FRENCH REPUBLIC

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Ministry of the Economy, Finance, and Industrial, Energy and Digital Sovereignty

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Decree No. xx of xx

on the characteristics of solar photovoltaic panels allowing an extension of the deadline for the obligation for outdoor parking lots with an area greater than 1,500 square metres

NOR: XX

Target audience: *owners of outdoor parking lots with a surface area of 1,500 square metres or more.*

Subject: *the decree sets out the technical and environmental performance, as well as the supply resilience of photovoltaic panels, allowing parking lot owners to benefit from additional time to meet their installation obligation.*

Entry into force: *The text enters into force on the day after its publication.*

Application: *the decree is issued pursuant to Article 40 of Law No 2023-175, of 10 March 2023, on the acceleration of renewable energy production.*

The Prime Minister,

On the report of the Minister for the Economy, Finance and Industrial, Energy, and Digital Sovereignty;

Having regard to Directive (EU) 2015/1535 of the European Parliament and of the Council, of 9 September 2015, laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services;

Having regard to Law No 2023-175, of 10 March 2023, as amended, on the acceleration of renewable energy production, particularly Article 40 thereof;

Having regard to Decree No 2009-697, of 16 June 2009, as amended, relating to standardisation;

Having regard to the Opinion of the Higher Energy Council, dated 03 March 2026;

Having regard to Notification XX addressed to the European Commission on XX;

Having regard to the observations made during the public consultation between XX and XX;

Hereby decrees:

Article 1

An additional period is provided in the aforementioned fourth paragraph of Section III of Article 40, of 10 March 2023, for owners of outdoor parking lots with a surface area equal to or greater than 10,000 square metres, referred to in the fifth paragraph of Section III of Article 40, who install photovoltaic panels meeting the following conditions:

a) Energy efficiency value or yield, defined as the ratio between the energy received by the exposed surface of the panel as implemented and the energy produced, strictly greater than 22%;
b) After the first year, annual decrease in energy efficiency of less than 0.4%;
c) A simplified carbon assessment value of the panel less than 740 $kgCO_2eq/kWp$;
d) Product warranty of 12 years or more (covering manufacturing defects);
e) Performance warranty of 30 years or more (the panel must produce at least 80% of its nominal capacity);
f) Module assembly by a company that does not carry out the majority of its module production in a third country representing more than 50% of the European Union supply of photovoltaic panels. Production is assessed at the group level, as defined by the National Institute of Statistics and Economic Studies (INSEE), of which the company is a subsidiary, if applicable.

If the parking lot owner uses a third party to install photovoltaic panels, it must provide, within the time limits specified in the fifth paragraph of Section III of Article 40 of Law

No 2023-175, of 10 March 2023, a commitment contract and a purchase order for photovoltaic panels intended to equip the parking lot in question, complying with the conditions set forth in Letters *a* to *f* of this Article.

The conditions listed in Letters *a* to *f* of this Article must be specified in the commitment contract or purchase order mentioned in the fifth paragraph of Section III of Article 40 (III) of Law No 2023-175, of 10 March 2023, referred to above.

The procedures for verifying compliance with the conditions set out in Letters *a* to *f* of this Article, as well as the methodology for calculating the simplified carbon assessment of the panel, are detailed in the Annex.

Article 2

An additional period is provided in the aforementioned fourth paragraph of Section III of Article 40, of 10 March 2023, for owners of outdoor parking lots with a surface area equal to or greater than 10,000 square metres, referred to in the fifth paragraph of Section III of Article 40, who install photovoltaic panels meeting the following conditions:

a) Energy efficiency value or yield, defined as the ratio between the energy received by the exposed surface of the panel as implemented and the energy produced, strictly greater than 22%;
b) After the first year, annual decrease in energy efficiency of less than 0.4%;
c) Simplified carbon assessment value of the panel less than 740 kgCO2eq/kWp;
d) Product warranty of 12 years or more (covering of manufacturing defects);
e) Performance warranty of 30 years or more (the panel must produce at least 80% of its nominal capacity);
f) Module assembly within the European Economic Area. Cell manufacturing shall not be take place in a third country that accounts for more than 50% of the European Union's supply of photovoltaic panels.

If the parking lot owner uses a third party to install photovoltaic panels, they must provide, within the time limits referred to in the sixth paragraph of Article 40(III) of Law No 2023-175, of 10 March 2023, cited above, proof of a commitment contract and a purchase order for photovoltaic panels intended to equip the parking lot in question and complying with the conditions set out in Letters *a* to *f* of this Article.

