Monthly Average Daily Radiation on a Tilted Collector (Liu–Jordan)

Monthly average daily radiation on an equator-facing tilted collector from horizontal data by the Liu and Jordan isotropic method with Klein's beam ratio.

Input parameters

Unit system: SI

Parameter	Value	Unit
Latitude (north positive, south negative)	43.000	°
Day of the year (1 = 1 January, 365 = 31 December)	162.00	
Monthly average daily radiation on a horizontal surface	23.000	MJ/m²
Collector slope (facing the equator)	60.000	°
Ground reflectance	20.000	%
Declination formula	Cooper (1969), as in the textbook examples	

Calculated results

Parameter	Value	Unit
Declination	23.086	°
Sunset hour angle	113.42	°
Sunset hour angle on the tilted surface	82.512	°
Extraterrestrial radiation	41.776	MJ/m²
Monthly clearness index	0.55055	
Diffuse fraction (Erbs monthly)	38.210	%
Monthly beam ratio	0.61664	
Beam on the collector	8.7635	MJ/m²
Sky diffuse on the collector	6.5913	MJ/m²
Ground-reflected on the collector	1.1500	MJ/m²
Total on the collector	16.505	MJ/m²
Ratio tilted to horizontal	0.71760	

Notes for this case

- Use the mean day of the month (17 Jan, 16 Feb, 16 Mar, 15 Apr, 15 May, 11 Jun, 17 Jul, 16 Aug, 15 Sep, 15 Oct, 14 Nov, 10 Dec).

Formula and method

$$\bar{H}_T = \bar{H}\left(1 - \frac{\bar{H}_d}{\bar{H}}\right)\bar{R}_b + \bar{H}_d\frac{1+\cos\beta}{2} + \bar{H}\rho_g\frac{1-\cos\beta}{2}$$

One further formula is shown on the calculator page: https://calc.firecad.com/environmental/solar-thermal/monthly-radiation-tilted-surface

Variables

ϕ	Latitude (north positive, south negative)	rad
n	Day of the year (1 = 1 January, 365 = 31 December)	-
$\bar{H}$	Monthly average daily radiation on a horizontal surface	J/m²

β	Collector slope (facing the equator)	rad
ρ_g	Ground reflectance	-
δ formula	Declination formula	-
δ	Declination	rad
ω_s	Sunset hour angle	rad
\omega'_s	Sunset hour angle on the tilted surface	rad
$\bar{H}_o$	Extraterrestrial radiation	J/m²
$\bar{K}_T$	Monthly clearness index	-
$\bar{H}_d/\bar{H}$	Diffuse fraction (Erbs monthly)	-
$\bar{R}_b$	Monthly beam ratio	-
$\bar{H}_{T,b}$	Beam on the collector	J/m²
$\bar{H}_{T,d}$	Sky diffuse on the collector	J/m²
$\bar{H}_{T,g}$	Ground-reflected on the collector	J/m²
$\bar{H}_T$	Total on the collector	J/m²
$\bar{R}$	Ratio tilted to horizontal	-

Method and standards

Liu and Jordan isotropic monthly method with Klein's R̄_b for equator-facing surfaces.

Assumptions and limits

- Equator-facing surfaces only; isotropic sky (conservative by a few percent).

Report details

Report reference	FCC-N96X-6X34 (the same inputs always give the same reference)
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Calculator	Monthly Average Daily Radiation on a Tilted Collector (Liu–Jordan)
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/monthly-radiation-tilted-surface

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.