Commission Implementing Decision (EU) 2016/1926 of 3 November 2016 on the approval of the battery-charging photovoltaic 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)

COMMISSION IMPLEMENTING DECISION (EU) 2016/1926

of 3 November 2016

on the approval of the battery-charging photovoltaic roof as an innovative technology for reducing CO_2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 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 (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emissions performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles[(1)], and in particular Article 12(4) thereof,

Having regard to Commission Implementing Regulation (EU) No 725/2011 of 25 July 2011 establishing a procedure for the approval and certification of innovative technologies for reducing CO_2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council[(2)], and in particular Article 10(2) thereof,

Whereas:

(1) The application submitted by the supplier a2solar Advanced and Automotive Solar Systems GmbH (‘the applicant’) on 4 February 2016 for the approval of the battery charging photovoltaic roof as an eco-innovation has been assessed in accordance with Article 12 of Regulation (EC) No 443/2009, Implementing Regulation (EU) No 725/2011 and the Technical Guidelines for the preparation of applications for the approval of innovative technologies pursuant to Regulation (EC) No 443/2009[(3)].

(2) The information provided in the application demonstrates that the conditions and the criteria referred to in Article 12 of Regulation (EC) No 443/2009 and in Articles 2 and 4 of Implementing Regulation (EU) No 725/2011 have been met. As a consequence, the battery charging photovoltaic roof proposed by the applicant should be approved as an innovative technology.

(3) By Implementing Decisions 2014/806/EU[(4)] and (EU) 2015/279[(5)] the Commission has approved two applications concerning battery charging photovoltaic roofs. Based on the experience gained from the assessment of those applications as well as the current application, it has been satisfactorily and conclusively demonstrated that a battery charging photovoltaic roof meets the eligibility criteria referred to in Article 12 of

Regulation (EC) No 443/2009 and Implementing Regulation (EU) No 725/2011 and provides a reduction in CO_2 emissions of at least 1 g CO_2/km compared to a baseline vehicle. It is therefore appropriate to generally acknowledge and, in accordance with Article 12(4) of Regulation (EC) No 443/2009, attest the capacity of this innovative technology to reduce CO_2 emissions and provide a generic testing methodology for the certification of the CO_2 savings.

(4) It is therefore appropriate to provide manufacturers with the possibility to certify the CO_2 savings from battery charging photovoltaic roofs that meet those conditions. In order to ensure that only photovoltaic roofs that are compliant with those conditions are proposed for certification, the manufacturer should provide a verification report from an independent and certified body confirming the compliance of the component with the conditions specified in this Decision together with the application for certification submitted to the type approval authority.

(5) If the type approval authority finds that the battery charging photovoltaic roof does not satisfy the conditions for certification, the application for certification of the savings should be rejected.

(6) It is appropriate to approve the testing methodology for determining the CO_2 savings from battery charging photovoltaic roofs.

(7) In order to determine the CO_2 savings from a battery charging photovoltaic roof it is necessary to define the baseline vehicle against which the efficiency of the vehicle equipped with the innovative technology should be compared as provided for in Articles 5 and 8 of Implementing Regulation (EU) No 725/2011. The Commission finds that the baseline vehicle should be a variant that in all aspects is identical to the eco-innovation vehicle with the exception of the photovoltaic 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.

(8) In accordance with Article 2(2)(b) of Implementing Regulation (EU) No 725/2011 it is to be demonstrated that the battery-charging photovoltaic roof is intrinsic to the efficient operation of the vehicle. This means that the energy generated by the photovoltaic roof should not for example be solely devoted to a comfort-enhancing appliance.

(9) In order to facilitate a wider deployment of battery-charging photovoltaic roofs in new vehicles, a manufacturer should also have the possibility to apply for the certification of the CO_2 savings from several photovoltaic roof systems by a single certification application. It is however appropriate to ensure that where this possibility is used a mechanism is applied that incentivises the deployment of only those photovoltaic roofs systems that offer the highest efficiency.

(10) For the purposes 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[6], the individual code to be used for the innovative technology should be specified,

HAS ADOPTED THIS DECISION:

Article 1

Approval

The battery-charging photovoltaic roof as described in the application by a2solar Advanced and Automotive Solar Systems GmbH is approved as an innovative technology within the meaning of Article 12 of Regulation (EC) No 443/2009.

Article 2

Application for certification of CO_2 savings

1 The manufacturer may apply for certification of the CO_2 savings from a battery charging photovoltaic roof system intended for use in conventional combustion-engine-powered M_1 vehicles which comprises all of the following elements:

a a photovoltaic roof;

b an appliance needed for the conversion of the solar energy into electricity and its storage;

c a dedicated storage capacity.

2 The total mass of those components shall be verified and confirmed in a report from an independent and certified body.

Article 3

Certification of CO_2 savings

1 The reduction in CO_2 emissions from the use of battery charging photovoltaic roof systems referred to in Article 2(1) shall be determined using the methodology set out in the Annex.