The conditions listed in Letters *a* to *f* of this Article must be specified in the commitment contract or the purchase order mentioned to in the sixth paragraph of Section III of Article 40 of Law No. 2023-175, of 10 March 2023, mentioned above.

The procedures for verifying compliance with the conditions set out in Letters *a* to *f* of this Article, as well as the methodology for calculating the simplified carbon assessment of the panel, are detailed in the Annex.

Article 3

Decree No. 2024-1104, of 3 December 2024, concerning the characteristics of photovoltaic solar panels, which allowed for a postponement of the deadline for the requirement imposed on outdoor parking lots with a surface area of 10,000 square metres or more, is repealed.

Article 4

The Minister of Ecological Transition, Biodiversity and International Negotiations on Climate and Nature and the Minister of Economy, Finance and Industrial, Energy and Digital Sovereignty shall be responsible, each within their respective areas of competence, for the implementation of this decree, which will be published on the Official Journal of the French Republic's website.

Drawn up on XX.

By the Prime Minister:
[First name LAST NAME]

The Minister of Ecological Transition, Biodiversity and International Negotiations on Climate and Nature,
[First name LAST NAME]

The Minister of Economy, Finance and Industrial, Energy and Digital Sovereignty,
[First name LAST NAME]

Annex

The assessment of compliance with the conditions set out in Letters *a* to *f* of Articles 1 and 2 of this decree is carried out by a certifying body accredited in accordance with standard NF EN ISO/IEC 17065: 2012 as well as accreditation in accordance with standard NF EN ISO/IEC 17025: 2017 relating to the photovoltaic module product (NF EN IEC 61215 and NF EN IEC 61730 series of standards or any other equivalent methods), issued by the national accreditation body, or the national accreditation body of another Member State of the European Union, a member of the European Cooperation for Accreditation and having signed multilateral mutual recognition agreements.

To this end, the certification body issues a certificate that must include the following:

- the certificate holder: name and address;
- the exact module reference, its power output, the cell characteristics, the module weight;
- for crystalline silicon photovoltaic modules, the characters (numbers or letters) identifying the manufacturing sites of the three main module components:
  - the module production plant;
  - the cell production plant;
  - the silicon wafer production plant;

  must be affixed to the label on the back of the module bearing its serial number, either integrated directly into the serial number or as a specific code;
- for thin-film photovoltaic modules, the characters (numbers or letters) identifying the module's production site must be affixed to the label on the back of the module that bears the serial number of this same, either by being integrated directly into that serial number or as a specific code;
- the name and address of the aforementioned production sites;
- for each of these production sites, the production steps carried out at the production site;
- the date of the last audit carried out at the module assembly site (this must be less than one year old);
- the validity period of the certificate;
- compliance with the conditions set out in Letters *a* to *f* of Articles 1 and 2 of this decree, and the results achieved.

The certificate has a maximum validity of 12 months.

The administrative authority may have the modules concerned checked annually by a certification body, as specified above, by sampling, after they have been placed on the market. The checks cover:

- conformity of the module to the contractual value of the simplified carbon footprint,
- verification of the power output stated on the module's label,
- measurement of the cell thickness.

The administrative authority reserves the right to carry out, or have carried out, any other check deemed necessary to ensure compliance with the provisions of this decree, in particular verification, either on the basis of documentary evidence or on-site, of the adequacy between the volumes contracted by the module assembly sites and the cell production sites and their respective production capacities.

A. Simplified carbon assessment methodology

For the simplified carbon assessment to be considered valid, the modules must be declared compliant with standards NF EN IEC 61215 and NF EN IEC 61730 or any other equivalent methods by a laboratory accredited in accordance with standard NF EN ISO/IEC 17025: 2017, as specified above, and the supply and origin of each of the materials required for the manufacture of the photovoltaic modules or films that are the subject of the carbon footprint calculation (listed in Annex A) must be documented during its execution.

I. Assumptions and scope of the simplified carbon assessment method

The simplified carbon assessment of the photovoltaic power plant modules is based solely on the simplified carbon assessment of the photovoltaic laminate (frameless photovoltaic module). The peak power of the modules is considered only on the frontsheet (the power on the backsheet is not taken into account).

A negative tolerance for peak power is not permitted in the simplified carbon assessment calculation.

Greenhouse gas emissions related to other components of the power plant are not considered.

