Hourly Radiation on a Tilted Surface: Isotropic and HDKR Sky

Beam, sky-diffuse and ground-reflected radiation on a sloped collector for one hour from horizontal radiation, by the isotropic or HDKR anisotropic sky model.

Input parameters

Unit system: SI

Parameter	Value	Unit
Sky model	HDKR anisotropic (Hay, Davies, Klucher, Reindl)	
Latitude (north positive, south negative)	18.500	°
Day of the year (1 = 1 January, 365 = 31 December)	15.000	
Hour midpoint (solar time)	12.000	h
Hour's total radiation on a horizontal surface	2.6000	MJ/m²
Collector slope	25.000	°
Collector azimuth (south 0, west positive)	0	°
Ground reflectance (grass 0.2, snow 0.6–0.7)	20.000	%
Declination formula	Cooper (1969), as in the textbook examples	

Calculated results

Parameter	Value	Unit
Hour's extraterrestrial radiation	3.8904	MJ/m²
Hourly clearness index	0.66831	
Diffuse fraction (Erbs)	29.829	%
Beam ratio	1.2580	
Anisotropy index	0.46896	
Beam on the collector	2.7528	MJ/m²
Sky diffuse on the collector	0.39590	MJ/m²
Ground-reflected on the collector	0.024360	MJ/m²
Total on the collector	3.1730	MJ/m²
Ratio tilted to horizontal total	1.2204	

Notes for this case

- Diffuse fraction from the Erbs hourly correlation. The HDKR model adds circumsolar and horizon-brightening diffuse and is the textbook's recommended model; the isotropic model is conservative.

Formula and method

$$I_T = I_b R_b + I_d \frac{1+\cos\beta}{2} + I\rho_g \frac{1-\cos\beta}{2} \quad \text{(isotropic)}$$

$$I_T = (I_b + I_d A_i) R_b + I_d (1 - A_i) \frac{1+\cos\beta}{2} \left[1 + f \sin^3 \frac{\beta}{2}\right] + I\rho_g \frac{1-\cos\beta}{2}, \quad A_i = \frac{I_b}{I_o}, \; f = \sqrt{\frac{I_b}{I}}$$

Variables

model	Sky model	-
ϕ	Latitude (north positive, south negative)	rad

n	Day of the year (1 = 1 January, 365 = 31 December)	-
t_s	Hour midpoint (solar time)	s
I	Hour's total radiation on a horizontal surface	J/m²
β	Collector slope	rad
γ	Collector azimuth (south 0, west positive)	rad
ρ_g	Ground reflectance (grass 0.2, snow 0.6–0.7)	-
δ formula	Declination formula	-
I_o	Hour's extraterrestrial radiation	J/m²
k_T	Hourly clearness index	-
I_d/I	Diffuse fraction (Erbs)	-
R_b	Beam ratio	-
A_i	Anisotropy index	-
$I_{T,b}$	Beam on the collector	J/m²
$I_{T,d}$	Sky diffuse on the collector	J/m²
$I_{T,g}$	Ground-reflected on the collector	J/m²
I_T	Total on the collector	J/m²
R	Ratio tilted to horizontal total	-

Method and standards

Transposition of horizontal radiation to the collector plane.

Assumptions and limits

- Hourly data; the diffuse split is from a correlation, not measured.

Report details

Report reference	FCC-5MYQ-0Q88 (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Hourly Radiation on a Tilted Surface: Isotropic and HDKR Sky
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	4 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/environmental/solar-thermal/tilted-surface-hourly-radiation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.