Calculation report

Preliminary calculation

Example: 9.9 kWp pitched roof, Kyiv

Project	Example: 9.9 kWp pitched roof, Kyiv
Version	1 · 02.11.2026
Location	Kyiv
Norms	DBN V.1.2-2:2006 (Ukraine, loads and actions) (UA-DBN-2006)
Engine version	0.15.0
Calculation id (calc_id)	1987ee96356c3428afe46a15d8140686633abc6cbd8b89895be9bf0091037063

Preliminary calculation. A qualified engineer must check it before installation.

PANELS	POWER	GENERATION
18	9,90 kWp	10 986 kWh/year PVGIS 5.3 (EU JRC)

CALCULATION PASSPORT

Snow and wind	Київ — from your address (the DBN table for the regional centre)
Altitude	default value
Soil	not entered — the pile holding and the ground are assumed; an engineer confirms them

1 check rests on default or assumed inputs (Altitude, Building height) and needs confirmation before installation.

Site

Panels	18
Power, kWp	9,90
Generation, kWh/year	11 063
Generation by PVGIS 5.3 (EU JRC), kWh/year (typical year 2014–2023)	10 986

System 1

Pitched roof (Metal tile): 18 panels, 35°

INPUTS

Roof covering	Metal tile, 35°
Roof slope	12 000 × 8 000 mm
Panels	18 = 2×9, portrait
Fixings	64 × Hanger bolt M10×200 + L-bracket + EPDM
Fixing spacing	600 mm
Rails	4 × 10 180
Region	Kyiv: S0 1 550, W0 370 Pa
Power	9.90 kW
Setbacks	400 / 300 / 400
Uplift per 1	0.71 kN
Building height	default value
Supports and bolts	default value

CHECKS

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Setbacks: eaves 400, ridge 300, gable 400 mm. Wind edge zone e/10 ≈ 600 mm (DBN 9.16). **Pitch ≥25° and eaves ≤500 mm — install snow guards.**

Source: heuristic, not a code check

INFO

INFORMATION

Kyiv: snow S0 = 1 550 Pa, wind W0 = 370 Pa (DBN V.1.2-2:2006, Annex E). Frost depth ≈ 1.10 m (for reference). Wind at 6.0 m height: W_m = 754 Pa ($\gamma_{fm} \cdot W_0 \cdot c_e(z) \cdot C_{alt}$, c_e 2.04; the EN 1991-1-4 coefficients are defined on the peak pressure, DBN 9.8). S_0/W_0 — for the regional centre; check against the map in Fig. 8.1/9.1 or Annex E.

Parameter: Snow S_0
Actual: 1 550 Pa
Parameter: Wind W_0
Actual: 370 Pa
Basis documents: DBN V.1.2-2:2006

INFO

INFORMATION

Up to 500 m above sea level there are no corrections.

Parameter: Altitude
Actual: 150 m · **Required:** ≤ 500 m
Basis documents: DBN V.1.2-2:2006

INFO

INFORMATION

2 350×1 100×35 mm · 550 W.

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Rails 520 mm from the panel ends.

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Metal tile: Hanger bolt M10×200 + L-bracket + EPDM → rafters. Hole at the crest of the corrugation, EPDM washer + sealant.

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Panels parallel to the roof — recommended: less wind and fewer snow drifts.

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

35° Snow on panel 743 Pa.

Parameter: Tilt angle
Actual: 35°
Source: heuristic, not a code check

INFO

INFORMATION

Fits up to 10 × 3 panels. Installed: 9 × 2 = 18 (48% of the roof slope area).

Parameter: Share of the roof area
Actual: 48%

NEEDS CONFIRMATION

CODE CHECK

Fixings every 600 mm (every 1 rafter(s)), 16 per rail, cantilever 198. Rail: strength 9%, deflection 4%. 64 fixings in total. Per fixing: uplift ≈ 0.71 kN (24% of ~3.0 kN), compression ≈ 0.69 kN (27%).