For the sake of simplicity and traceability, only the following manufacturing steps are taken into account for the simplified carbon assessment of the module:

Crystalline silicon sector:

- Manufacture of the metallurgical silicon (MG-Si)
- Manufacture of the polysilicon
- Manufacture of the ingot (ingot as-grown)
- Manufacture of the silicon brick (ingot to brick)
- Manufacture of the wafer
- Manufacture of the cell (prior to the cutting process carried out at the module assembly site)
- Manufacture of the module
- Manufacture of the glass and tempered glass
- Manufacture of the encapsulant (EVA, POE or other)
- Manufacture of the backsheet (PET, PVF, POE or other)

Thin-film sector:

- Manufacture of the module
- Manufacture of the glass and tempered glass
- Manufacture of the encapsulant (EVA, PET, PVF, POE or other)
- Manufacture of the backsheet (PET, PVF, POE or other).

Greenhouse gas emissions from other life cycle stages of the module are not taken into account (transport to commissioning and operating site, installation, use, end of life).

II. Calculation formula used

The simplified carbon assessment of the modules used for the photovoltaic plant is based on the following Formula 1:

Formula 1

$$G = \sum_{i\ components\ of\ the\ module} G_i$$

Formula in which:

- **G**, [kg eq CO_2/kWp], represents the quantity of greenhouse gases emitted during the manufacture of one peak kilowatt of photovoltaic module.

G is obtained by adding the Gi, which represent the greenhouse gas emission values of each component i of the photovoltaic module per peak kilowatt of power. Gi is expressed in the same unit as G. Each Gi is obtained using Formula 2.

Formula 2

$$G_i[kg\ eq\ CO_2/kWc] = \sum_j (GWP_{ij} * X_{ij}) * Q_i$$

Formula in which:

- **Qi** represents the quantity of component i (determined in step 1) required to manufacture one kWp of photovoltaic module or film, including losses and breakages.
- **xij**, unitless, represents the distribution fraction (determined in step 2) of the manufacturing sites j of component i. This coefficient is averaged over a year of supply.
- **Unit GWPij**, expressed in kilograms CO_2 equivalent per unit of quantification of the component, represents the specific CO_2eq emission associated with the manufacture of component i per unit of quantification of the component (e.g. m² for module) in the manufacturing site j (determined in step 3) (GWP = Global Warming Potential).

III. Steps required for calculating the simplified carbon footprint of a photovoltaic module or film

III.1/ Inventory of the quantity of material required to manufacture the photovoltaic module or film

The first step in calculating the simplified carbon analysis of the photovoltaic module is to inventory and quantify the components required to manufacture one kilowatt peak of photovoltaic module. The coefficients in Table 2, relating to the quantity of materials and components required to manufacture the intermediate product, will be applied in order to account

for losses and breakages during the manufacturing of modules using crystalline silicon technology.

The quantity of each component required to manufacture one kilowatt peak of module, denoted Qi, is indicated in a unit specific to the component:

- **MG-Si** in kg. This value is brought down to the mass of silicon required to manufacture 1 kWp of module. Losses and breakages will be taken into account.
- **Polysilicon** in kg. This value is brought down to the mass of silicon required to manufacture 1 kWp of module. Losses and breakages will be taken into account.
- **Ingots** in kg of silicon. This value is brought down to the mass of silicon required to manufacture 1 kWp of module. Losses and breakages will be taken into account.
- **Brick** in kg of silicon. This value is brought down to the mass of silicon required to manufacture 1 kWp of module. Losses and breakages will be taken into account (head, tail and squaring).
- **Wafers** in m² of wafers. This value is brought down to the surface area of wafers required to produce 1 kWp. Losses and breakages will be taken into account. The calculation of losses and breakages is detailed in Table 2 for a kerf loss fixed at 70 µm and a silicon density of 2,330 kg/m².
- **Cells** in m² of cells. This value is brought down to the cell surface area required to produce 1kWp. Losses and breakages will be taken into account.
- **Modules** in m² of modules. This value is the module surface area required to produce 1 kWp for crystalline or thin-film modules.
- **Glass** in kg. This value is the mass of glass required to produce 1 kWp (thus brought down to the surface area and thickness of glass, reference density 2 700 kg/m^3).
- **Tempered glass** in kg. This value is the mass of tempered glass required to produce 1 kWp (thus brought down to the surface area and thickness of the tempered glass, reference density 2,700 kg/m^3).
- **Encapsulant: EVA** or other equivalent material in kg. This value is the mass of encapsulant required to produce 1 kWp (thus brought down to the surface area and thickness of the encapsulant, reference density 963 kg/m^3).
- **Backsheet: PET, backsheet** or other equivalent material in kg. This value is the mass of backsheet required to produce 1 kWp (thus brought down to the surface area and thickness of the backsheet, reference density 1,400 kg/m^3).
- **PVF** in kg. This value is the mass of PVF required to produce 1 kWp (thus brought down to the surface area and thickness of the PVF, reference density 1 400 kg/m^3).

