Commission Implementing Decision of 18 November 2014 on the approval of the battery charging Webasto solar roof as an innovative technology for reducing CO2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (Text with EEA relevance) (2014/806/EU)

ANNEX

METHODOLOGY FOR DETERMINING THE REDUCTION IN CO_2 EMISSIONS DUE TO THE USE OF BATTERY CHARGING WEBASTO SOLAR ROOF

1. Introduction

The testing procedure and the testing conditions to be applied in order to determine the CO_2 reductions that can be attributed to the use of the battery charging Webasto solar roof in an M1 vehicle are set out in points 2 and 3.

2. The testing procedure

The peak power output (P_P) of the PV panel is to be determined experimentally for each vehicle variant. Measurements are to be done in accordance with the testing methodology specified in the international standard IEC 61215:2005[(1)].

A dismantled complete PV panel is to be used. The four corner points of the panel are to touch the horizontal measurement panel.

The measurements are to be done at least five times.

The lengthwise inclination angle and total storage capacity (or resulting Solar Correction Coefficient (SCC)) is to be supplied by the manufacturer of the vehicle.

The possible lengthwise inclination of the car roof is to be corrected mathematically afterwards by applying a cosine function.

3. Formulae

1. The standard deviation of arithmetic mean of the peak power output is to be calculated by formula (1).

Formula (1):

$$\Delta\bar{P}_P = \sqrt{\frac{\sum_{i=1}^{n}\left(P_{P_i} - \bar{P}_P\right)^2}{n(n-1)}}$$

Where:

$\Delta\bar{P}_P$	:	Standard deviation of arithmetic mean of the peak power output (Wp);
P_{P_i}	:	Measurement value of the peak power output (Wp);
$\bar{P}_P$	:	Arithmetic mean of the peak power output (Wp);
n	:	Number of measurements.

The gain of additional electric power depends on the available electric on-board storage capacity which must be verified. If the capacity is below 0,666 Ah per Watt peak power of the PV panel, the solar radiation arising on sunny and clear summer days cannot be used completely because of fully charged batteries. In this case the solar correction coefficient referred to in point 2 is to be applied to derive the usable share of the incoming solar energy.

2. The following input data for the calculation of CO_2 savings potential are to be used:

— mean solar irradiation $\mathbf{P_{SR}}$ specified in Chapter 5.7.1 of the Technical Guidelines[(2)], i.e. 120 W/m^2,

— usage factor/shading effect $\mathbf{UF_{IR}}$ specified in Chapter 5.4.2 of the Technical Guidelines, i.e. 0,51,

— efficiency of the solar system η_{SS} specified in Chapter 5.1.3 of the Technical Guidelines, i.e. 0,76,

— solar correction coefficient **SCC** specified in Table 1 and in Chapter 5.7.2 of the Technical Guidelines,

TABLE 1

Total available storage capacity (12 V)/ PV peak power (Ah/ Wp)[a]	0,10	0,20	0,30	0,40	0,50	0,60	> 0,666
Solar correction coefficient (SCC)	0,481	0,656	0,784	0,873	0,934	0,977	1

a The total storage capacity includes a mean usable storage capacity of the starter battery of 10 Ah (12 V). All values refer to a mean annual solar radiation of 120 W/m^2, a shading share of 0,49 and a mean vehicle driving time of 1 hour per day at 750 W electric power requirement.

— consumption of effective power for petrol $\mathbf{V_{Pe-P}}$ and diesel-fuelled vehicles $\mathbf{V_{Pe-D}}$ specified in Table 2 and in Chapter 5.1.1 of the Technical Guidelines,

TABLE 2

Type of engine	**Consumption of effective power V_{Pe} (l/kWh)**
Petrol (V_{Pe-P})	0,264
Diesel (V_{Pe-D})	0,22

— efficiency of the alternator η_A, specified in Chapter 5.1.2 of the Technical Guidelines, i.e. 0,67.