Parameter: Strength
Actual: 9% · **Required:** ≤ 100% · **Result:** needs confirmation
Parameter: Deflection
Actual: 4% · **Required:** ≤ 100% · **Result:** needs confirmation
Parameter: Fixing pull-out
Actual: 0,71 kN · **Required:** ≤ 3 kN · **Result:** needs confirmation
Parameter: Fixing bearing
Actual: 27% · **Required:** ≤ 100% · **Result:** needs confirmation
Basis documents: DBN V.1.2-2:2006

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Portrait: 2 horizontal rails per row — standard.

Source: heuristic, not a code check

INFO

INFORMATION

18 panels · 9.90 kW.

Basis documents: DBN V.1.2-2:2006

INFO

INFORMATION

Rail 10 180 mm. Splices: 4.

INFO

INFORMATION

Installing a PV system on the roof of a detached house, a garden or country house, or an outbuilding requires no permit documents or commissioning acceptance; structural survey at the owner's discretion (CMU Resolution No. 77 of 28.01.2026, List, cl. 32, note 6). Checking the load-bearing capacity of the roof is recommended.

INFO

INFORMATION

There are no mandatory Ukrainian norms on fire setbacks and access paths for rooftop PV systems; setbacks in the calculation are for wind and structural reasons. DBN V.1.1-7:2016 cl. 8.4–8.6 only regulate roof exits.

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Inverter and battery: do not store combustible materials closer than 1 m to them or under the switchboard (NAPB A.01.001-2014, sect. IV ch. 1 cl. 1.18).

Source: heuristic, not a code check

INFO

INFORMATION

Switching off the inverter does not remove voltage from the module DC cables during the day: a DC isolator for each inverter is included in the electrical bill of materials (DSTU HD 60364-7-712, 712.537).

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Recommended (not mandatory in Ukraine): at the shutdown point — a sign “PV system, DC live during daytime” with a diagram and the shutdown location (SES of Ukraine guidelines, 2020).

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Check insulation resistance and protection tripping at least every 2 years (NAPB A.01.001-2014, sect. IV ch. 1 cl. 1.20).

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

The need for lightning protection is determined by a risk assessment per DSTU EN 62305-2:2022 (DBN V.2.5-23:2025 cl. 4.5; DBN V.1.1-7:2016 cl. 6.45; NAPB IV 1.21); there is no rule “PV system ⇒ mandatory lightning protection”. For the estimate: $N_G \approx 2.0$ 1/km²·year (Kyiv, thunderstorm days per UkrHMC 2015–2023 / 10).

Source: heuristic, not a code check

RECOMMENDATION

RECOMMENDATION (RULE OF THUMB, NOT A CODE CHECK)

Bond the module frames and rails to each other and to the building's main earthing terminal (DSTU HD 60364-7-712, 712.54; PUE:2026 1.7.59).

Source: heuristic, not a code check

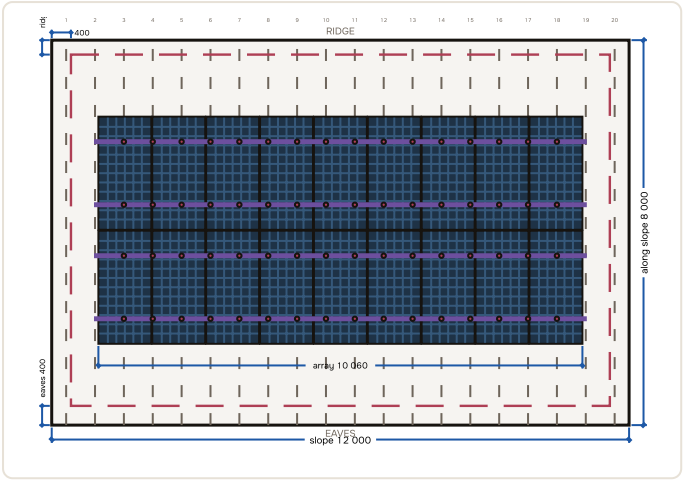
VALUES

Fixings	64
Uplift/1	0.71 kN
Stock lengths	8
Slope	35°
Panels	18 = 2×9
Fill	48%
Fixings	64
Fixing spacing	600 mm
Uplift per 1	0.71 kN
Rails	4 × 10 180
Stock lengths	8
Power	9.90 kW
Snow / wind	1 550 / 754 Pa

