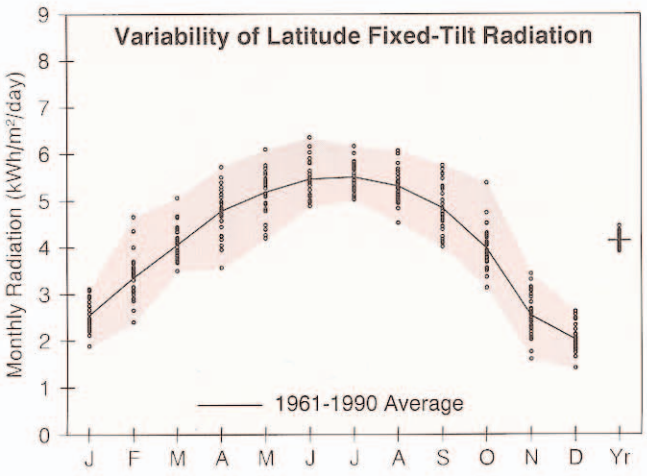


Akron, OH

WBAN NO. 14895

LATITUDE: 40.92° N
LONGITUDE: 81.43° W
ELEVATION: 377 meters
MEAN PRESSURE: 973 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.7	2.4	3.4	4.6	5.5	6.1	6.0	5.2	4.2	2.9	1.8	1.4	3.8
	Min/Max	1.5/1.9	2.0/3.1	3.0/4.0	3.6/5.3	4.5/6.4	5.4/7.1	5.5/6.7	4.6/5.9	3.6/4.8	2.5/3.7	1.4/2.1	1.2/1.6	3.6/4.0
Latitude -15	Average	2.3	3.1	4.0	4.9	5.5	5.9	5.9	5.5	4.8	3.8	2.3	1.8	4.2
	Min/Max	1.8/2.8	2.3/4.2	3.5/4.9	3.7/5.8	4.5/6.5	5.3/6.9	5.4/6.7	4.7/6.3	4.0/5.7	3.0/5.0	1.6/3.1	1.4/2.3	4.0/4.5
Latitude	Average	2.5	3.4	4.1	4.8	5.2	5.5	5.5	5.3	4.8	4.0	2.5	2.0	4.1
	Min/Max	1.9/3.1	2.4/4.7	3.5/5.1	3.6/5.7	4.2/6.1	4.9/6.3	5.0/6.2	4.5/6.1	4.0/5.8	3.1/5.4	1.6/3.4	1.4/2.6	3.9/4.4
Latitude +15	Average	2.7	3.4	3.9	4.4	4.6	4.7	4.8	4.8	4.6	4.0	2.6	2.1	3.9
	Min/Max	1.9/3.3	2.4/4.9	3.4/5.0	3.3/5.3	3.7/5.4	4.3/5.5	4.4/5.4	4.1/5.5	3.8/5.5	3.1/5.4	1.6/3.6	1.4/2.8	3.7/4.2
90	Average	2.5	3.0	3.0	2.9	2.6	2.5	2.6	3.0	3.3	3.2	2.2	1.9	2.7
	Min/Max	1.8/3.2	2.0/4.5	2.5/3.8	2.2/3.4	2.2/3.0	2.3/2.8	2.4/2.8	2.6/3.4	2.7/3.9	2.4/4.5	1.3/3.2	1.2/2.7	2.6/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.2	3.2	4.3	5.8	6.9	7.6	7.6	6.8	5.5	3.9	2.2	1.7	4.8
	Min/Max	1.7/2.6	2.3/4.3	3.8/5.4	4.2/7.2	5.3/8.5	6.6/9.6	6.9/8.9	5.6/8.0	4.5/6.6	3.1/5.3	1.4/2.9	1.2/2.1	4.5/5.2
Latitude -15	Average	2.6	3.7	4.8	6.1	7.0	7.6	7.7	7.0	6.0	4.5	2.7	2.0	5.2
	Min/Max	1.9/3.3	2.5/5.2	4.2/6.2	4.3/7.6	5.3/8.7	6.6/9.6	6.9/9.0	5.7/8.4	4.8/7.3	3.5/6.3	1.6/3.7	1.4/2.7	4.8/5.6
Latitude	Average	2.8	3.9	4.8	6.0	6.8	7.3	7.4	6.9	6.0	4.7	2.8	2.2	5.1
	Min/Max	2.0/3.6	2.6/5.5	4.2/6.3	4.2/7.6	5.1/8.4	6.3/9.2	6.7/8.7	5.6/8.2	4.8/7.4	3.6/6.6	1.7/3.9	1.4/2.9	4.8/5.6
Latitude +15	Average	2.9	3.9	4.7	5.8	6.3	6.8	6.9	6.6	5.9	4.7	2.9	2.3	5.0
	Min/Max	2.0/3.7	2.6/5.7	4.1/6.2	4.0/7.3	4.8/7.9	5.8/8.6	6.2/8.2	5.3/7.8	4.7/7.2	3.5/6.7	1.6/4.1	1.4/3.1	4.6/5.5

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.0	3.9	4.8	6.1	7.1	7.8	7.8	7.1	6.1	4.8	2.9	2.3	5.3
	Min/Max	2.1/3.8	2.6/5.7	4.2/6.3	4.3/7.7	5.4/8.8	6.7/9.8	7.0/9.2	5.8/8.4	4.9/7.4	3.6/6.7	1.7/4.1	1.4/3.1	5.0/5.8

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.3	1.7	2.0	2.5	2.9	3.4	3.4	3.0	2.7	2.3	1.4	1.0	2.3
	Min/Max	0.5/2.0	0.7/2.8	1.3/3.2	1.2/3.6	1.8/4.2	2.6/4.9	2.7/4.5	2.0/4.1	1.9/3.7	1.5/3.7	0.5/2.4	0.3/1.6	2.0/2.7
1-Axis, N-S Horiz Axis	Average	0.9	1.5	2.2	3.2	3.9	4.4	4.4	3.9	3.2	2.3	1.0	0.6	2.6
	Min/Max	0.3/1.4	0.7/2.5	1.5/3.5	1.6/4.7	2.2/5.6	3.4/6.5	3.5/5.9	2.6/5.4	2.2/4.4	1.4/3.6	0.4/1.8	0.2/1.0	2.3/3.1
1-Axis, N-S Tilt=Latitude	Average	1.4	2.0	2.6	3.4	3.8	4.2	4.3	4.0	3.7	2.9	1.5	1.0	2.9
	Min/Max	0.6/2.2	0.9/3.4	1.8/4.2	1.6/5.0	2.2/5.5	3.2/6.2	3.4/5.7	2.7/5.5	2.5/5.0	1.8/4.6	0.5/2.6	0.3/1.7	2.5/3.4
2-Axis	Average	1.5	2.1	2.6	3.5	4.0	4.5	4.6	4.2	3.7	2.9	1.6	1.1	3.0
	Min/Max	0.6/2.3	0.9/3.5	1.8/4.2	1.7/5.1	2.3/5.8	3.5/6.7	3.7/6.1	2.8/5.7	2.5/5.0	1.9/4.7	0.6/2.8	0.3/1.8	2.7/3.5

