Hourly Solar Radiation from Daily Total (Collares-Pereira–Rabl)

Hourly total, diffuse and beam radiation on a horizontal surface from the day's total by the Collares-Pereira and Rabl and Liu and Jordan distributions.

Input parameters

Unit system: SI

Parameter	Value	Unit
Latitude (north positive, south negative)	23.000	°
Day of the year (1 = 1 January, 365 = 31 December)	91.000	
Hour midpoint (solar time)	12.000	h
Day's total radiation on a horizontal surface	20.000	MJ/m²
The day is	A single day (Erbs daily diffuse)	
Declination formula	Cooper (1969), as in the textbook examples	

Calculated results

Parameter	Value	Unit
Sunset hour angle	91.708	°
Day length	12.228	h
Day's extraterrestrial radiation	36.158	MJ/m²
Daily clearness index	0.55312	
Daily diffuse fraction	51.770	%
Hour's share of the day's total	13.940	%
Hour's share of the day's diffuse	12.872	%
Hourly total radiation	2.7880	MJ/m²
Hourly diffuse radiation	1.3328	MJ/m²
Hourly beam radiation	1.4552	MJ/m²

Notes for this case

- The distributions assume a day symmetrical about solar noon; they suit average days best and individual days only roughly.

Formula and method

$$r_t = \frac{\pi}{24}(a + b\cos\omega)\frac{\cos\omega - \cos\omega_s}{\sin\omega_s - \frac{\pi\omega_s}{180}\cos\omega_s}, \quad a = 0.409 + 0.5016\sin(\omega_s - 60),\ b = 0.6609 - 0.4767\sin(\omega_s - 60)$$

$$r_d = \frac{\pi}{24}\frac{\cos\omega - \cos\omega_s}{\sin\omega_s - \frac{\pi\omega_s}{180}\cos\omega_s}, \quad I = r_t H,\ I_d = r_d H_d$$

Variables

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
H	Day's total radiation on a horizontal surface	J/m²
basis	The day is	-

δ formula	Declination formula	-
ω_s	Sunset hour angle	rad
N	Day length	s
H_o	Day's extraterrestrial radiation	J/m²
K_T	Daily clearness index	-
H_d/H	Daily diffuse fraction	-
r_t	Hour's share of the day's total	-
r_d	Hour's share of the day's diffuse	-
I	Hourly total radiation	J/m²
I_d	Hourly diffuse radiation	J/m²
I_b	Hourly beam radiation	J/m²

Method and standards

Statistical hourly distributions of daily radiation.

Assumptions and limits

- Symmetric average days; ±10 % or more for individual hours.

Report details

Report reference	FCC-S4AT-HB8B (the same inputs always give the same reference)
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Calculator	Hourly Solar Radiation from Daily Total (Collares-Pereira–Rabl)
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Release checks	3 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/hourly-solar-radiation-from-daily

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.