III.2/ Identification of the manufacturing site(s) of each component

Calculation of the simplified carbon assessment requires knowing the manufacturing sites of each component of the photovoltaic module. The quantity of greenhouse gases that are consequently emitted directly or indirectly (electricity production) is highly dependent on the country of manufacture.

The site and country of manufacture of each component must be indicated in column 6 of Table 1.

If the same component i comes from different manufacturing sites j, the allocation coefficients xij of the supply sources across the different production sites (averaged over one year of supply) must be indicated in column 3 of Table 1 (for each component i, the sum of xij over j is equal to 1).

III.3/ Determination of the quantity of greenhouse gases in CO_2 equivalent emitted directly or indirectly during the manufacture of component i per unit of quantification of the component at manufacturing site j (GWPij terms)

The unit GWPij values are determined using the values provided in Table 3 according to the methodology described in the paragraph below. Table 3 gives the greenhouse gas emission values in CO_2eq for the manufacturing steps of the photovoltaic module components according to the country or geographical area of the country of manufacture.

- Each row of the table corresponds to a type of photovoltaic module technology: monocrystalline, CdTe film or CIGS film. If the country(ies) of manufacture is (are) listed in the table, the specific CO_2eq emission value from the corresponding column should be used.
- If the country(ies) of manufacture is (are) not listed in Table 3: a conservative specific emission value will be used:
  - ✓ If the country is part of the European Economic Area, the value to be used is indicated in the Column “other country in Europe”;
  - ✓ If the country is not part of the European Economic Area, the value to be used is indicated in the column “Other country in the World”.

The simplified carbon assessment of the photovoltaic laminate takes into account a recycled silicon rate (GWPij values defined by Table 3) of 33%.

III.4/ Final calculation of G

The final calculation of G from Formula 1 is performed by adding the Gi values for all components i of the photovoltaic module or film.

Table 1:

- Inventory of the composition of one kilowatt peak of a photovoltaic module or film (Qi)
- Identification of manufacturing sites and distribution of supply sources for a component that may come from several manufacturing sites
- GWPij (Global Warming Potential) values for each component of the photovoltaic module or film, taken from Table 3

	Quantification of each component required to manufacture 1 kWp of power.	Coefficients for distributing supply sources across the different manufacturing sites	Type reference of the component	Company name of the manufacturing site for the component	Full address and country of the manufacturing site for the component	Unit GWPij values to be used by default
Metallurgical polysilicon (Mg-Si)	Quantity: kg	X 1: % X 2: %	Ref. 1 Ref. 2	Site 1 Site 2	Full address 1 Country Full address 2 Country	Value 1: kg $eqCO_2$/kg Value 2: kg $eqCO_2$/kg
Polysilicon siemens (SoG-Si)	Quantity: kg	X 1: % X 2: % …	Ref. 1 Ref. 2 …	Site 1 Site 2 …	Full address 1 Full address 2	Value 1: kg $eqCO_2$/kg Value 2: kg $eqCO_2$/kg
Ingots	Quantity: kg	X 1: % …	Ref. 1 …	Site 1: …	Full address 1	Value 1: kg $eqCO_2$/kg
Bricks	Quantity: kg	X 1: % …	Ref. 1 …	Site 1: …	Full address 1	Value 1: kg $eqCO_2$/kg
Wafer	Length: mm Width: mm Thickness: mm	X 1: % …	Ref. 1 …	Site 1: …	Full address 1	Value 1: kg $eqCO_2/m^2$
Cells	Technology: Length: mm Width: mm Thickness: mm	X 1: % …	Ref. 1 …	Site 1: …	Full address 1 …	Value 1: kg $eqCO_2/m^2$ …
Modules	Length: mm Width: mm Power range per step of 5 Wc	X 1: % …	Ref. 1 …	Site 1: …	Full address 1 …	Value 1: kg $eqCO_2/m^2$ …

Glass	Length: mm Width: mm Thickness: mm	X 1: % …	Ref. 1 …	Site 1: …	Full address 1 …	Value 1: kg $eqCO_2$/kg …
Tempered glass	Length: mm Width: mm Thickness: mm	X 1: % …	Ref. 1 …	Site 1: …	Full address 1 …	Value 1: kg $eqCO_2$/kg …
Encapsulant	Thickness: µm	X 1: % X 2: % …	Ref. 1 Ref. 2 …	Site 1: Site 2:	Full address 1 Full address 2	Value 1: kg $eqCO_2$/kg: Value 2: kg $eqCO_2$/kg:
Backsheet	Thickness: µm	X 1: % X 2: % …	Ref. 1 Ref. 2 …	Site 1: Site 2: …	Full address 1 Full address 2 …	Value 1: kg $eqCO_2$/kg: Value 2: kg $eqCO_2$/kg: …

Table 2: loss and breakage coefficients for intermediate products.