For the conversion factors **CF** the data in Table 3 is to be used:

TABLE 3

Type of fuel	**Conversion factor (l/100 km) → (g CO_2/ km) (100 g/l)**
Petrol (CF_P)	23,3 (= 2 330 g CO_2/l)
Diesel (CF_D)	26,4 (= 2 640 g CO_2/l)

For the mean annual mileage the data in Table 4 is to be used (km/year):

TABLE 4

Type of fuel	Mean annual mileage (km/year)
Petrol (M_P)	12 700
Diesel (M_D)	17 000

With these input data the CO_2 savings for a petrol-fuelled vehicle are to be calculated by Formula (2).

The difference in mass between the baseline vehicle and the eco-innovation vehicle due to the installation of the solar roof and where relevant, the extra battery, is to be taken into account by applying the mass correction coefficient[3]. The baseline vehicle is to be a vehicle variant that in all aspects is identical to the eco-innovation vehicle with the exception of the solar roof and, where applicable, without the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage.

For a new version of a vehicle in which the solar roof panel is installed the baseline vehicle is to be specified as follows: it is the vehicle in which the solar roof panel is disconnected and the change in mass due to the installation of the solar roof is taken into account. In case the solar roof panel is made of glass a correction for the change in mass is to be introduced, i.e. an extra mass of 3,4 kg. In case the solar roof panel is made of low weight synthetic material no correction for the change in mass has to be made. On this change of mass the manufacturer must hand over verified documentation to the Type-Approval Authority.

Formula (2):

$$C_{CO_2} = P_{SR} \times UF_{IR} \times \eta_{SS} \times P_P \times SCC \times \frac{V_{Pe-P}}{\eta_A} \times \frac{CF_P}{M_P} \times \cos\Phi - \Delta CO_{2mP}$$

Where:

C_{CO_2}	:	CO_2 savings (g CO_2/km);
P_{SR}	:	Mean solar irradiation (W/m^2);
UF_{IR}	:	Usage factor/shading effect (-);
η_{SS}	:	Efficiency of the solar system (-);
P_P	:	Peak power output (Wp);
SCC	:	Solar correction coefficient (-);
V_{Pe-P}	:	Consumption of effective power for petrol vehicles (l/kWh);
η_A	:	Efficiency of the alternator (-);
CF_P	:	Conversion factor for petrol vehicles (100 g/l);
M_P	:	Mean annual mileage for petrol vehicles (km/year);
Φ	:	Lengthwise inclination of the solar panel [°];
ΔCO_{2mP}	:	CO_2 correction coefficient due to the change in mass following the installation of the solar roof and, where applicable, the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage for petrol vehicles (g CO_2/km).

The CO_2 savings for diesel-fuelled vehicles are to be calculated by Formula (3).

The difference in mass between the baseline vehicle and the eco-innovation vehicle due to the installation of solar roof and, where relevant, the extra battery is to be taken into account by applying the mass correction coefficient[3]. The baseline vehicle is to be a vehicle variant that in all aspects is identical to the eco-innovation vehicle with the exception of the solar roof and,

where applicable, without the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage.

For a new version of a vehicle in which the solar roof panel is installed the baseline vehicle is to be specified as follows: it is the vehicle in which the solar roof panel is disconnected, and the change in mass due to the installation of the solar roof is taken into account. In case the solar roof panel is made of glass a correction for the change in mass is to be introduced, i.e. an extra mass of 3,4 kg. In case the solar roof panel is made of low weight synthetic material no correction for the change in mass has to be made. On this change of mass the manufacturer must hand over verified documentation to the Type-Approval Authority.

Formula (3):

$$C_{CO_2} = P_{SR} \times UF_{IR} \times \eta_{SS} \times P_P \times SCC \times \frac{V_{Pe-D}}{\eta_A} \times \frac{CF_D}{M_D} \times \cos\Phi - \Delta CO_{2mD}$$

Where:

V_{Pe-D}	:	Consumption of effective power for diesel vehicles (l/kWh);
CF_D	:	Conversion factor for diesel vehicles (100 g/l);
M_D	:	Mean annual mileage for diesel vehicles (km/year);
ΔCO_{2mD}	:	CO_2 correction coefficient due to the change in mass following the installation of the solar roof and, where applicable, the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage for diesel vehicles (g CO_2/km).