Average Climatic Conditions

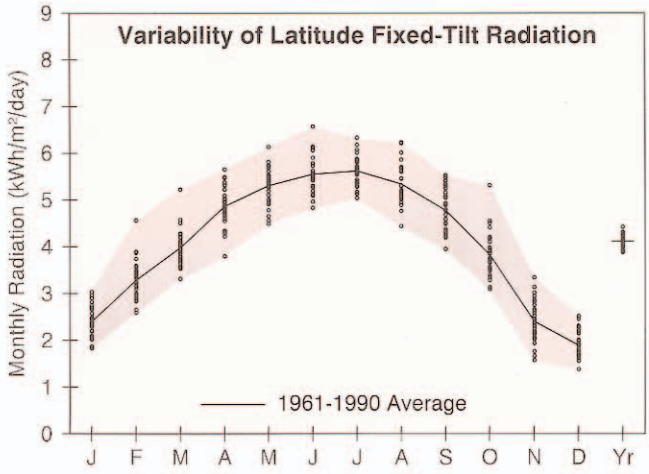
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.0	-2.6	3.3	9.2	15.0	19.9	22.2	21.3	17.6	11.3	5.6	-0.7	9.8
Daily Minimum Temp	-8.4	-7.3	-1.9	3.3	9.0	13.9	16.4	15.6	12.1	5.9	1.2	-4.7	4.6
Daily Maximum Temp	0.3	2.2	8.5	15.1	20.9	25.8	27.9	26.9	23.2	16.7	9.8	3.2	15.1
Record Minimum Temp	-31.1	-25.0	-19.4	-12.2	-4.4	0.0	6.1	5.0	0.0	-6.7	-18.3	-26.7	-31.1
Record Maximum Temp	21.1	20.0	27.2	31.1	33.9	37.8	38.3	36.7	37.2	30.0	26.7	24.4	38.3
HDD, Base 18.3°C	692	585	465	275	124	21	0	7	57	222	383	591	3422
CDD, Base 18.3°C	0	0	0	0	21	67	121	98	36	4	0	0	347
Relative Humidity (%)	73	72	68	64	66	68	70	73	74	70	72	75	70
Wind Speed (m/s)	5.2	4.9	5.1	4.8	4.1	3.7	3.4	3.3	3.6	4.1	4.8	5.1	4.3

Cleveland, OH

WBAN NO. 14820

LATITUDE: 41.40° N
LONGITUDE: 81.85° W
ELEVATION: 245 meters
MEAN PRESSURE: 988 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.6	2.4	3.3	4.6	5.6	6.2	6.1	5.3	4.1	2.8	1.7	1.3	3.8
	Min/Max	1.4/1.9	2.1/3.0	2.9/4.1	3.8/5.2	4.8/6.4	5.4/7.3	5.5/6.9	4.5/6.0	3.5/4.6	2.4/3.6	1.3/2.1	1.2/1.5	3.6/3.9
Latitude -15	Average	2.2	3.1	3.9	5.0	5.6	6.0	6.1	5.6	4.7	3.6	2.2	1.7	4.2
	Min/Max	1.8/2.7	2.5/4.2	3.3/5.0	3.9/5.8	4.8/6.6	5.3/7.2	5.4/6.8	4.7/6.5	4.0/5.4	3.0/4.9	1.5/3.0	1.3/2.2	3.9/4.4
Latitude	Average	2.4	3.3	4.0	4.9	5.3	5.5	5.6	5.3	4.8	3.8	2.4	1.9	4.1
	Min/Max	1.8/3.0	2.6/4.6	3.3/5.2	3.8/5.7	4.5/6.1	4.8/6.6	5.0/6.3	4.4/6.2	4.0/5.5	3.1/5.3	1.6/3.3	1.4/2.5	3.9/4.4
Latitude +15	Average	2.5	3.3	3.9	4.5	4.7	4.8	4.9	4.9	4.6	3.8	2.4	2.0	3.9
	Min/Max	1.9/3.2	2.6/4.8	3.2/5.1	3.5/5.3	4.0/5.4	4.2/5.7	4.4/5.5	4.0/5.7	3.8/5.3	3.1/5.4	1.5/3.5	1.4/2.7	3.6/4.2
90	Average	2.3	2.9	3.0	3.0	2.7	2.6	2.7	3.0	3.2	3.1	2.1	1.8	2.7
	Min/Max	1.7/3.0	2.3/4.4	2.4/4.0	2.3/3.5	2.4/3.0	2.3/2.9	2.5/2.9	2.5/3.4	2.7/3.8	2.4/4.4	1.2/3.1	1.2/2.6	2.5/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.0	3.1	4.2	5.9	7.0	7.8	7.8	6.8	5.4	3.7	2.1	1.6	4.8
	Min/Max	1.6/2.5	2.4/4.1	3.5/5.6	4.4/6.8	5.6/8.7	6.6/9.6	6.8/9.2	5.4/8.3	4.3/6.3	3.0/5.3	1.4/2.8	1.2/2.0	4.5/5.1
Latitude -15	Average	2.5	3.6	4.7	6.2	7.2	7.8	7.9	7.1	5.9	4.3	2.5	1.9	5.1
	Min/Max	1.9/3.2	2.8/5.0	3.8/6.3	4.6/7.3	5.7/8.9	6.5/9.7	6.8/9.3	5.6/8.7	4.7/7.0	3.4/6.3	1.6/3.5	1.4/2.5	4.8/5.6
Latitude	Average	2.6	3.8	4.7	6.1	6.9	7.5	7.6	7.0	5.9	4.5	2.6	2.0	5.1
	Min/Max	1.9/3.5	2.8/5.3	3.8/6.5	4.5/7.3	5.5/8.6	6.3/9.3	6.6/9.0	5.4/8.6	4.7/7.1	3.5/6.5	1.6/3.8	1.4/2.8	4.8/5.6
Latitude +15	Average	2.7	3.8	4.6	5.9	6.5	7.0	7.1	6.6	5.8	4.5	2.7	2.1	4.9
	Min/Max	2.0/3.6	2.9/5.5	3.7/6.4	4.3/6.9	5.1/8.1	5.8/8.7	6.2/8.4	5.1/8.2	4.5/6.9	3.5/6.6	1.6/4.0	1.4/2.9	4.6/5.4

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

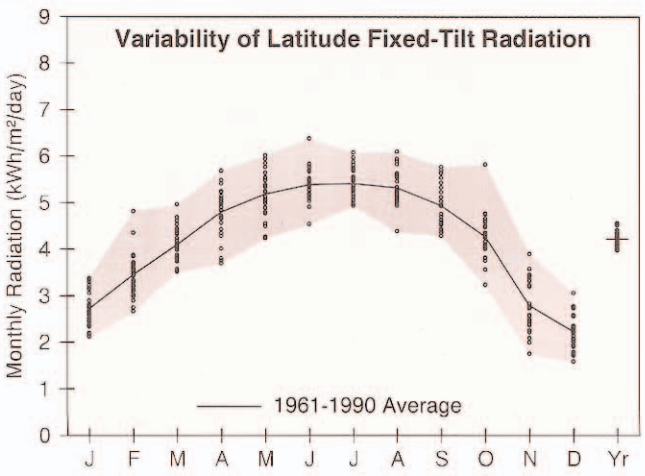
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	2.8	3.8	4.7	6.2	7.3	8.0	8.0	7.2	6.0	4.5	2.7	2.1	5.3
	Min/Max	2.0/3.6	2.9/5.5	3.8/6.5	4.6/7.3	5.7/9.0	6.7/9.9	7.0/9.5	5.6/8.8	4.7/7.1	3.5/6.6	1.6/4.0	1.4/3.0	4.9/5.7