Process step/material	Quantity of material required to manufacture the intermediate product, including losses and breakages
Polysilicon, as grown	1.13 kg MG-Si/kg polycilium
Ingot, mono, as-grown	1.04 kg polySi/kg ingot*
Brick, mono (ingot to brick)	1.79 kg ingot/kg brick
Wafer,	[(kerf loss + wafer thickness) * silicon density kg brick/m² wafer
Cell, mono, multi and monolike	1.01 m² wafer/m² cell
Module, mono/multi, m² of cells	1.02 m² cell/module
Glass	1 kg glass/kg glass per module
Tempered glass	1 kg glass/kg glass per module
Encapsulant sheet (EVA, POE, etc.)	1.01 kg encapsulant/kg encapsulant per module
Backsheet (PET/POE/PVF)	1.02 kg backsheet/kg backsheet per module
modules, CdTe,	Not applicable
modules, CIGS	Not applicable

The recycling of polysilicon from losses and breakages during ingot production is taken into account with an emission value of GWPij defined in Table 3 (default value = 0 kgCOeq/kg).

Example:
Consider a 2.56 m² module containing 72 182x182 mm² monocrystalline silicon cells. The wafer thickness is 160 µm.
The mass of encapsulant (EVA) contained in this module is 2.5 kg. The mass of encapsulant required to manufacture one module is 2.525 kg, taking losses into account. 2.5 kg is multiplied by the coefficient in Table 2, which is 1.01 kg EVA/kg EVA in the module
The following table presents the quantities of components required to manufacture the module, including losses and breakages:

Materials/Component	***Quantity contained in one module (excluding losses and breakages)***	***Quantity required to manufacture one module***	***Loss and breakage coefficient***
Encapsulant	2.5 kg	2.525 kg	1.01 kg/kg EVA
Backsheet	1.08 kg	1.10 kg	1.02 kg/kg PET
Glass	20.5 kg	20.5 kg	1.00 kg/kg Glass
Tempered	20.5 kg	20.5 kg	1.00 kg/kg Glass
Module (m²)	2.56	2.56	1
Cells (m²)	2.38 *= 72 * 0.182 * 0.182*	2.43	1.02 x m² cell/module
Wafer (m²)	2.38	2.46	1.01 m² wafer/m² cell
Brick (kg)	0.89	1.32 $=2.46*(160+70)*2330*10^{-6}$	
Ingot mono Si (kg)	0.89	2.36	1.79 kg ingot/kg brick
Polysilicon (kg)	0.89	2.45	1.04 kg polySi/kg ingot
Metallurgical silicon (MG-Si)	0.89	2.77	1.13 kg MG-Si/kg Poly Si

It then remains to determine Q, the quantity of component required to manufacture one kWp module, and to apply Formula 2 to calculate G.

Table 3: GHG emission values in CO2eq for the manufacture of components:
GWP = Global Warming Potential, Method: IPCC2021 GWP100 years, Software: Sima Pro 3.9
Database: Ecoinvent 3.9, Sources: CEA INES

Manufacturing step/Material	Unit	Austria	Belgium	Bulgaria	Switzer-land	Cyprus	Czech Re-public	Germany	Denmark	Estonia	Spain	Finland	France
Metallurgical silicon MG-Si	kg CO_2-eq/kg	7.73	7.11	10.74	5.22	16.89	12.25	10.06	7.21	11.96	7.82	7.34	5.73
polySi, Siemens process	kg CO_2-eq/kg	29.72	25.81	48.88	13.78	88.02	58.51	44.59	26.40	56.64	30.30	27.23	17.04
Production of ingot, mono	kg CO_2-eq/kg	16.52	14.74	25.28	9.24	43.17	29.68	23.32	15.01	28.83	16.79	15.39	10.73
Production of brick	kg CO_2-eq/kg	0.87	0.80	1.20	0.59	1.87	1.36	1.12	0.81	1.33	0.88	0.82	0.65
Manufacture of mono wafers	kg CO_2-eq/m²	3.72	3.44	5.08	2.59	7.86	5.76	4.77	3.48	5.63	3.76	3.54	2.82
Production of cells	kg CO_2-eq/m²	20.52	19.12	27.37	14.82	41.37	30.82	25.84	19.33	30.15	20.73	19.63	15.99
Glass	kg CO_2-eq/kg	1.00	1.00	1.03	0.98	1.09	1.05	1.02	1.00	1.04	1.00	1.00	0.98
Tempered glass	kg CO_2-eq/kg	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	2.69	2.65	2.88	2.54	3.25	2.97	2.84	2.66	2.95	2.70	2.67	2.57
Backsheet (PET or equivalent)	kg CO_2-eq/kg	3.71	3.67	3.90	3.56	4.27	3.99	3.86	3.68	3.97	3.72	3.69	3.59
Backsheet (PVF)	kg CO_2-eq/kg	20.52	20.37	21.29	19.89	22.86	21.68	21.12	20.39	21.60	20.55	20.43	20.02
Crystalline module	kg CO_2-eq/m² module	4.96	4.75	5.99	4.10	8.10	6.51	5.76	4.78	6.41	4.99	4.82	4.27
Manufacture of CdTe module,	kg CO_2-eq/m² module	25.55	22.30	41.45	12.31	73.95	49.45	37.89	22.79	47.90	26.03	23.48	15.02
Manufacture of CIGS module	kg CO_2-eq/m² module	39.73	32.89	73.23	11.87	141.65	90.06	65.72	33.93	86.80	40.75	35.38	17.56

