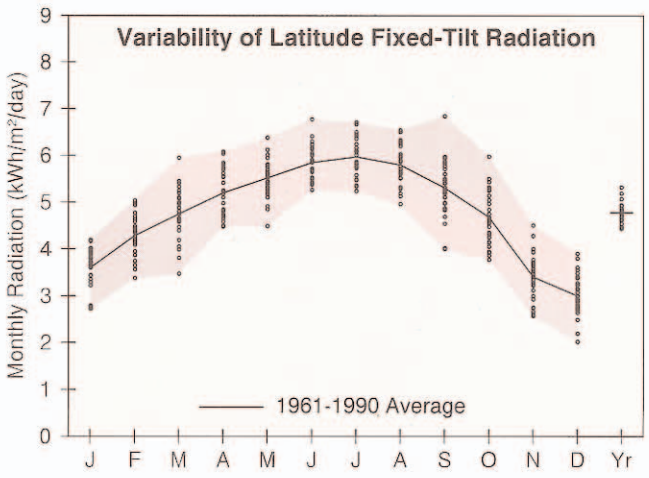


Des Moines, IA

WBAN NO. 14933

LATITUDE: 41.53° N
LONGITUDE: 93.65° W
ELEVATION: 294 meters
MEAN PRESSURE: 982 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	2.0	2.8	3.8	4.9	5.8	6.5	6.5	5.7	4.4	3.2	2.1	1.7	4.1
	Min/Max	1.7/2.2	2.5/3.2	3.0/4.4	4.3/5.6	4.8/6.7	5.8/7.5	5.8/7.3	4.9/6.3	3.6/5.5	2.8/3.9	1.7/2.4	1.4/2.0	3.9/4.5
Latitude -15	Average	3.2	3.9	4.6	5.3	5.9	6.4	6.5	6.0	5.2	4.4	3.1	2.6	4.8
	Min/Max	2.4/3.6	3.2/4.6	3.4/5.7	4.6/6.2	4.8/6.8	5.7/7.4	5.7/7.3	5.2/6.8	4.0/6.7	3.6/5.5	2.4/4.0	1.9/3.3	4.4/5.3
Latitude	Average	3.6	4.3	4.7	5.2	5.5	5.8	6.0	5.8	5.3	4.7	3.4	3.0	4.8
	Min/Max	2.7/4.2	3.4/5.0	3.5/5.9	4.5/6.1	4.5/6.4	5.3/6.8	5.2/6.7	5.0/6.5	4.0/6.8	3.8/6.0	2.6/4.5	2.0/3.9	4.4/5.3
Latitude +15	Average	3.9	4.4	4.7	4.8	4.9	5.1	5.2	5.3	5.1	4.7	3.6	3.2	4.6
	Min/Max	2.8/4.6	3.5/5.2	3.3/5.9	4.1/5.6	4.0/5.6	4.6/5.8	4.6/5.8	4.5/5.9	3.8/6.6	3.8/6.1	2.6/4.8	2.1/4.3	4.2/5.1
90	Average	3.7	4.0	3.6	3.2	2.8	2.7	2.8	3.2	3.6	3.9	3.2	3.1	3.3
	Min/Max	2.6/4.4	3.0/4.8	2.5/4.5	2.7/3.6	2.4/3.1	2.5/2.9	2.5/3.0	2.8/3.6	2.7/4.7	3.0/5.1	2.4/4.4	1.9/4.2	3.0/3.6

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	3.0	4.0	5.1	6.5	7.6	8.6	8.6	7.7	6.2	4.7	2.9	2.4	5.6
	Min/Max	2.2/3.4	3.1/4.8	3.7/6.5	5.4/7.8	6.0/9.1	7.2/10.3	7.3/10.1	6.4/8.8	4.5/8.3	3.7/6.1	2.3/3.9	1.7/3.1	5.2/6.4
Latitude -15	Average	3.8	4.9	5.8	6.9	7.7	8.6	8.7	8.0	6.8	5.5	3.7	3.1	6.1
	Min/Max	2.8/4.5	3.7/5.9	4.1/7.4	5.7/8.3	6.0/9.4	7.2/10.3	7.4/10.2	6.7/9.2	4.9/9.2	4.3/7.2	2.7/5.0	2.0/4.1	5.6/7.0
Latitude	Average	4.2	5.2	5.9	6.8	7.5	8.2	8.4	7.9	6.8	5.8	4.0	3.4	6.2
	Min/Max	3.0/5.0	3.9/6.3	4.1/7.7	5.6/8.3	5.8/9.1	6.9/9.9	7.1/9.9	6.5/9.1	4.8/9.3	4.4/7.6	2.9/5.4	2.2/4.6	5.7/7.1
Latitude +15	Average	4.4	5.3	5.8	6.5	7.1	7.7	7.9	7.5	6.7	5.8	4.1	3.6	6.0
	Min/Max	3.1/5.3	3.9/6.4	4.0/7.6	5.3/7.9	5.5/8.6	6.4/9.3	6.7/9.3	6.2/8.6	4.7/9.1	4.4/7.7	2.9/5.6	2.3/4.9	5.5/6.9