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.2	1.6	1.9	2.7	3.2	3.6	3.6	3.1	2.7	2.2	1.2	0.9	2.3
	Min/Max	0.4/2.1	0.9/2.6	1.3/3.3	1.5/3.5	2.2/4.5	2.8/5.1	2.7/4.8	2.0/4.3	1.8/3.4	1.5/3.7	0.4/2.2	0.3/1.5	2.1/2.7
1-Axis, N-S Horiz Axis	Average	0.8	1.4	2.1	3.3	4.1	4.7	4.7	4.1	3.2	2.1	0.9	0.5	2.7
	Min/Max	0.3/1.4	0.7/2.2	1.4/3.5	2.0/4.4	2.7/6.0	3.5/6.7	3.6/6.3	2.6/5.7	2.1/4.1	1.3/3.6	0.3/1.7	0.2/0.9	2.3/3.0
1-Axis, N-S Tilt=Latitude	Average	1.3	1.9	2.5	3.6	4.0	4.4	4.5	4.2	3.6	2.7	1.4	0.9	2.9
	Min/Max	0.4/2.2	1.0/3.0	1.7/4.3	2.1/4.7	2.7/5.9	3.4/6.3	3.5/6.0	2.6/5.8	2.4/4.6	1.8/4.7	0.4/2.5	0.3/1.6	2.6/3.3
2-Axis	Average	1.3	2.0	2.5	3.6	4.3	4.8	4.8	4.3	3.6	2.8	1.4	1.0	3.0
	Min/Max	0.4/2.4	1.1/3.1	1.7/4.3	2.1/4.8	2.8/6.2	3.7/6.8	3.7/6.5	2.7/6.0	2.4/4.6	1.8/4.7	0.4/2.6	0.3/1.7	2.7/3.5

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.0	-2.7	2.9	8.7	14.4	19.8	22.2	21.3	17.7	11.6	5.9	-0.6	9.8
Daily Minimum Temp	-8.0	-7.1	-2.1	2.9	8.5	13.8	16.3	15.7	12.3	6.4	1.7	-4.2	4.7
Daily Maximum Temp	-0.1	1.7	7.9	14.4	20.3	25.7	28.0	26.9	23.1	16.7	10.0	3.0	14.8
Record Minimum Temp	-28.3	-26.1	-20.6	-12.2	-3.9	-0.6	5.0	3.3	0.0	-7.2	-16.1	-26.1	-28.3
Record Maximum Temp	22.8	20.6	28.3	31.1	33.3	40.0	39.4	38.9	38.3	32.2	27.8	25.0	40.0
HDD, Base 18.3°C	692	588	477	290	139	22	0	6	55	215	373	587	3445
CDD, Base 18.3°C	0	0	0	0	18	66	121	99	37	4	0	0	345
Relative Humidity (%)	73	73	70	66	67	69	70	73	74	71	72	74	71
Wind Speed (m/s)	5.5	5.1	5.3	5.0	4.3	4.1	3.8	3.6	3.9	4.3	5.0	5.2	4.6



Columbus, OH

WBAN NO. 14821

LATITUDE: 40.00° N
LONGITUDE: 82.88° W
ELEVATION: 254 meters
MEAN PRESSURE: 988 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.8	2.5	3.5	4.6	5.5	6.0	5.9	5.3	4.3	3.1	1.9	1.5	3.8
	Min/Max	1.5/2.1	2.2/3.2	3.1/4.0	3.7/5.3	4.6/6.4	5.1/7.1	5.4/6.5	4.5/5.9	3.8/4.8	2.6/4.0	1.4/2.3	1.2/1.7	3.6/4.1
Latitude -15	Average	2.5	3.2	4.0	4.9	5.5	5.9	5.8	5.5	4.9	4.0	2.6	2.0	4.2
	Min/Max	2.0/3.0	2.6/4.4	3.5/4.8	3.8/5.8	4.5/6.4	4.9/6.9	5.3/6.5	4.6/6.3	4.3/5.7	3.1/5.4	1.7/3.5	1.5/2.7	4.0/4.6
Latitude	Average	2.7	3.4	4.1	4.8	5.2	5.4	5.4	5.3	4.9	4.3	2.8	2.2	4.2
	Min/Max	2.1/3.4	2.7/4.8	3.5/5.0	3.7/5.7	4.2/6.0	4.6/6.4	4.9/6.1	4.4/6.1	4.3/5.8	3.2/5.8	1.8/3.9	1.6/3.1	4.0/4.6
Latitude +15	Average	2.9	3.5	4.0	4.4	4.6	4.7	4.8	4.8	4.7	4.3	2.9	2.3	4.0
	Min/Max	2.2/3.6	2.7/5.1	3.4/4.9	3.4/5.3	3.8/5.3	4.0/5.5	4.3/5.3	4.0/5.6	4.1/5.5	3.2/5.9	1.8/4.1	1.6/3.3	3.7/4.3
90	Average	2.6	3.0	3.0	2.8	2.6	2.4	2.5	2.9	3.3	3.4	2.5	2.1	2.8
	Min/Max	1.9/3.5	2.2/4.7	2.5/3.7	2.2/3.3	2.2/2.9	2.2/2.7	2.4/2.8	2.4/3.3	2.9/3.9	2.5/4.8	1.4/3.7	1.4/3.1	2.6/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.3	3.3	4.4	5.8	6.9	7.6	7.5	6.8	5.7	4.3	2.4	1.8	4.9
	Min/Max	1.9/2.9	2.5/4.5	3.7/5.4	4.3/7.2	5.4/8.6	6.3/9.3	6.6/8.6	5.5/8.1	4.8/6.7	3.1/5.8	1.5/3.3	1.4/2.5	4.6/5.4
Latitude -15	Average	2.8	3.8	4.8	6.1	7.0	7.5	7.5	7.1	6.2	4.9	2.9	2.3	5.3
	Min/Max	2.2/3.6	2.8/5.4	4.0/6.0	4.4/7.7	5.4/8.7	6.2/9.3	6.6/8.7	5.6/8.4	5.2/7.4	3.5/6.9	1.8/4.2	1.6/3.2	4.9/5.8
Latitude	Average	3.1	4.0	4.9	6.0	6.8	7.2	7.2	6.9	6.2	5.1	3.1	2.5	5.3
	Min/Max	2.3/3.9	2.9/5.8	4.1/6.2	4.3/7.6	5.2/8.4	5.9/8.9	6.4/8.4	5.4/8.3	5.2/7.5	3.7/7.3	1.8/4.5	1.7/3.5	4.9/5.8
Latitude +15	Average	3.2	4.0	4.8	5.8	6.4	6.7	6.8	6.6	6.0	5.1	3.2	2.5	5.1
	Min/Max	2.4/4.1	2.9/5.9	4.0/6.1	4.1/7.3	4.9/7.9	5.6/8.3	5.9/7.9	5.2/7.9	5.1/7.3	3.6/7.3	1.8/4.7	1.7/3.7	4.7/5.6

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.2	4.1	4.9	6.1	7.1	7.7	7.6	7.1	6.2	5.2	3.2	2.6	5.4
	Min/Max	2.4/4.1	2.9/5.9	4.1/6.2	4.5/7.7	5.5/8.8	6.4/9.5	6.7/8.9	5.6/8.5	5.2/7.5	3.7/7.3	1.9/4.7	1.7/3.7	5.1/6.0