The CO_2 correction coefficient due to the change in mass is to be calculated by Formulas (4) and (5).

Formula (4):

$\Delta CO_{2mP} = 0{,}0277 \times \Delta m$ for a petrol-fuelled vehicle

and

Formula (5):

$\Delta CO_{2mD} = 0{,}0383 \times \Delta m$ for a diesel-fuelled vehicle

Where:

Δm	:	Change in mass due to the installation of the solar roof and, where applicable, the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage (e.g. 5 kg).

3. The error in the CO_2 savings should be calculated using Formula (6).

Formula (6):

$$\Delta\overline{C_{CO_2}} = \sqrt{\sum_{i=1}^{n}\left(\frac{\partial C_{CO_2}}{\partial P_{P_i}}\Delta\overline{P_P}\right)^2}$$

Where:

$\Delta\bar{C}_{CO_2}$	:	Error of the total CO_2 saving (g CO_2/km);

$\frac{\partial C_{CO_2}}{\partial P_{P_i}}$: Sensitivity of calculated CO_2 saving related to the measured during the test I;

n : Number of measurements.

In order to calculate the error in the CO_2 savings for a petrol-fuelled vehicle, the results of Formula (6) are to be applied in the Formula (2) in accordance with the following Formula (7):

Formula (7):

$$\Delta C_{CO_2}^{-} = P_{SR} \times UF_{IR} \times \eta_{SS} \times SCC \times \frac{V_{Pe-P}}{\eta_A} \times \frac{CF_P}{M_P} \times \Delta \bar{P} \times \cos\Phi$$

In order to calculate the error in the CO_2 savings for a diesel-fuelled vehicle, the results of Formula (6) are to be applied in the Formula (3), which leads to Formula (8). This is the error in the CO_2 savings for a diesel-fuelled vehicle.

Formula (8):

$$\Delta C_{CO_2}^{-} = P_{SR} \times UF_{IR} \times \eta_{SS} \times SCC \times \frac{V_{Pe-D}}{\eta_A} \times \frac{CF_D}{M_D} \times \Delta \bar{P} \times \cos\Phi$$

4. In order to demonstrate that the minimum threshold of 1 g CO_2/km is exceeded in a statistically significant way the following Formula (9) is to be used:

Formula (9):

$$MT \leq C_{CO_2} - \Delta C_{CO_2}^{-}$$

Where:

MT : Minimum threshold (g CO_2/km), i.e. 1 g CO_2/km;
C_{CO_2} : Total CO_2 saving (g CO_2/km);
$\Delta C_{CO_2}^{-}$: Error of the total CO_2 saving (g CO_2/km)

Where the CO_2 emission savings, as a result of the calculation using Formula (9), are below the threshold specified in Article 9(1) of Implementing Regulation (EU) No 725/2011, the second subparagraph of Article 11(2) of that Regulation shall apply.

(**1**) IEC 61215. Crystalline silicon terrestrial photovoltaic (PV) modules — Design qualification and type-approval. Reference number IEC 61215:2005(E).

(**2**) The Technical Guidelines for the preparation of applications for the approval of innovative technologies pursuant to Regulation (EC) No 443/2009 (version of February 2013).

(**3**) Chapter 5, par. 5.1 of the reference JRC study http://europa.eu/!qN68wc

Status:
Point in time view as at 31/01/2020.

Changes to legislation:
There are outstanding changes not yet made to Commission Implementing Decision of 18 November 2014 on the approval of the battery charging Webasto solar roof as an innovative technology for reducing CO2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (Text with EEA relevance) (2014/806/EU). Any changes that have already been made to the legislation appear in the content and are referenced with annotations.