2 Where a manufacturer applies for the certification of the CO_2 savings from more than one battery charging photovoltaic roof system in relation to one vehicle version, the type approval authority shall determine which of the roofs tested delivers the lowest CO_2 savings, and record the lowest value in the relevant type approval documentation. That value shall be indicated in the certificate of conformity in accordance with Article 11(2) of Implementing Regulation (EU) No 725/2011.

Article 4

Eco-innovation code

The eco-innovation code No 21 shall be entered into the type approval documentation where reference is made to this Decision in accordance with Article 11(1) of Implementing Regulation (EU) No 725/2011.

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, 3 November 2016.

For the Commission

The President

Jean-Claude JUNCKER

ANNEX

METHODOLOGY TO DETERMINE THE CO_2 SAVINGS OF BATTERY CHARGING PHOTOVOLTAIC ROOFS

1. INTRODUCTION

In order to determine the CO_2 emission reductions that can be attributed to a battery charging photovoltaic (PV) roof for use in an M_1 vehicle, it is necessary to establish the following:

(1) the testing conditions

(2) the test equipment;

(3) the determination of the peak power output;

(4) the calculation of the CO_2 savings;

(5) the calculation of the statistical margin of the CO_2 savings.

2. SYMBOLS, PARAMETERS AND UNITS

Latin symbols

C_{CO_2}	— CO_2 savings [g CO_2/km]
CO_2	— Carbon dioxide
CF	— Conversion factor (l/100 km) — (g CO_2/km) [gCO_2/l] as defined in *Table 3*
M	— Mean annual mileage [km/year] as defined in *Table 4*
$\bar{mP}_P$	— Measured average solar PV roof peak power output [W]
n	— Number of measurements of the solar PV roof peak power output, which is at least 5
SCC	— Solar correction coefficient [-] as defined in *Table 1*
$s_{C_{CO_2}}$	— Statistical margin of the total CO_2 savings [g CO_2/km]
S_{IR}	— Yearly European mean solar irradiation [W/m^2], which is 120 W/m^2
S_{IR_STC}	— Global irradiation at Standard Test Conditions (STC) [W/m^2], which is 1 000 W/m^2
$s_{\bar{mP}_P}$	— Standard deviation of the arithmetic mean of the solar PV roof peak power output [W]
UF_{IR}	— Usage factor (shading effect), which is 0,51
V_{Pe}	— Consumption of effective power [l/kWh] as defined in *Table 2*
$\frac{\partial C_{CO_2}}{\partial \overline{mP}_P}$	— Sensitivity of calculated CO_2 savings related to the average solar PV roof peak power output

Greek symbols

ΔCO_{2m}	— CO_2 correction coefficient due to the extra mass of the solar system [g CO_2/km] as defined in *Table 5*
Δm	— Extra mass due to the installation of the solar system [kg]
η_A	— Alternator efficiency [%], which is 67 %
η_{SS}	— Solar system efficiency [%], which is 76 %
Φ	— Lengthwise inclination of the solar panel [°]

Subscripts

Index (i) refers to measurement of the PV roof peak power output

3. MEASUREMENTS AND DETERMINATION OF THE PEAK POWER OUTPUT

The measured average peak power output
$\left(\bar{mP}_P\right)$
of the PV roof is to be determined experimentally for each vehicle variant. Initial stabilisation of the tested device is to be done in accordance with the methodology specified in the international standard IEC 61215-2:2016[7]. The measurements of the peak power output shall be performed at standard test conditions as defined in the international standard IEC/TS 61836:2007[8].

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

The measurements of the peak power output shall be performed at least five times and the arithmetic mean (
$\bar{mP}_P$
) has to be calculated.

4. CALCULATION OF THE CO_2 SAVINGS

The CO_2 savings of the PV roof are to be calculated by Formula 1[9].

Formula 1

$$C_{CO_2} = S_{IR} \times UF_{IR} \times \eta_{SS} \times \frac{\bar{mP}_P}{S_{IR\_STC}} \times SCC \times \frac{V_{Pe}}{\eta_A} \times \frac{CF}{M} \times \cos\Phi - \Delta CO_{2m}$$

Where:

C_{CO_2}	:	CO_2 savings [g CO_2/km]
S_{IR}	:	Yearly European mean solar irradiation [W/m^2], which is 120 W/m^2
UF_{IR}	:	Usage factor (shading effect) [-], which is 0,51
η_{SS}	:	Efficiency of the photovoltaic system [%], which is 76 %
$\bar{mP}_P$	:	Measured average PV roof peak power output [W]
S_{IR_STC}	:	Global irradiation at Standard Test Conditions (STC) [W/m^2], which is 1 000 W/m^2
SCC	:	Solar correction coefficient [-] as defined in Table 1. Total available storage capacity of the battery system or the SCC value is to be supplied by the vehicle manufacturer.

TABLE 1

Solar correction coefficient

Total available storage capacity of (12 V) battery	0,10	0,20	0,30	0,40	0,50	0,60	> 0,666

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.

system/ average PV roof peak power output [Ah/ W][a]							
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.