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.5	1.8	2.0	2.5	3.0	3.3	3.2	3.0	2.8	2.7	1.6	1.2	2.4
	Min/Max	0.7/2.4	1.0/3.0	1.3/3.1	1.3/3.6	1.8/4.3	2.3/4.8	2.5/4.2	1.9/4.0	2.0/3.7	1.5/4.4	0.7/2.9	0.6/2.2	2.1/2.9
1-Axis, N-S Horiz Axis	Average	1.1	1.6	2.3	3.2	3.9	4.4	4.3	4.0	3.4	2.6	1.2	0.8	2.7
	Min/Max	0.5/1.7	0.9/2.7	1.5/3.4	1.6/4.8	2.4/5.8	3.1/6.2	3.3/5.6	2.6/5.3	2.5/4.5	1.5/4.3	0.5/2.2	0.4/1.4	2.4/3.3
1-Axis, N-S Tilt=Latitude	Average	1.7	2.2	2.7	3.4	3.8	4.1	4.1	4.1	3.8	3.3	1.8	1.3	3.0
	Min/Max	0.7/2.6	1.2/3.6	1.7/4.1	1.7/5.1	2.4/5.6	2.9/5.9	3.1/5.3	2.6/5.4	2.8/5.1	1.9/5.5	0.7/3.2	0.6/2.3	2.6/3.6
2-Axis	Average	1.8	2.2	2.7	3.5	4.1	4.5	4.4	4.2	3.8	3.4	1.9	1.4	3.2
	Min/Max	0.8/2.8	1.2/3.7	1.7/4.1	1.7/5.1	2.5/6.0	3.1/6.4	3.3/5.7	2.7/5.6	2.8/5.1	1.9/5.5	0.8/3.4	0.7/2.5	2.8/3.8

Average Climatic Conditions

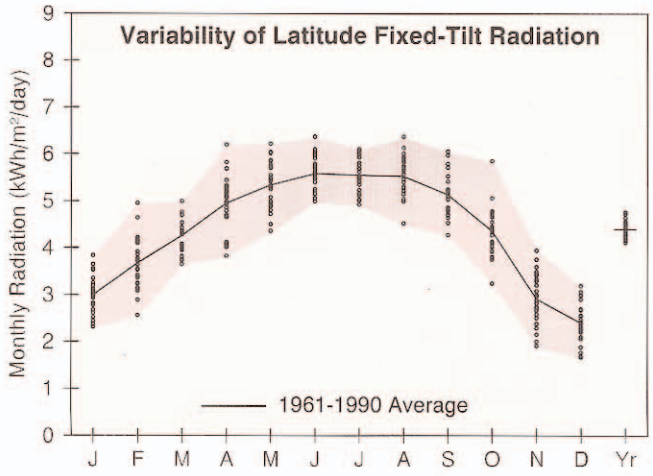
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.1	-1.3	4.9	10.6	16.2	20.7	22.9	21.9	18.6	12.1	6.1	-0.1	10.8
Daily Minimum Temp	-7.5	-6.0	-0.4	4.4	10.1	14.4	17.1	16.0	12.7	6.1	1.3	-4.1	5.3
Daily Maximum Temp	1.2	3.3	10.3	16.7	22.4	26.9	28.7	27.8	24.6	18.1	10.8	4.0	16.2
Record Minimum Temp	-28.3	-25.0	-21.1	-10.0	-3.9	1.7	6.1	3.9	-0.6	-6.7	-15.0	-27.2	-28.3
Record Maximum Temp	23.3	22.8	29.4	31.7	34.4	38.9	37.8	38.3	37.8	32.2	26.7	24.4	38.9
HDD, Base 18.3°C	665	551	415	233	104	13	0	7	45	201	368	570	3171
CDD, Base 18.3°C	0	0	0	0	38	83	143	119	53	6	0	0	443
Relative Humidity (%)	71	69	65	63	67	68	71	73	73	69	72	74	70
Wind Speed (m/s)	4.4	4.2	4.6	4.3	3.7	3.3	3.0	2.8	2.9	3.3	4.0	4.3	3.7

Dayton, OH

WBAN NO. 93815

LATITUDE: 39.90° N
LONGITUDE: 84.22° W
ELEVATION: 306 meters
MEAN PRESSURE: 981 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.9	2.6	3.6	4.7	5.7	6.2	6.0	5.4	4.4	3.2	2.0	1.5	3.9
	Min/Max	1.6/2.3	2.1/3.3	3.2/4.0	3.8/5.7	4.7/6.6	5.6/7.1	5.4/6.6	4.6/6.2	3.8/5.0	2.6/4.0	1.5/2.3	1.2/1.8	3.8/4.2
Latitude -15	Average	2.7	3.4	4.2	5.1	5.7	6.1	6.0	5.7	5.1	4.1	2.7	2.1	4.4
	Min/Max	2.1/3.4	2.5/4.5	3.6/4.8	4.0/6.3	4.7/6.7	5.4/6.9	5.3/6.6	4.7/6.6	4.3/5.9	3.1/5.4	1.8/3.5	1.6/2.8	4.1/4.7
Latitude	Average	3.0	3.7	4.3	4.9	5.3	5.6	5.6	5.5	5.1	4.4	2.9	2.4	4.4
	Min/Max	2.3/3.8	2.6/4.9	3.7/5.0	3.8/6.2	4.4/6.2	5.0/6.4	4.9/6.1	4.5/6.4	4.3/6.1	3.2/5.8	1.9/3.9	1.7/3.2	4.1/4.8
Latitude +15	Average	3.1	3.8	4.1	4.6	4.7	4.8	4.9	5.0	4.9	4.4	3.0	2.5	4.2
	Min/Max	2.4/4.1	2.5/5.2	3.5/4.9	3.5/5.8	3.9/5.5	4.3/5.5	4.3/5.3	4.1/5.8	4.0/5.8	3.2/5.9	1.9/4.2	1.7/3.4	3.9/4.5
90	Average	2.9	3.2	3.1	2.9	2.6	2.5	2.6	3.0	3.4	3.5	2.6	2.3	2.9
	Min/Max	2.1/4.0	2.1/4.8	2.6/3.8	2.3/3.7	2.2/3.0	2.3/2.7	2.4/2.8	2.5/3.4	2.8/4.1	2.5/4.8	1.6/3.7	1.4/3.3	2.7/3.2

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.5	3.5	4.6	6.1	7.2	7.9	7.8	7.1	5.9	4.4	2.6	2.0	5.1
	Min/Max	2.0/3.3	2.5/4.6	3.9/5.4	4.4/7.8	5.7/8.7	6.9/9.5	6.7/8.7	5.9/8.4	4.9/7.2	3.1/5.9	1.7/3.4	1.4/2.6	4.8/5.6
Latitude -15	Average	3.1	4.1	5.1	6.4	7.3	7.9	7.8	7.4	6.5	5.1	3.1	2.4	5.5
	Min/Max	2.4/4.1	2.8/5.6	4.3/6.0	4.6/8.4	5.7/8.9	6.9/9.5	6.7/8.8	6.0/8.8	5.3/7.9	3.6/6.9	1.9/4.3	1.7/3.3	5.1/6.1
Latitude	Average	3.4	4.3	5.1	6.3	7.1	7.6	7.5	7.3	6.5	5.3	3.3	2.6	5.5
	Min/Max	2.5/4.5	2.8/5.9	4.3/6.2	4.5/8.3	5.5/8.6	6.6/9.1	6.4/8.5	5.9/8.7	5.3/8.0	3.7/7.3	2.0/4.6	1.7/3.6	5.1/6.1
Latitude +15	Average	3.5	4.4	5.0	6.0	6.6	7.1	7.0	6.9	6.3	5.3	3.4	2.8	5.4
	Min/Max	2.6/4.7	2.8/6.1	4.2/6.1	4.3/8.0	5.1/8.1	6.1/8.5	6.0/7.9	5.6/8.3	5.1/7.8	3.6/7.3	2.0/4.8	1.8/3.8	4.9/5.9