Manufacturing step/Material	Unit	United Kingdom	Greece	Croatia	Hungary	Ireland	Iceland	Italy	Lithuania	Luxembourg	Latvia	Malta	Netherlands
Metallurgical silicon MG-Si	kg CO_2-eq/kg	8.12	12.77	9.40	9.30	9.65	5.44	9.29	9.84	9.24	10.60	10.11	10.43
polySi, Siemens process	kg CO_2-eq/kg	32.21	61.83	40.38	39.75	41.96	15.17	39.64	43.18	39.33	47.98	44.85	46.95
Production of ingot, mono	kg CO_2-eq/kg	17.66	31.20	21.40	21.11	22.12	9.87	21.06	22.68	20.92	24.87	23.44	24.40
Production of brick	kg CO_2-eq/kg	0.91	1.42	1.05	1.04	1.08	0.61	1.04	1.10	1.03	1.18	1.13	1.16
Manufacture of mono wafers	kg CO_2-eq/m²	3.89	6.00	4.47	4.43	4.59	2.68	4.42	4.67	4.40	5.01	4.79	4.94
Production of cells	Kg CO_2.eq/m²	21.41	32.00	24.33	24.11	24.90	15.32	24.07	25.34	23.96	27.05	25.93	26.68
Glass	kg CO_2-eq/kg	1.01	1.05	1.02	1.02	1.02	0.98	1.02	1.02	1.02	1.03	1.03	1.03
Tempered glass	kg CO_2-eq/kg	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	2.72	3.00	2.79	2.79	2.81	2.55	2.79	2.82	2.78	2.87	2.84	2.86
Backsheet (PET or equivalent)	kg CO_2-eq/kg	3.74	4.02	3.81	3.81	3.83	3.57	3.81	3.84	3.80	3.89	3.86	3.88
Backsheet (PVF)	kg CO_2-eq/kg	20.62	21.81	20.95	20.93	21.01	19.94	20.92	21.06	20.91	21.26	21.13	21.21
Crystalline module	kg CO_2-eq/m² module	5.09	6.69	5.53	5.50	5.62	4.17	5.49	5.68	5.47	5.94	5.77	5.88
Manufacture of CdTe module,	kg CO_2-eq/m² module	27.61	52.21	34.40	33.88	35.71	13.47	33.78	36.72	33.53	40.71	38.11	39.85
Manufacture of CIGS module	kg CO_2-eq/m² module	44.09	95.87	58.37	57.27	61.14	14.29	57.07	63.27	56.53	71.66	66.19	69.85