BILL OF MATERIALS

ITEM	QTY	
Aluminium rail 40×40, stock length 6 000 mm (price per metre)	8	bar
Al rail connector 40×40	4	pcs
Rail end cap	8	pcs
Hanger bolt M10×200 + L-bracket + EPDM (+10%)	71	pcs
MS polymer sealant 290 ml	5	tube
T-bolt M8 + nut (bracket → rail) (+10%)	71	pcs
End clamp 35 mm	8	pcs
Mid clamp (30–40 mm)	32	pcs
Bolt M8×50 A2 + hammer-head nut in the rail slot (+10%)	44	pcs
Rail earthing clamp M8	8	pcs
Module earthing clip (under the clamp)	18	pcs
Wire PV-3 6 mm² green-yellow	36	m
Cable clip, stainless	54	pcs

DRAWINGS



CALCULATION TABLES

1. Loads per DBN V.1.2-2:2006 as amended by No. 1 (2007) and No. 2 (2020)

Snow S_0 / wind W_0	Annex E, region (8.5, 9.6)	1 550 / 370 Pa
Return period T	parameter; γ_{fm} snow — Table 8.1, wind — Table 9.1	50 years → 1.00 / 1.00
C_{alt} snow / wind	(8.5), (9.4)	1.00 / 1.00
μ (snow)	Annex Zh, scheme 1: 1 up to 25°, 0 from 60°, linear in between	0.71
Snow S_m on horizontal projection	$\gamma_{fm}\cdot S_0\cdot C_{alt}\cdot \mu$, C_e = 1 (8.9)	1 107 Pa
$c_e(z)$	EN 1991-1-4 4.5, terrain type II as category EN, z = 6.0 m	2.04
Wind W_m	$\gamma_{fm}\cdot W_0\cdot c_e(z)\cdot C_{alt}$: the EN 1991-1-4 coefficients are defined on the peak pressure (9.8), W_0 taken as q_b (9.6, EN 1991-1-4 4.5); C_{rel} = C_{dir} = 1	754 Pa
C_h	Table 9.01, terrain category II, z = 6.0 m	0.74
Wind $W_{m,h}$ for the DBN coefficients	$\gamma_{fm}\cdot W_0\cdot C_h\cdot C_{alt}$ (9.1); C_{rel} = C_{dir} = C_d = 1 (9.11–9.13)	274 Pa
Uplift coefficient of the fixings	outside the e/10 = 600 mm strips: parallel to the roof, 1.3 — reference value (EN 1991-1-4, DBN 9.8)	1.30
γ_n	DBN V.1.2-14, consequence class — set in parameters	1.00

Combination — per 4.18 (Amendment No. 2). Uplift on the fixings — per 9.16: in the e/10 strip along the roof's outer edge C_aer = -2, in the roof corners (zones A) -3.5; e — the smallest overall dimension of the building (the slope is taken as one of the two slopes of a gable building, the height to the ridge). Annex I has no uplift coefficient for panels parallel to the roof: 1.3 from reference data (EN 1991-1-4), as 9.8 allows; on a tilt frame — the canopy c_f × 1.2. The DBN coefficients (9.16, Annex I) multiply W_m,h = γfm·W0·Ch·Calt, the EN 1991-1-4 coefficients are defined on the peak pressure and multiply W_m = γfm·W0·c_e(z)·Calt; in the strips the larger uplift governs. Pressure: downward wind only when c_e1 of the windward slope per Annex I, scheme 2, is positive; otherwise self-weight and snow.