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

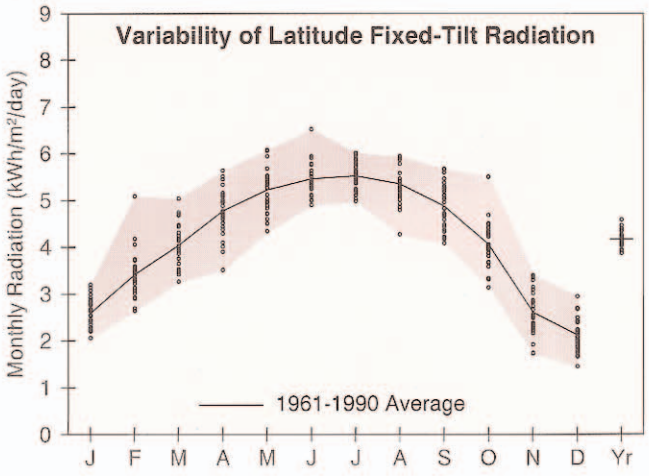
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.6	4.4	5.2	6.4	7.4	8.1	8.0	7.5	6.5	5.3	3.4	2.8	5.7
	Min/Max	2.6/4.7	2.9/6.1	4.3/6.2	4.6/8.4	5.8/9.0	7.0/9.7	6.8/8.9	6.0/8.9	5.3/8.0	3.7/7.3	2.0/4.8	1.8/3.9	5.2/6.3

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.8	2.1	2.2	2.7	3.2	3.6	3.5	3.3	3.1	2.8	1.7	1.4	2.6
	Min/Max	1.0/2.7	0.9/3.3	1.5/3.0	1.4/4.2	2.1/4.5	2.8/5.0	2.7/4.3	2.2/4.4	2.1/4.3	1.6/4.4	0.8/3.0	0.6/2.2	2.2/3.1
1-Axis, N-S Horiz Axis	Average	1.3	1.9	2.5	3.5	4.2	4.8	4.7	4.4	3.7	2.7	1.4	0.9	3.0
	Min/Max	0.7/2.0	0.9/3.0	1.7/3.3	1.8/5.4	2.8/5.9	3.7/6.6	3.6/5.7	3.1/5.8	2.7/5.2	1.5/4.3	0.6/2.3	0.4/1.5	2.6/3.6
1-Axis, N-S Tilt=Latitude	Average	2.0	2.5	2.9	3.7	4.1	4.5	4.5	4.5	4.2	3.5	2.0	1.5	3.3
	Min/Max	1.0/3.0	1.1/4.0	2.0/3.9	1.9/5.8	2.7/5.8	3.5/6.2	3.4/5.4	3.1/5.9	3.0/5.8	2.0/5.5	0.8/3.3	0.7/2.3	2.8/4.0
2-Axis	Average	2.1	2.6	2.9	3.8	4.4	4.9	4.8	4.6	4.2	3.5	2.1	1.6	3.5
	Min/Max	1.1/3.2	1.2/4.1	2.0/3.9	2.0/5.8	2.8/6.1	3.8/6.7	3.7/5.8	3.2/6.1	3.0/5.9	2.0/5.5	0.9/3.5	0.7/2.5	3.0/4.1

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.3	-1.4	4.7	10.7	16.5	21.3	23.4	22.3	18.8	12.3	6.1	-0.2	10.9
Daily Minimum Temp	-7.8	-6.2	-0.6	4.7	10.6	15.1	17.4	16.3	12.8	6.4	1.3	-4.4	5.5
Daily Maximum Temp	1.2	3.3	10.0	16.6	22.5	27.6	29.4	28.3	24.7	18.1	10.7	3.9	16.4
Record Minimum Temp	-31.1	-26.7	-21.7	-9.4	-2.8	4.4	6.7	4.4	0.0	-6.1	-18.9	-28.9	-31.1
Record Maximum Temp	21.7	21.7	27.8	31.7	33.9	38.9	38.9	38.9	38.3	31.7	26.1	22.2	38.9
HDD, Base 18.3°C	672	554	422	230	103	6	0	3	41	197	368	575	3171
CDD, Base 18.3°C	0	0	0	0	46	96	158	128	54	10	0	0	492
Relative Humidity (%)	73	72	69	64	65	66	69	72	72	69	73	76	70
Wind Speed (m/s)	5.0	4.8	5.1	4.9	4.1	3.9	3.5	3.3	3.5	3.9	4.6	4.8	4.3



Mansfield, OH

WBAN NO. 14891

LATITUDE: 40.82° N
LONGITUDE: 82.52° W
ELEVATION: 395 meters
MEAN PRESSURE: 970 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.7	2.5	3.4	4.6	5.5	6.1	6.0	5.3	4.2	3.0	1.8	1.4	3.8
	Min/Max	1.5/1.9	2.1/3.3	3.0/4.0	3.5/5.3	4.7/6.4	5.5/7.3	5.5/6.6	4.4/5.8	3.7/4.8	2.5/3.8	1.4/2.1	1.2/1.7	3.6/4.1
Latitude -15	Average	2.3	3.2	4.0	4.9	5.6	5.9	6.0	5.6	4.8	3.8	2.4	1.9	4.2
	Min/Max	1.9/2.8	2.5/4.6	3.3/4.9	3.6/5.8	4.6/6.5	5.3/7.1	5.4/6.5	4.5/6.2	4.1/5.6	3.0/5.1	1.7/3.0	1.4/2.6	3.9/4.6
Latitude	Average	2.6	3.4	4.0	4.8	5.2	5.5	5.5	5.3	4.9	4.1	2.6	2.1	4.2
	Min/Max	2.1/3.2	2.6/5.1	3.3/5.0	3.5/5.6	4.3/6.1	4.9/6.5	5.0/6.0	4.3/5.9	4.1/5.7	3.1/5.5	1.7/3.4	1.4/2.9	3.9/4.6
Latitude +15	Average	2.7	3.5	3.9	4.4	4.6	4.7	4.8	4.9	4.6	4.1	2.7	2.2	3.9
	Min/Max	2.1/3.4	2.6/5.3	3.1/4.9	3.2/5.3	3.9/5.4	4.3/5.6	4.4/5.3	3.9/5.4	3.9/5.4	3.1/5.6	1.7/3.5	1.4/3.2	3.6/4.3
90	Average	2.5	3.1	3.0	2.9	2.6	2.5	2.6	3.0	3.3	3.3	2.3	2.0	2.8
	Min/Max	1.9/3.1	2.2/4.9	2.4/3.8	2.2/3.5	2.3/3.0	2.3/2.8	2.4/2.8	2.4/3.3	2.7/3.9	2.5/4.6	1.4/3.2	1.2/3.0	2.5/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.2	3.2	4.3	5.8	7.0	7.7	7.7	6.9	5.6	4.0	2.3	1.7	4.9
	Min/Max	1.8/2.6	2.5/4.7	3.3/5.4	4.0/6.9	5.4/8.7	6.6/9.9	6.8/8.7	5.2/7.9	4.6/6.5	3.1/5.5	1.5/2.9	1.3/2.3	4.5/5.5
Latitude -15	Average	2.7	3.8	4.7	6.1	7.1	7.7	7.7	7.1	6.1	4.7	2.7	2.1	5.2
	Min/Max	2.1/3.3	2.8/5.7	3.6/6.1	4.2/7.4	5.5/8.8	6.6/9.9	6.8/8.8	5.3/8.2	4.9/7.2	3.5/6.5	1.8/3.6	1.4/3.0	4.8/5.9
Latitude	Average	2.9	3.9	4.8	6.0	6.8	7.4	7.4	7.0	6.1	4.8	2.9	2.3	5.2
	Min/Max	2.2/3.6	2.9/6.1	3.6/6.2	4.1/7.3	5.3/8.6	6.3/9.5	6.6/8.4	5.2/8.1	4.9/7.3	3.5/6.8	1.8/3.9	1.5/3.3	4.8/5.9
Latitude +15	Average	3.0	4.0	4.7	5.7	6.4	6.9	7.0	6.6	5.9	4.8	3.0	2.4	5.0
	Min/Max	2.3/3.8	2.9/6.3	3.5/6.2	3.9/7.0	4.9/8.1	5.9/8.9	6.2/7.9	4.9/7.7	4.8/7.1	3.5/6.8	1.8/4.0	1.5/3.5	4.6/5.8