Manufacturing step/Material	Unit	Norway	Poland	Portugal	Romania	Sweden	Slovenia	Slovakia	China	Japan	South Korea	Malaysia	Philippines
Metallurgical silicon MG-Si	kg CO_2-eq/kg	5.18	15.28	8.57	9.32	5.28	8.83	9.41	15.37	12.24	12.56	14.24	14.98
polySi, Siemens process	kg CO_2-eq/kg	13.54	77.81	35.08	39.89	14.15	36.74	40.43	75.21	55.27	57.34	68.02	72.72
Production of ingot, mono	kg CO_2-eq/kg	9.12	38.51	18.97	21.17	9.40	19.73	21.42	38.77	29.66	30.60	35.49	37.64
Production of brick	kg CO_2-eq/kg	0.59	1.70	0.96	1.04	0.60	0.99	1.05	1.71	1.36	1.40	1.58	1.66
Manufacture of mono wafers	kg CO_2-eq/m²	2.57	7.13	4.10	4.44	2.61	4.22	4.48	7.37	5.95	6.10	6.86	7.19
Production of cells	kg CO_2-eq/m²	14.73	37.71	22.44	24.16	14.95	23.03	24.35	37.91	30.78	31.52	35.34	37.02
Glass	kg CO_2-eq/kg	0.98	1.08	1.01	1.02	0.98	1.01	1.02	1.08	1.04	1.05	1.06	1.07
Tempered glass	kg CO_2-eq/kg	0.066	0.079	0.071	0.071	0.067	0.071	0.072	0.059	0.055	0.055	0.057	0.058
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	2.54	3.15	2.74	2.79	2.54	2.76	2.80	3.45	3.26	3.28	3.38	3.42
Backsheet (PET or equivalent)	kg CO_2-eq/kg	3.56	4.17	3.76	3.81	3.56	3.78	3.82	4.14	3.95	3.97	4.07	4.11
Backsheet (PVF)	kg CO_2-eq/kg	19.88	22.45	20.74	20.93	19.90	20.81	20.95	21.97	21.17	21.26	21.68	21.87
Crystalline module	kg CO_2-eq/m² module	4.08	7.55	5.24	5.50	4.12	5.33	5.53	7.57	6.50	6.61	7.19	7.44
Manufacture of CdTe module,	kg CO_2-eq/m² module	12.11	65.47	30.00	33.99	12.61	31.38	34.44	65.92	49.36	51.08	59.95	63.85
Manufacture of CIGS module	kg CO_2-eq/m² module	11.43	123.80	49.10	57.50	12.50	52.01	58.46	124.75	89.88	93.50	112.17	120.39

Manufacturing step/Material	Unit	Taiwan	United States	Russia	Canada	Türkiye	Tunisia	Vietnam	Thailand	Singapore	Mexico	Jordan	India
Metallurgical silicon MG-Si	kg CO_2-eq/kg	13.32	10.08	12.72	6.97	11.34	12.00	12.31	13.49	10.40	11.92	11.23	19.40
polySi, Siemens process	kg CO_2-eq/kg	62.18	41.56	58.35	21.79	49.56	53.78	55.75	63.25	43.61	53.24	48.87	100.84
Production of ingot, mono	kg CO_2-eq/kg	32.82	23.39	31.07	14.35	27.05	28.98	29.88	33.31	24.33	28.73	26.73	50.49
Production of brick	kg CO_2-eq/kg	1.48	1.13	1.42	0.78	1.26	1.34	1.37	1.50	1.16	1.33	1.25	2.15
Manufacture of mono wafers	kg CO_2-eq/m²	6.44	4.98	6.17	3.58	5.55	5.85	5.99	6.52	5.13	5.81	5.50	9.19
Production of cells	kg CO_2-eq/m²	33.25	25.88	31.88	18.81	28.74	30.25	30.95	33.63	26.61	30.05	28.49	47.07
Glass	kg CO_2-eq/kg	1.06	1.02	1.05	0.99	1.04	1.04	1.05	1.06	1.03	1.04	1.03	1.12
Tempered glass	kg CO_2-eq/kg	0.056	0.052	0.056	0.049	0.054	0.055	0.055	0.057	0.053	0.055	0.054	0.064
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	3.32	3.13	3.29	2.94	3.20	3.24	3.26	3.33	3.15	3.24	3.20	3.70
Backsheet (PET or equivalent)	kg CO_2-eq/kg	4.01	3.82	3.98	3.63	3.89	3.93	3.95	4.02	3.84	3.93	3.89	4.39
Backsheet (PVF)	kg CO_2-eq/kg	21.45	20.62	21.30	19.83	20.94	21.11	21.19	21.49	20.71	21.09	20.92	23.00
Crystalline module	kg CO_2-eq/m² module	6.87	5.76	6.67	4.70	6.19	6.42	6.53	6.93	5.87	6.39	6.16	8.96
Manufacture of CdTe module,	kg CO_2-eq/m² module	55.10	37.98	51.92	21.56	44.62	48.13	49.77	55.99	39.69	47.68	44.05	87.20
Manufacture of CIGS module	kg CO_2-eq/m² module	101.97	65.92	95.28	31.35	79.90	87.28	90.73	103.84	69.51	86.34	78.69	169.55