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	4.5	5.3	5.9	6.9	7.8	8.8	8.9	8.1	6.9	5.8	4.1	3.7	6.4
	Min/Max	3.1/5.3	3.9/6.4	4.1/7.7	5.7/8.4	6.1/9.5	7.3/10.6	7.5/10.4	6.7/9.3	4.9/9.3	4.5/7.7	3.0/5.7	2.3/4.9	5.9/7.3

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	2.6	2.8	2.8	3.1	3.6	4.2	4.3	3.9	3.4	3.2	2.4	2.1	3.2
	Min/Max	1.4/3.3	1.7/3.8	1.6/4.4	2.2/4.4	2.2/5.0	3.0/5.9	3.2/5.5	2.8/4.8	1.9/5.4	2.3/4.7	1.2/3.6	1.0/3.0	2.7/4.0
1-Axis, N-S Horiz Axis	Average	1.8	2.4	3.1	4.0	4.7	5.6	5.7	5.1	4.1	3.2	1.8	1.4	3.6
	Min/Max	1.0/2.3	1.5/3.4	1.7/4.8	2.9/5.7	3.0/6.6	3.8/7.7	4.2/7.4	3.7/6.4	2.3/6.5	2.2/4.7	0.9/2.8	0.6/2.0	3.1/4.5
1-Axis, N-S Tilt=Latitude	Average	2.8	3.3	3.7	4.3	4.7	5.3	5.5	5.3	4.7	4.1	2.7	2.2	4.0
	Min/Max	1.5/3.5	2.0/4.6	2.1/5.8	3.1/6.0	3.0/6.5	3.6/7.3	4.1/7.1	3.8/6.6	2.6/7.4	2.8/6.0	1.3/4.1	1.0/3.2	3.5/5.1
2-Axis	Average	3.0	3.4	3.7	4.4	4.9	5.7	5.9	5.4	4.7	4.1	2.8	2.4	4.2
	Min/Max	1.6/3.8	2.1/4.7	2.1/5.8	3.2/6.1	3.2/6.8	3.9/7.9	4.3/7.6	3.9/6.8	2.6/7.4	2.9/6.0	1.4/4.3	1.1/3.5	3.6/5.3

Average Climatic Conditions

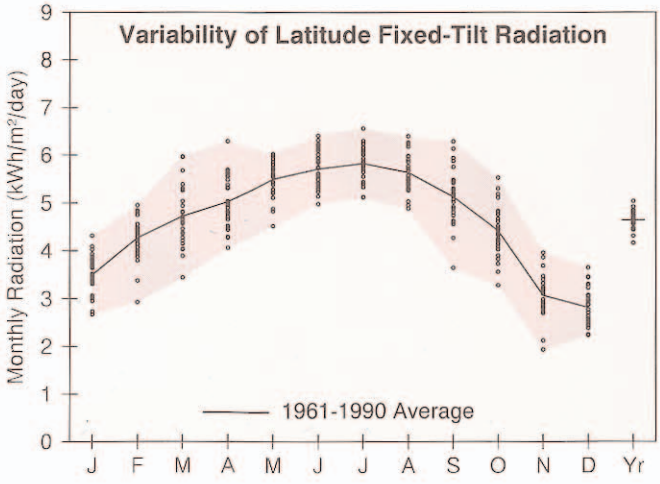
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-7.0	-4.1	2.9	10.5	16.8	22.1	24.8	23.3	18.4	11.9	3.9	-4.2	9.9
Daily Minimum Temp	-11.8	-9.1	-2.4	4.4	10.8	16.2	19.2	17.6	12.5	5.9	-1.2	-8.8	4.4
Daily Maximum Temp	-2.2	0.9	8.3	16.6	22.8	27.9	30.4	29.0	24.2	17.9	8.9	0.3	15.4
Record Minimum Temp	-31.1	-28.9	-30.0	-12.8	-1.1	3.3	8.3	4.4	-3.3	-10.0	-20.0	-30.0	-31.1
Record Maximum Temp	18.3	22.8	32.8	33.9	36.7	39.4	40.6	42.2	38.3	35.0	24.4	20.6	42.2
HDD, Base 18.3°C	786	627	477	238	92	6	0	6	39	207	433	699	3609
CDD, Base 18.3°C	0	0	0	3	45	119	200	159	41	8	0	0	576
Relative Humidity (%)	71	71	68	63	63	65	68	70	71	67	71	75	68
Wind Speed (m/s)	5.1	5.0	5.5	5.5	4.8	4.4	3.9	3.8	4.1	4.4	4.8	4.9	4.7