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.0	4.0	4.8	6.1	7.2	7.9	7.9	7.2	6.1	4.9	3.0	2.4	5.4
	Min/Max	2.3/3.8	2.9/6.3	3.6/6.3	4.2/7.4	5.6/8.9	6.7/10.1	7.0/8.9	5.3/8.2	5.0/7.3	3.6/6.9	1.8/4.1	1.5/3.6	4.9/6.1

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.4	1.7	2.0	2.5	3.0	3.5	3.4	3.1	2.8	2.5	1.4	1.1	2.4
	Min/Max	0.7/2.2	1.0/3.1	0.9/3.1	1.2/3.5	1.8/4.5	2.6/5.2	2.7/4.2	1.7/4.0	1.9/3.6	1.3/4.0	0.5/2.3	0.3/2.0	2.0/3.0
1-Axis, N-S Horiz Axis	Average	1.0	1.5	2.2	3.2	4.0	4.5	4.5	4.0	3.3	2.4	1.1	0.7	2.7
	Min/Max	0.5/1.5	0.9/2.7	1.0/3.4	1.5/4.4	2.3/6.1	3.4/6.9	3.6/5.7	2.2/5.2	2.3/4.4	1.3/3.9	0.4/1.8	0.2/1.3	2.3/3.5
1-Axis, N-S Tilt=Latitude	Average	1.5	2.1	2.6	3.4	3.9	4.3	4.3	4.1	3.8	3.1	1.6	1.2	3.0
	Min/Max	0.8/2.4	1.2/3.7	1.2/4.1	1.6/4.7	2.3/5.9	3.2/6.5	3.4/5.4	2.3/5.3	2.6/5.0	1.6/5.0	0.6/2.6	0.3/2.1	2.5/3.8
2-Axis	Average	1.6	2.1	2.6	3.4	4.1	4.7	4.6	4.3	3.8	3.1	1.7	1.3	3.1
	Min/Max	0.9/2.6	1.2/3.8	1.2/4.1	1.7/4.8	2.4/6.3	3.5/7.1	3.7/5.8	2.3/5.5	2.6/5.0	1.7/5.0	0.6/2.7	0.4/2.3	2.6/4.0

Average Climatic Conditions

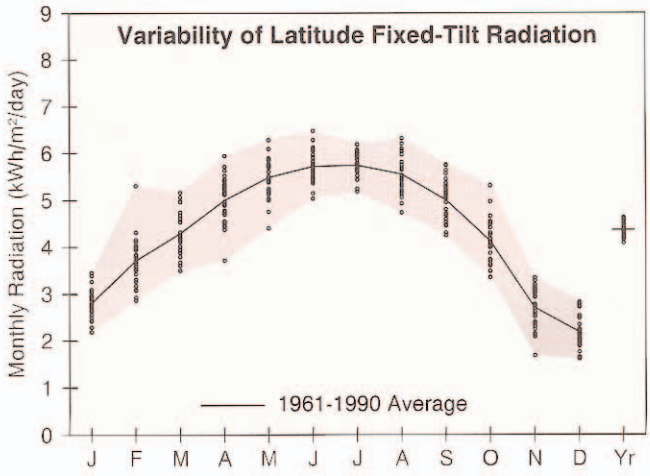
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.2	-2.8	3.1	9.1	14.9	19.9	22.3	21.3	17.7	11.5	5.3	-1.2	9.7
Daily Minimum Temp	-8.4	-7.3	-1.9	3.4	9.1	14.1	16.7	15.8	12.2	6.2	1.1	-5.2	4.7
Daily Maximum Temp	0.1	1.7	8.1	14.8	20.7	25.7	27.8	26.7	23.2	16.8	9.6	2.7	14.8
Record Minimum Temp	-30.0	-23.9	-21.1	-13.3	-3.9	2.8	6.1	4.4	0.6	-6.7	-16.7	-27.2	-30.0
Record Maximum Temp	17.2	19.4	27.8	30.0	33.3	38.3	37.8	36.1	33.9	29.4	25.6	22.8	38.3
HDD, Base 18.3°C	698	591	472	277	127	24	0	11	61	220	390	606	3477
CDD, Base 18.3°C	0	0	0	0	21	71	125	103	43	8	0	0	370
Relative Humidity (%)	76	74	71	66	68	70	71	74	74	70	74	78	72
Wind Speed (m/s)	5.9	5.2	5.6	5.5	4.9	4.2	3.8	3.7	4.0	4.5	5.2	5.8	4.9

