator and the baseline alternator, calculated in accordance with Table 4 [gCO₂/km]

Table 4

Type of fuel	CO ₂ correction (ΔCO _{2m}) [gCO ₂ /km]
Petrol/E85	0,0277 • Δm
Diesel	0,0383 • Δm
LPG	0,0251 • Δm
CNG	0,0209 • Δm

4. CERTIFICATION OF CO₂ SAVINGS

The CO₂ savings to be certified by the type-approval authority in accordance with Article 11 of Implementing Regulations (EU) No 725/2011 or (EU) No 427/2014 (CS_{CO₂}) [gCO₂/km] are those calculated in accordance with Formula 11. The CO₂ savings shall be recorded in the type approval certificate for each vehicle version fitted with the 12V motor-generator.

Formula 11

$$CS_{CO_2} = (C_{CO_2} - s_{CO_2})$$

where,

C_{CO₂} is the CO₂ savings as determined in accordance with Formula 6 under point 3.2 [gCO₂/km]

s_{CO₂} is the uncertainty of the CO₂ savings of the 12V motor-generator calculated in accordance with Formula 9 under point 3.3 [gCO₂/km]