Mason City, IA

WBAN NO. 14940

LATITUDE: 43.15° N
LONGITUDE: 93.33° W
ELEVATION: 373 meters
MEAN PRESSURE: 972 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	2.7	3.7	4.7	5.8	6.3	6.3	5.5	4.3	3.0	1.8	1.5	4.0
	Min/Max	1.6/2.2	2.2/3.1	3.0/4.3	3.9/5.6	4.8/6.3	5.6/7.1	5.6/7.1	4.8/6.2	3.4/5.0	2.4/3.6	1.5/2.1	1.3/1.8	3.7/4.2
Latitude -15	Average	3.1	3.9	4.6	5.1	5.9	6.2	6.3	5.9	5.1	4.1	2.8	2.5	4.6
	Min/Max	2.4/3.7	2.8/4.4	3.4/5.7	4.2/6.4	4.8/6.4	5.4/7.0	5.5/7.1	5.1/6.7	3.7/6.2	3.1/5.1	1.8/3.5	2.0/3.1	4.2/5.0
Latitude	Average	3.5	4.3	4.7	5.0	5.5	5.7	5.8	5.6	5.1	4.4	3.1	2.8	4.6
	Min/Max	2.7/4.3	2.9/4.9	3.4/6.0	4.1/6.3	4.5/6.0	5.0/6.4	5.1/6.6	4.9/6.4	3.7/6.3	3.3/5.5	1.9/4.0	2.2/3.7	4.2/5.0
Latitude +15	Average	3.8	4.4	4.7	4.6	4.9	4.9	5.1	5.1	4.9	4.4	3.2	3.0	4.4
	Min/Max	2.8/4.7	3.0/5.2	3.3/6.0	3.8/5.8	4.0/5.3	4.3/5.5	4.5/5.7	4.4/5.8	3.4/6.1	3.3/5.6	2.0/4.2	2.3/4.0	3.9/4.8
90	Average	3.6	4.1	3.8	3.2	2.9	2.7	2.9	3.2	3.6	3.7	2.9	2.9	3.3
	Min/Max	2.7/4.4	2.7/4.9	2.6/5.3	2.7/3.9	2.5/3.1	2.5/3.0	2.6/3.1	2.8/3.6	2.5/4.5	2.7/4.7	1.7/3.8	2.2/4.0	2.9/3.5

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	2.8	3.9	5.0	6.2	7.5	8.3	8.4	7.4	5.9	4.3	2.6	2.2	5.4
	Min/Max	2.2/3.4	2.7/4.6	3.5/6.5	4.7/7.9	5.9/8.5	7.1/9.6	7.3/10.0	6.2/8.6	4.1/7.4	3.2/5.4	1.7/3.3	1.7/2.8	4.8/5.9
Latitude -15	Average	3.7	4.8	5.7	6.6	7.7	8.3	8.5	7.7	6.5	5.1	3.3	2.9	5.9
	Min/Max	2.8/4.7	3.1/5.7	3.9/7.5	5.0/8.5	6.0/8.7	7.0/9.6	7.3/10.1	6.5/9.1	4.4/8.3	3.7/6.6	2.0/4.3	2.2/3.8	5.2/6.5
Latitude	Average	4.1	5.1	5.8	6.5	7.5	8.0	8.2	7.6	6.6	5.4	3.5	3.2	6.0
	Min/Max	3.0/5.1	3.2/6.1	3.9/7.7	4.9/8.4	5.8/8.5	6.7/9.2	7.0/9.8	6.4/9.0	4.3/8.4	3.8/6.9	2.1/4.7	2.5/4.2	5.2/6.6
Latitude +15	Average	4.3	5.2	5.8	6.2	7.0	7.5	7.7	7.2	6.4	5.4	3.6	3.3	5.8
	Min/Max	3.1/5.4	3.3/6.2	3.8/7.7	4.7/8.1	5.5/8.0	6.3/8.6	6.6/9.2	6.0/8.6	4.2/8.3	3.8/7.0	2.1/4.8	2.6/4.5	5.1/6.4