V_{Pe} : Consumption of effective power [l/kWh] as defined in Table 2

TABLE 2

Consumption of effective power

Type of engine	**Consumption of effective power (V_{Pe})[l/kWh]**
Petrol	0,264
Petrol Turbo	0,280
Diesel	0,220

η_A : Efficiency of the alternator [%], which is 67 %;

CF : Conversion factor (l/100km) — (g CO_2/km) [gCO_2/l] as defined in Table 3

TABLE 3

Fuel conversion factor

Type of fuel	**Conversion factor (l/100 km) — (g CO_2/km) (CF) [gCO_2/l]**
Petrol	2 330
Diesel	2 640

M : Mean annual mileage [km/year] as defined in Table 4

TABLE 4

Mean annual mileage for M_1 vehicles

Type of fuel	**Mean annual mileage (M) [km/year]**
Petrol	12 700
Diesel	17 000

Φ : Lengthwise inclination of the solar panel [°]. This value is to be supplied by the vehicle manufacturer

ΔCO_{2m} : CO_2 correction coefficient due to the extra mass 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 [g CO_2/km] as defined in Table 5.

TABLE 5

CO_2 correction coefficient due to the extra mass

Type pf fuel	**CO_2 correction coefficient due to the extra mass (ΔCO_{2m})[g CO_2/km]**
Petrol	0,0277 · Δm
Diesel	0,0383 · Δm

In Table 5 Δm is the extra mass due to the installation of the photovoltaic system, composed by the PV roof and, where applicable, the additional battery and other appliances needed specifically for the conversion of the solar energy into electricity and its storage.

In particular, Δm is the positive difference between the mass of the photovoltaic system mass and the mass of a standard steel roof. The mass of a standard steel roof is assumed equal to 12 kg. In case the weight of the solar system is lower than 12 kg, no correction for the change in mass has to be made.

5. CALCULATION OF THE STATISTICAL MARGIN

The standard deviation of the arithmetic mean of the peak power output is to be calculated by Formula 2.

Formula 2

$$s_{\overline{mP_P}} = \sqrt{\frac{\sum_{i=1}^{n}\left(mP_{P_i} - \overline{mP}_P\right)^2}{n(n-1)}}$$

Where:

$s_{\overline{mP_P}}$: Standard deviation of the arithmetic mean of the peak power output [W]

mP_{P_i} : Measurement value of the peak power output [W]

$\overline{mP}_P$: Arithmetic mean of the peak power output [W]

n : Number of measurements of the peak power output, which is at least 5

The standard deviation of arithmetic mean of the PV roof peak power output leads to a statistical margin in the CO_2 savings

$\left(s_{C_{CO_2}}\right)$

. This value is to be calculated in accordance with Formula 3.

Formula 3

$$s_{C_{CO_2}} = \sqrt{\left(\frac{\partial C_{CO_2}}{\partial \overline{mP}_P} \cdot s_{\overline{mP}_P}\right)^2} = S_{IR} \cdot \frac{1}{S_{IR\_STC}} \cdot UF_{IR} \cdot \eta_{SS} \cdot SCC \cdot \frac{V_{Pe}}{\eta_A} \cdot \frac{CF}{M} \cdot \cos\Phi \cdot s_{\overline{mP}_P}$$

6. STATISTICAL SIGNIFICANCE

It has to be demonstrated for each type, variant and version of a vehicle fitted with the battery charging PV roof that the minimum threshold of 1 gCO_2/km is exceeded in a statistically significant way, as specified in Article 9(1) of Implementing Regulation (EU) No 725/2011. As a consequence, Formula 4 is to be used.

Formula 4

$$MT \leq C_{CO_2} - s_{C_{CO_2}}$$

Where:

MT	:	Minimum threshold [g CO_2/km], which is 1 g CO_2/km
$s_{C_{CO_2}}$	:	Statistical margin of the total CO_2 savings [g CO_2/km]

Where the CO_2 emission savings, as a result of the calculation using Formula 4, 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**) OJ L 140, 5.6.2009, p. 1.

(**2**) OJ L 194, 26.7.2011, p. 19.

(**3**) https://circabc.europa.eu/w/browse/f3927eae-29f8-4950-b3b3-d2e700598b52

(**4**) Commission Implementing Decision 2014/806/EU of 18 November 2014 on the approval of the battery charging Webasto solar roof as an innovative technology for reducing CO_2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (OJ L 332, 19.11.2014, p. 34).

(**5**) Commission Implementing Decision (EU) 2015/279 of 19 February 2015 on the approval of the battery charging Asola solar roof as an innovative technology for reducing CO_2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (OJ L 47, 20.2.2015, p. 26).

(**6**) Directive 2007/46/EC of the European Parliament and of 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).

(**7**) The International Electrotechnical Commission (IEC), IEC 61215-2:2016 standard for 'Terrestrial photovoltaic (PV) modules — Design qualification and type approval'

(**8**) The International Electrotechnical Commission (IEC), IEC 61836-2007 standard for 'Solar photovoltaic energy systems — Terms, definitions and symbols'

(**9**) Technical Guidelines for the preparation of applications for the approval of innovative technologies pursuant to Regulation (EC) No 443/2009 and Regulation (EU) No 510/2011 https://circabc.europa.eu/sd/a/bbf05038-a907-4298-83ee-3d6cce3b4231/Technical%20Guidelines%20October%202015.pdf