

# ROANOKE, VA (37.3°N, 80.0°W)

Elevation: 358 m

Pressure: 976 mb

## SOLAR RADIATION FOR FLAT-PLATE COLLECTORS FACING SOUTH AT A FIXED TILT\*

Tilt		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0°	Average	2.3	3.1	4.1	5.2	5.8	6.2	5.9	5.5	4.5	3.6	2.5	2.0	4.2
	Minimum	2.0	2.5	3.5	4.4	5.1	5.6	5.1	4.9	3.7	3.3	1.9	1.8	4.0
	Maximum	2.7	3.7	4.6	6.4	6.4	6.9	6.8	5.9	5.2	4.3	2.9	2.3	4.4
Lat - 15°	Average	3.3	4.0	4.8	5.6	5.8	6.0	5.9	5.7	5.1	4.6	3.5	2.9	4.8
	Minimum	2.6	3.0	4.0	4.6	5.0	5.4	5.0	5.0	4.0	4.0	2.5	2.4	4.4
	Maximum	4.0	5.0	5.5	7.0	6.5	6.8	6.8	6.2	6.0	5.5	4.3	3.6	5.0
Lat°	Average	3.7	4.3	5.0	5.5	5.5	5.6	5.5	5.5	5.1	4.9	3.9	3.4	4.8
	Minimum	2.8	3.1	4.1	4.5	4.7	5.0	4.7	4.8	3.9	4.2	2.7	2.7	4.5
	Maximum	4.6	5.5	5.8	6.9	6.1	6.2	6.3	6.0	6.1	6.0	4.9	4.2	5.1
Lat + 15°	Average	3.9	4.5	4.9	5.1	4.9	4.8	4.8	5.0	4.9	4.9	4.1	3.6	4.6
	Minimum	3.0	3.2	3.9	4.2	4.2	4.4	4.1	4.4	3.7	4.2	2.7	2.8	4.3
	Maximum	5.0	5.8	5.7	6.4	5.4	5.4	5.5	5.5	5.8	6.1	5.2	4.5	4.9
90°	Average	3.6	3.7	3.6	3.1	2.5	2.3	2.4	2.8	3.3	3.9	3.6	3.3	3.2
	Minimum	2.6	2.5	2.8	2.6	2.3	2.2	2.1	2.5	2.5	3.3	2.3	2.5	3.0
	Maximum	4.6	4.8	4.2	3.8	2.7	2.5	2.6	3.1	3.9	4.8	4.6	4.2	3.4

## SOLAR RADIATION FOR 1-AXIS TRACKING FLAT-PLATE COLLECTORS WITH A NORTH-SOUTH AXIS\*

Axis Tilt		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0°	Average	3.3	4.3	5.5	6.8	7.3	7.8	7.4	7.0	5.9	5.0	3.5	2.9	5.6
	Minimum	2.5	3.1	4.4	5.3	6.1	6.7	6.1	6.1	4.5	4.3	2.4	2.3	5.1
	Maximum	4.1	5.6	6.5	9.0	8.3	9.0	8.8	7.8	7.1	6.3	4.5	3.5	5.9
Lat - 15°	Average	4.0	5.0	6.1	7.2	7.4	7.7	7.4	7.2	6.4	5.7	4.2	3.6	6.0
	Minimum	3.0	3.5	4.8	5.5	6.1	6.7	6.1	6.2	4.7	4.9	2.8	2.8	5.5
	Maximum	5.1	6.6	7.2	9.5	8.4	9.0	8.9	8.1	7.7	7.2	5.4	4.5	6.4
Lat°	Average	4.3	5.2	6.2	7.1	7.2	7.4	7.2	7.1	6.4	6.0	4.6	3.9	6.1
	Minimum	3.2	3.6	4.8	5.4	5.9	6.4	5.9	6.1	4.7	5.1	3.0	3.0	5.6
	Maximum	5.6	7.0	7.4	9.4	8.2	8.6	8.5	7.9	7.8	7.6	5.9	4.9	6.5
Lat + 15°	Average	4.5	5.3	6.1	6.8	6.7	6.9	6.7	6.7	6.2	6.0	4.7	4.1	5.9
	Minimum	3.3	3.6	4.7	5.1	5.5	5.9	5.5	5.8	4.5	5.1	3.0	3.1	5.4
	Maximum	5.9	7.1	7.4	9.1	7.7	8.1	8.0	7.5	7.6	7.6	6.2	5.3	6.3