Toledo, OH

WBAN NO. 94830

LATITUDE: 41.60° N
LONGITUDE: 83.80° W
ELEVATION: 211 meters
MEAN PRESSURE: 992 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.7	2.6	3.5	4.7	5.8	6.3	6.2	5.4	4.3	3.0	1.8	1.4	3.9
	Min/Max	1.5/2.0	2.2/3.4	3.1/4.0	3.7/5.4	4.7/6.6	5.6/7.2	5.6/6.7	4.8/6.1	3.8/4.8	2.6/3.6	1.4/2.1	1.1/1.6	3.7/4.1
Latitude -15	Average	2.5	3.4	4.2	5.1	5.8	6.2	6.2	5.8	5.0	3.9	2.5	2.0	4.4
	Min/Max	2.0/3.0	2.7/4.8	3.5/5.0	3.8/6.0	4.7/6.7	5.5/7.1	5.6/6.7	5.0/6.6	4.3/5.7	3.2/4.9	1.6/3.0	1.5/2.5	4.1/4.6
Latitude	Average	2.8	3.7	4.3	5.0	5.5	5.7	5.7	5.6	5.0	4.1	2.7	2.2	4.4
	Min/Max	2.2/3.5	2.9/5.3	3.5/5.2	3.7/5.9	4.4/6.3	5.0/6.5	5.2/6.2	4.7/6.3	4.2/5.8	3.3/5.3	1.7/3.3	1.6/2.8	4.1/4.6
Latitude +15	Average	3.0	3.8	4.2	4.6	4.9	5.0	5.0	5.0	4.8	4.1	2.8	2.3	4.1
	Min/Max	2.3/3.7	2.9/5.6	3.4/5.1	3.4/5.5	3.9/5.6	4.4/5.6	4.6/5.4	4.3/5.8	4.0/5.5	3.3/5.4	1.7/3.5	1.6/3.0	3.8/4.4
90	Average	2.8	3.4	3.2	3.1	2.8	2.6	2.8	3.1	3.4	3.4	2.4	2.1	2.9
	Min/Max	2.0/3.6	2.5/5.2	2.6/4.0	2.3/3.6	2.3/3.1	2.5/2.9	2.6/2.9	2.7/3.5	2.8/4.0	2.7/4.4	1.4/3.1	1.5/2.9	2.7/3.2

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.3	3.4	4.6	6.1	7.4	8.1	8.0	7.1	5.7	4.0	2.3	1.8	5.1
	Min/Max	1.8/2.8	2.7/4.8	3.7/5.5	4.3/7.3	5.8/9.1	6.8/9.7	7.0/9.0	6.0/8.2	4.8/6.7	3.2/5.2	1.5/2.9	1.4/2.2	4.8/5.5
Latitude -15	Average	2.9	4.1	5.1	6.5	7.5	8.1	8.1	7.5	6.2	4.7	2.8	2.2	5.5
	Min/Max	2.2/3.6	3.1/5.9	4.0/6.3	4.5/7.8	5.9/9.3	6.7/9.7	7.0/9.1	6.2/8.6	5.2/7.4	3.7/6.3	1.7/3.6	1.6/2.9	5.1/5.9
Latitude	Average	3.2	4.3	5.2	6.4	7.3	7.8	7.8	7.3	6.3	4.9	3.0	2.4	5.5
	Min/Max	2.4/4.0	3.2/6.3	4.0/6.4	4.4/7.8	5.7/9.0	6.4/9.3	6.8/8.7	6.0/8.4	5.2/7.5	3.8/6.6	1.8/3.9	1.7/3.2	5.1/5.9
Latitude +15	Average	3.3	4.4	5.1	6.1	6.8	7.3	7.3	7.0	6.1	4.9	3.1	2.5	5.3
	Min/Max	2.5/4.2	3.2/6.5	3.9/6.4	4.2/7.4	5.3/8.5	6.0/8.7	6.3/8.2	5.7/8.0	5.0/7.3	3.8/6.6	1.8/4.0	1.7/3.3	4.9/5.8

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

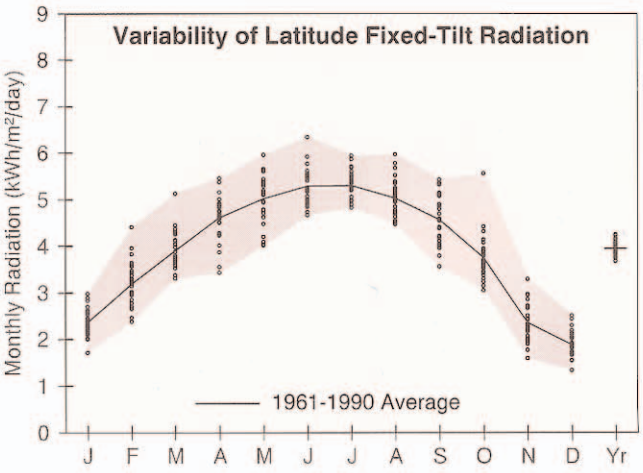
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.3	4.4	5.2	6.5	7.6	8.3	8.2	7.5	6.3	5.0	3.1	2.5	5.7
	Min/Max	2.5/4.2	3.2/6.5	4.0/6.4	4.5/7.8	5.9/9.4	6.9/9.9	7.2/9.2	6.2/8.6	5.2/7.5	3.9/6.6	1.8/4.0	1.7/3.4	5.3/6.1

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.6	2.1	2.2	2.8	3.3	3.8	3.7	3.3	2.9	2.5	1.6	1.2	2.6
	Min/Max	1.1/2.3	1.2/3.3	1.2/3.3	1.3/3.9	2.2/4.7	2.7/4.9	2.7/4.5	2.3/4.2	2.0/3.9	1.6/3.8	0.6/2.3	0.5/1.8	2.2/3.0
1-Axis, N-S Horiz Axis	Average	1.1	1.8	2.5	3.5	4.4	5.0	4.9	4.3	3.4	2.4	1.2	0.8	2.9
	Min/Max	0.8/1.6	1.0/2.8	1.3/3.5	1.6/4.8	2.9/6.3	3.5/6.4	3.6/6.0	3.1/5.5	2.4/4.6	1.5/3.7	0.4/1.7	0.3/1.2	2.6/3.4
1-Axis, N-S Tilt=Latitude	Average	1.8	2.5	3.0	3.8	4.3	4.7	4.7	4.5	3.9	3.1	1.7	1.2	3.3
	Min/Max	1.2/2.5	1.4/3.9	1.6/4.3	1.8/5.2	2.8/6.2	3.3/6.1	3.5/5.8	3.1/5.7	2.8/5.3	2.0/4.8	0.6/2.6	0.5/1.9	2.8/3.7
2-Axis	Average	1.9	2.5	3.0	3.8	4.6	5.1	5.0	4.6	3.9	3.2	1.8	1.4	3.4
	Min/Max	1.3/2.7	1.4/4.0	1.6/4.3	1.8/5.3	3.0/6.6	3.6/6.6	3.7/6.2	3.3/5.8	2.8/5.3	2.0/4.9	0.7/2.7	0.6/2.1	3.0/3.9

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-5.3	-3.8	2.3	8.7	14.8	19.9	22.3	21.1	17.2	10.7	4.4	-2.3	9.2
Daily Minimum Temp	-9.5	-8.3	-2.9	2.4	8.2	13.3	15.9	14.7	10.8	4.4	-0.3	-6.4	3.6
Daily Maximum Temp	-1.0	0.8	7.5	14.9	21.4	26.6	28.6	27.4	23.6	16.9	9.2	1.8	14.8
Record Minimum Temp	-28.9	-25.6	-21.1	-13.3	-3.9	0.0	4.4	1.1	-3.3	-9.4	-16.7	-28.3	-28.9
Record Maximum Temp	16.7	20.0	26.7	31.1	35.0	40.0	39.4	36.7	36.7	32.8	25.6	20.0	40.0
HDD, Base 18.3°C	732	619	496	290	132	18	0	9	61	242	417	639	3655
CDD, Base 18.3°C	0	0	0	0	22	67	125	93	27	4	0	0	339
Relative Humidity (%)	74	73	70	66	66	69	72	76	76	72	76	79	72
Wind Speed (m/s)	5.0	4.7	5.1	4.9	4.2	3.8	3.3	3.1	3.4	3.8	4.5	4.6	4.2