Manufacturing step/Material	Unit	South Africa	Qatar	Saudi Arabia	UAE	Algeria	Morocco	Egypt	Brazil	Ukraine	North Macedonia	Serbia
Metallurgical silicon MG-Si	kg CO_2-eq/kg	16.77	11.36	16.53	11.24	12.44	14.91	12.21	6.72	10.85	15.33	15.22
polySi, Siemens process	kg CO_2-eq/kg	84.12	49.68	82.59	48.91	56.57	72.31	55.12	20.15	46.44	78.09	74.27
Production of ingot, mono	kg CO_2-eq/kg	42.85	27.10	42.15	26.75	30.25	37.45	29.59	13.61	25.62	38.64	38.34
Production of brick	kg CO_2-eq/kg	1.86	1.27	1.83	1.25	1.38	1.66	1.36	0.76	1.21	1.70	1.69
Manufacture of mono wafers	kg CO_2-eq/m²	8.00	5.56	7.89	5.50	6.05	7.16	5.94	3.46	5.33	7.15	7.30
Production of cells	kg CO_2-eq/m²	41.10	28.78	40.55	28.51	31.24	36.87	30.72	18.22	27.62	37.82	37.57
Glass	kg CO_2-eq/kg	1.09	1.04	1.09	1.03	1.05	1.07	1.04	0.99	1.03	1.08	1.07
Tempered glass	kg CO_2-eq/kg	0.06	0.05	0.06	0.05	0.06	0.06	0.05	0.05	0.05	0.08	0.06
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	3.53	3.20	3.52	3.20	3.27	3.42	3.26	2.92	3.17	3.16	3.44
Backsheet (PET or equivalent)	kg CO_2-eq/kg	4.22	3.89	4.21	3.89	3.96	4.11	3.95	3.61	3.86	4.18	4.13
Backsheet (PVF)	kg CO_2-eq/kg	22.33	20.95	22.27	20.92	21.22	21.85	21.17	19.77	20.82	22.46	21.93
Crystalline module	kg CO_2-eq/m² module	8.05	6.20	7.97	6.16	6.57	7.42	6.49	4.61	6.03	7.56	7.52
Manufacture of CdTe module,	kg CO_2-eq/m² module	73.32	44.72	72.05	44.09	50.44	63.52	49.24	20.21	42.03	65.71	65.14
Manufacture of CIGS module	kg CO_2-eq/m² module	140.33	80.11	137.65	78.78	92.16	119.68	89.62	28.49	74.45	124.29	123.10

Manufacturing step/Material	Unit	Other country in Europe	Other country in the World
Metallurgical silicon MG-Si	kg CO_2-eq/kg	8.60	12.67
polySi, Siemens process	kg CO_2-eq/kg	35.29	58.03
Production of ingot, mono	kg CO_2-eq/kg	19.07	30.92
Production of brick	kg CO_2-eq/kg	0.96	1.41
Manufacture of mono wafers	kg CO_2.eq/m²	4.11	6.15
Production of cells	kg CO_2-eq/m²	22.51	31.77
Glass	kg CO_2-eq/kg	1.01	1.05
Tempered glass	kg CO_2-eq/kg	0.07	0.06
Encapsulant (EVA or equivalent)	kg CO_2-eq/kg	2.75	3.28
Backsheet (PET or equivalent)	kg CO_2-eq/kg	3.77	3.97
Backsheet (PVF)	kg CO_2-eq/kg	20.75	21.28
Crystalline module	kg CO_2-eq/m² module	5.26	6.65
Manufacture of CdTe module,	kg CO_2-eq/m² module	30.17	51.66
Manufacture of CIGS module	kg CO_2-eq/m² module	49.46	94.72

B. Procedures for applying the resilience criterion

The location of the module assembly site is verified as part of the simplified carbon assessment, in particular by providing the site audit report carried out by a third party accredited according to standard NF EN ISO/IEC 17065: 2012 as well as accreditation in accordance with standard NF EN ISO/IEC 17025: 2017 relating to the photovoltaic module product (NF EN IEC 61215 and NF EN IEC 61730 series of standards or any other equivalent methods), issued by the national accreditation body, or the national accreditation body of another Member State of the European Union, a member of the European Cooperation for Accreditation and having signed multilateral mutual recognition agreements.

Third countries representing more than 50 % of the European Union's supply of photovoltaic panels are the countries defined in Table 1 of European Commission Communication C/2025/9034 or its subsequent amendments.

Member countries of the European Economic Area are: the Member States of the European Union as well as Iceland, Liechtenstein and Norway.

Cell manufacturing encompasses all stages of the transformation of the silicon wafer to the cell, which must include the quality control of incoming wafers up to metallisation and cell power measurements.

Module assembly encompasses all cell welding, cell assembly and lamination, and module electrical testing operations.