Monthly Utilizability φ̄ (Klein) and Utilizable Solar Energy

Monthly average daily utilizability of radiation on a tilted collector above a critical level by Klein's correlation, and the month's utilizable or collected energy.

Input parameters

Unit system: SI

Parameter	Value	Unit
Latitude	18.500	°
Mean day of the month	17.000	
Monthly average daily radiation on a horizontal surface	19.500	MJ/m²
Collector slope (facing the equator)	25.000	°
Ground reflectance	20.000	%
Critical radiation level	250.00	W/m²
Days in the month	31.000	
Collector F_R(τα), monthly mean (0 = utilizable radiation only)	70.000	%

Calculated results

Parameter	Value	Unit
Monthly clearness index	0.70308	
Monthly ratio tilted to horizontal	1.2752	
Noon ratio on the average day	1.1992	
Dimensionless critical level	0.25214	
Monthly utilizability	62.090	%
Daily radiation on the collector	24.867	MJ/m²
Utilizable energy in the month	478.63	MJ/m²
Collected energy per m² (if F_R(τα) given)	335.04	MJ/m²

Notes for this case

• Klein (1978) correlation for equator-facing surfaces; the noon-day quantities use the average day (H = H̄) with the Erbs daily diffuse fraction and the monthly R̄ the Erbs monthly fraction, in common practice. For a collector the critical level is F_RU_L(T_i − T̄_a)/F_R(τα).

Formula and method

$$\bar{\phi} = \exp\left\{\left[a + b\frac{R_n}{\bar{R}}\right]\left[\bar{X}_c + c\bar{X}_c^2\right]\right\}, \quad \bar{X}_c = \frac{I_{Tc}}{r_{t,n} R_n \bar{H}}$$

$$a = 2.943 - 9.271\bar{K}_T + 4.031\bar{K}_T^2,\ b = -4.345 + 8.853\bar{K}_T - 3.602\bar{K}_T^2,\ c = -0.170 - 0.306\bar{K}_T + 2.936\bar{K}_T^2$$

Variables

ϕ	Latitude	rad
n	Mean day of the month	-
$\bar{H}$	Monthly average daily radiation on a horizontal surface	J/m²
β	Collector slope (facing the equator)	rad
ρ_g	Ground reflectance	-
$I_{T,c}$	Critical radiation level	W/m²

N	Days in the month	-
$F_R(\tau\bar{\alpha})$	Collector F_R(τα), monthly mean (0 = utilizable radiation only)	-
$\bar{K}_T$	Monthly clearness index	-
$\bar{R}$	Monthly ratio tilted to horizontal	-
R_n	Noon ratio on the average day	-
$\bar{X}_c$	Dimensionless critical level	-
$\bar{\phi}$	Monthly utilizability	-
$\bar{H}_T$	Daily radiation on the collector	J/m²
$\bar{H}_T N \bar{\phi}$	Utilizable energy in the month	J/m²
Q_u/A_c	Collected energy per m² (if F_R(τα) given)	J/m²

Method and standards

Klein's monthly average daily utilizability.

Assumptions and limits

- Equator-facing surfaces; monthly averages.

Report details

Report reference	FCC-R7ME-BEBE (the same inputs always give the same reference)
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Calculator	Monthly Utilizability φ̄ (Klein) and Utilizable Solar Energy
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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/monthly-utilizability-klein

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.