Youngstown, OH

WBAN NO. 14852

LATITUDE: 41.27° N
LONGITUDE: 80.67° W
ELEVATION: 361 meters
MEAN PRESSURE: 974 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.6	2.4	3.3	4.4	5.3	5.9	5.8	5.0	4.0	2.8	1.7	1.3	3.6
	Min/Max	1.4/1.8	2.0/3.0	2.9/4.0	3.5/5.1	4.3/6.2	5.2/7.1	5.3/6.5	4.5/5.8	3.3/4.6	2.5/3.7	1.3/2.0	1.1/1.5	3.4/3.9
Latitude -15	Average	2.2	3.0	3.8	4.7	5.4	5.8	5.7	5.3	4.6	3.6	2.2	1.7	4.0
	Min/Max	1.6/2.7	2.3/4.0	3.3/4.9	3.6/5.6	4.3/6.3	5.1/6.9	5.2/6.4	4.7/6.2	3.6/5.4	3.0/5.1	1.5/3.0	1.3/2.2	3.7/4.3
Latitude	Average	2.4	3.2	3.9	4.6	5.0	5.3	5.3	5.0	4.6	3.8	2.4	1.9	3.9
	Min/Max	1.7/3.0	2.4/4.4	3.3/5.1	3.4/5.5	4.0/6.0	4.7/6.3	4.8/5.9	4.5/6.0	3.6/5.4	3.0/5.6	1.6/3.3	1.3/2.5	3.7/4.3
Latitude +15	Average	2.5	3.2	3.8	4.3	4.5	4.6	4.7	4.6	4.3	3.7	2.4	1.9	3.7
	Min/Max	1.7/3.2	2.3/4.6	3.2/5.1	3.2/5.1	3.6/5.3	4.1/5.5	4.3/5.2	4.1/5.4	3.3/5.2	3.0/5.7	1.6/3.4	1.3/2.7	3.5/4.0
90	Average	2.3	2.8	2.9	2.8	2.6	2.5	2.6	2.8	3.1	3.0	2.1	1.8	2.6
	Min/Max	1.5/3.0	2.0/4.3	2.4/3.9	2.1/3.4	2.2/3.0	2.3/2.8	2.4/2.8	2.5/3.3	2.4/3.7	2.4/4.7	1.3/3.1	1.1/2.5	2.4/2.9

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.0	3.0	4.1	5.6	6.6	7.4	7.4	6.4	5.2	3.7	2.1	1.6	4.6
	Min/Max	1.5/2.5	2.3/4.0	3.5/5.6	4.0/6.8	5.0/8.1	6.2/9.4	6.5/8.6	5.4/7.9	4.0/6.3	3.0/5.5	1.4/2.7	1.2/2.0	4.2/5.0
Latitude -15	Average	2.4	3.5	4.6	5.9	6.7	7.4	7.4	6.7	5.7	4.3	2.5	1.9	4.9
	Min/Max	1.7/3.1	2.5/4.8	3.9/6.3	4.1/7.2	5.0/8.3	6.2/9.4	6.5/8.6	5.6/8.3	4.2/6.9	3.4/6.6	1.6/3.5	1.3/2.6	4.5/5.4
Latitude	Average	2.6	3.6	4.6	5.8	6.5	7.1	7.1	6.5	5.7	4.4	2.6	2.0	4.9
	Min/Max	1.8/3.4	2.6/5.2	3.9/6.5	4.0/7.2	4.8/8.0	5.9/9.0	6.3/8.3	5.5/8.2	4.2/7.0	3.5/6.9	1.6/3.7	1.3/2.8	4.5/5.4
Latitude +15	Average	2.7	3.7	4.5	5.5	6.1	6.6	6.7	6.2	5.5	4.4	2.6	2.1	4.7
	Min/Max	1.8/3.5	2.6/5.3	3.8/6.4	3.8/6.8	4.5/7.5	5.5/8.4	5.9/7.8	5.2/7.8	4.1/6.8	3.4/7.0	1.6/3.8	1.3/3.0	4.3/5.2

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	2.7	3.7	4.6	5.9	6.8	7.6	7.6	6.7	5.7	4.5	2.7	2.1	5.1
	Min/Max	1.8/3.5	2.6/5.3	3.9/6.5	4.1/7.3	5.1/8.4	6.3/9.6	6.6/8.8	5.7/8.3	4.3/7.0	3.5/7.0	1.6/3.9	1.3/3.0	4.6/5.6

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.1	1.5	1.8	2.3	2.8	3.2	3.1	2.7	2.5	2.1	1.2	0.8	2.1
	Min/Max	0.3/1.9	0.7/2.4	1.1/3.3	1.1/3.5	1.5/4.0	2.1/4.9	2.3/4.1	1.9/3.9	1.4/3.4	1.4/4.1	0.5/2.3	0.2/1.6	1.8/2.6
1-Axis, N-S Horiz Axis	Average	0.8	1.3	2.0	3.0	3.6	4.2	4.2	3.6	3.0	2.1	0.9	0.5	2.4
	Min/Max	0.2/1.3	0.6/2.1	1.2/3.6	1.5/4.4	2.0/5.1	2.8/6.4	3.1/5.5	2.4/5.2	1.6/4.1	1.3/4.0	0.4/1.6	0.2/1.0	2.0/3.0
1-Axis, N-S Tilt=Latitude	Average	1.2	1.8	2.4	3.2	3.6	4.0	4.0	3.7	3.4	2.7	1.3	0.9	2.7
	Min/Max	0.3/2.1	0.9/2.9	1.5/4.4	1.6/4.7	2.0/5.0	2.6/6.1	3.0/5.3	2.5/5.3	1.9/4.7	1.7/5.1	0.6/2.5	0.3/1.7	2.2/3.2
2-Axis	Average	1.3	1.8	2.4	3.2	3.8	4.3	4.3	3.8	3.4	2.7	1.4	0.9	2.8
	Min/Max	0.4/2.2	0.9/3.0	1.5/4.4	1.6/4.8	2.1/5.3	2.8/6.6	3.2/5.7	2.6/5.5	1.9/4.7	1.7/5.2	0.6/2.6	0.3/1.8	2.3/3.4

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.7	-3.4	2.4	8.5	14.2	19.0	21.3	20.4	16.8	10.7	5.0	-1.4	9.1
Daily Minimum Temp	-8.7	-7.8	-2.6	2.7	7.9	12.7	15.1	14.4	10.9	5.3	0.9	-5.1	3.8
Daily Maximum Temp	-0.7	1.1	7.4	14.3	20.4	25.2	27.4	26.4	22.6	16.1	9.1	2.2	14.3
Record Minimum Temp	-28.9	-25.6	-23.3	-11.7	-4.4	-1.1	5.6	0.0	-1.7	-6.7	-17.2	-24.4	-28.9
Record Maximum Temp	21.7	19.4	27.8	31.1	33.3	37.2	37.8	36.1	37.2	30.6	26.7	24.4	37.8
HDD, Base 18.3°C	713	608	494	295	149	34	4	12	72	242	400	612	3636
CDD, Base 18.3°C	0	0	0	0	19	54	96	78	25	4	0	0	276
Relative Humidity (%)	75	73	70	65	68	71	72	75	76	73	75	78	72
Wind Speed (m/s)	5.2	4.9	5.1	4.8	4.2	3.7	3.4	3.3	3.6	4.1	4.7	5.0	4.3