2. Roof fixings

Panel area	18 panels	46.53 m²
Brackets	4 rails × 16	64 pcs
Uplift per bracket	$\gamma_n \cdot c_p \cdot W_m \cdot A / n$	712 N
c_{e1} of the windward slope	Annex I, scheme 2: α = 35°, h_1/l = 0.11	+0.30

2. Roof fixings

Pressure on bracket	$\gamma_n \cdot (1.05 \cdot 120 + \max(S + 0.9 \cdot W\downarrow, W\downarrow + 0.9 \cdot S)) \cdot A / n$, $S = S_m \cdot \cos^2\alpha$, $W\downarrow = c_{e1} \cdot W_{m,h}$ = 83 Pa (4.18)	686 N

A bracket is fixed only on rafters, so their layout depends on the rafter spacing, not on dividing the rail evenly.

3. Rail

Rail: Aluminium rail 40×40, span 600 mm	strip 1 175 mm	
Wind W↓ on the rail	$c_{e1} \cdot W_{m,h}$, c_{e1} = +0.30 (Annex I, scheme 2)	83 Pa
Design load q_d	1.05·G + S + 0.9·W↓ (DBN 4.18)	1.108 N/mm
Moment M	$q \cdot L^2/8$	0.05 kN·m
Strength σ/f_y	M / W (3 500 mm³) / 160 MPa	9%
Deflection / (L/200)	$5 \cdot q \cdot L^4/(384 \cdot E \cdot I)$; $G + \gamma_{fe} \cdot S + 0.9 \cdot \gamma_{fe} \cdot W\downarrow$, γ_{fe} = 0.49 / 0.21 (Tables 8.3, 9.3, η = 0.02)	4%

M = q·L²/8 also for a continuous beam: snow may lie on half of the span (DBN 8.7).

4. Fire safety and lightning protection

Basis	Cabinet of Ministers of Ukraine Resolution No. 77 of 28.01.2026 (List, cl. 32); NAPB A.01.001-2014 (sect. IV ch. 1, cl. 1.18, 1.20, 1.21); DBN V.1.1-7:2016 (cl. 6.20, 6.45, 8.4–8.6, Annex A); DBN V.2.5-23:2025 (cl. 4.5, 7.53, 7.54, 7.62, 8.6); DSTU EN 62305-1:2012, -2:2022, -3:2021, -4:2012; DSTU HD 60364-7-712:2022	
Building type	the “Building type” parameter	detached, garden or country house; outbuilding
Lightning protection on the building	electrics parameter	none / unknown

Ukrainian codes do not set fire setbacks, rapid shutdown or marking for rooftop PV systems; the SES of Ukraine recommendations given are for reference only. The need for lightning protection is determined by a risk assessment per DSTU EN 62305-2; this calculation is preliminary.

- Roof covering: Metal tile → Hanger bolt M10×200 + L-bracket + EPDM, fixed to: rafters. Hole at the crest of the corrugation, EPDM washer + sealant.
- Setbacks — EU practice recommendations (Ukraine has no norms specifically for PV systems): ≥ 300 mm, in edge wind zones (e/10 ≈ 600 mm) place fixings closer together.
- Loads: DBN V.1.2-2:2006 as amended by No. 1 (2007) and No. 2 (2020); c_p of the fixings — reference values (EN 1991-1-4, DBN 9.8). Fixing capacity assumed as typical (3.0 kN against uplift) — check against the datasheet.
- Rail 10 180 mm — thermal expansion gap every 12–15 m. Rail cantilever ≤ 1/3 of the span.
- Raising the tilt with a frame on a pitched roof is not provided: wind, snow drift, gain only 2–3%.

WHAT THIS CALCULATION DOES NOT COVER

- This is a preliminary calculation, not an independent review: the formulas and factors come from the codes named above.
- Snow and wind are those of the nearest regional centre, or your own values. A site in another snow or wind zone, or at another altitude, needs its own values.
- A qualified engineer verifies the design for the actual site, roof or soil and the local building rules before installation.

CHECKED BY ENGINEER

Full name _____

Licence no. _____

Date _____

Signature _____