## SOLAR RADIATION FOR 2-AXIS TRACKING FLAT-PLATE COLLECTORS\*

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2-Axis Tracking	Average	4.6	5.4	6.2	7.2	7.5	7.9	7.6	7.2	6.4	6.0	4.7	4.2	6.3
	Minimum	3.3	3.6	4.8	5.5	6.2	6.8	6.2	6.2	4.7	5.1	3.0	3.1	5.8
	Maximum	6.0	7.1	7.5	9.5	8.5	9.2	9.0	8.1	7.8	7.6	6.2	5.3	6.7

## DIRECT BEAM SOLAR RADIATION FOR CONCENTRATING COLLECTORS\*

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1-Axis (E-W) Tracking	Average	2.7	2.9	3.1	3.3	3.3	3.5	3.3	3.2	3.0	3.3	2.7	2.5	3.1
	Minimum	1.7	1.5	2.0	1.9	2.2	2.7	2.3	2.3	1.7	2.5	1.4	1.6	2.7
	Maximum	3.9	4.4	3.9	5.1	4.1	4.5	4.4	3.8	4.1	4.5	3.9	3.6	3.4
1-Axis (N-S) Tracking, Tilt = 0°	Average	2.1	2.7	3.5	4.3	4.4	4.6	4.3	4.1	3.6	3.3	2.2	1.8	3.4
	Minimum	1.3	1.5	2.3	2.4	2.9	3.5	3.1	3.1	2.2	2.6	1.1	1.2	3.0
	Maximum	3.0	4.2	4.6	6.7	5.4	5.9	5.7	5.0	4.9	4.7	3.2	2.6	3.9
1-Axis (N-S) Tracking, Tilt = Lat°	Average	2.9	3.5	4.1	4.5	4.3	4.3	4.1	4.2	4.0	4.1	3.1	2.7	3.8
	Minimum	1.9	1.9	2.7	2.6	2.8	3.3	2.9	3.1	2.4	3.2	1.6	1.8	3.4
	Maximum	4.3	5.4	5.3	7.0	5.3	5.6	5.4	5.1	5.4	5.7	4.5	3.8	4.3
2-Axis Tracking	Average	3.2	3.6	4.1	4.6	4.5	4.7	4.4	4.3	4.0	4.2	3.3	2.9	4.0
	Minimum	2.0	1.9	2.7	2.6	3.0	3.5	3.1	3.2	2.4	3.2	1.7	1.9	3.5
	Maximum	4.6	5.5	5.3	7.1	5.6	6.0	5.8	5.2	5.5	5.8	4.7	4.2	4.5

## AVERAGE CLIMATIC CONDITIONS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Temperature (°C)	1.4	2.9	8.2	13.1	17.8	21.9	24.2	23.7	19.8	13.6	8.6	3.5	13.2
Average Low (°C)	-3.9	-2.7	2.1	6.6	11.4	15.7	18.2	17.7	13.8	7.1	2.8	-1.7	7.2
Average High (°C)	6.6	8.5	14.3	19.6	24.3	28.3	30.2	29.6	25.8	20.1	14.4	8.7	19.2
Record Low (°C)	-23.9	-17.2	-12.2	-6.7	-0.6	3.9	8.3	5.6	1.1	-5.6	-12.8	-20.0	-23.9
Record High (°C)	25.6	26.7	30.6	35.0	35.6	37.8	40.0	40.6	38.3	33.9	28.3	24.4	40.6
Heating Degree Days†	526	431	313	161	58	3	0	0	22	157	292	460	2422
Cooling Degree Days†	0	0	0	4	43	111	183	166	67	11	0	0	584
Relative Humidity (%)	61	60	57	57	66	69	71	73	74	68	65	64	65
Wind Speed (m/s)	4.2	4.1	4.3	4.3	3.4	3.1	2.9	2.7	2.7	3.0	3.5	3.8	3.5

\* in kWh/m<sup>2</sup>/day, ±9%

† based on 18.3°C (65°F)