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

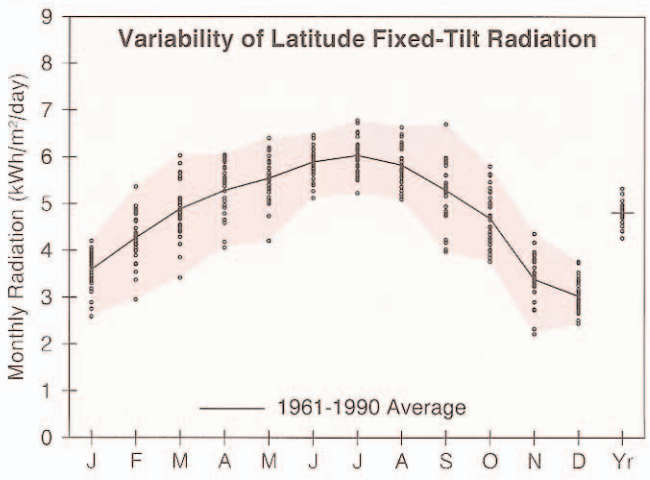
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	4.3	5.2	5.8	6.6	7.8	8.5	8.6	7.8	6.6	5.4	3.6	3.4	6.2
	Min/Max	3.2/5.5	3.3/6.2	3.9/7.7	5.0/8.5	6.1/8.9	7.2/9.9	7.4/10.3	6.6/9.2	4.4/8.4	3.9/7.0	2.1/4.9	2.6/4.6	5.4/6.8

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	2.4	2.6	2.6	2.9	3.5	4.0	4.1	3.6	3.2	3.0	2.0	1.9	3.0
	Min/Max	1.5/3.7	1.0/3.7	1.3/4.3	1.6/4.5	2.3/4.3	3.0/5.1	3.1/5.3	2.7/4.8	1.5/4.6	1.9/4.1	0.8/3.0	1.3/2.7	2.4/3.6
1-Axis, N-S Horiz Axis	Average	1.6	2.3	2.9	3.7	4.7	5.2	5.4	4.8	3.8	2.8	1.5	1.2	3.3
	Min/Max	1.0/2.6	0.9/3.2	1.4/4.8	2.1/5.7	3.0/5.8	3.9/6.7	4.2/7.2	3.5/6.3	1.9/5.5	1.7/3.9	0.5/2.3	0.8/1.7	2.7/4.0
1-Axis, N-S Tilt=Latitude	Average	2.6	3.2	3.5	4.0	4.6	5.0	5.2	4.9	4.4	3.7	2.3	2.0	3.8
	Min/Max	1.6/4.1	1.2/4.4	1.7/5.8	2.3/6.1	3.0/5.7	3.7/6.4	4.0/6.9	3.7/6.5	2.1/6.4	2.3/5.2	0.9/3.4	1.3/2.8	3.0/4.5
2-Axis	Average	2.8	3.2	3.5	4.0	4.9	5.4	5.6	5.1	4.4	3.7	2.4	2.1	3.9
	Min/Max	1.7/4.4	1.3/4.5	1.7/5.8	2.3/6.2	3.2/6.0	4.1/6.9	4.3/7.4	3.8/6.7	2.1/6.4	2.3/5.2	0.9/3.6	1.4/3.0	3.1/4.7

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-10.4	-7.4	-0.3	7.9	14.8	20.2	22.5	21.0	15.9	9.6	1.1	-7.6	7.3
Daily Minimum Temp	-15.4	-12.3	-5.1	2.0	8.2	13.8	16.4	14.8	9.6	3.3	-3.9	-12.1	1.6
Daily Maximum Temp	-5.5	-2.5	4.4	13.9	21.4	26.6	28.7	27.2	22.3	15.8	6.1	-3.1	12.9
Record Minimum Temp	-36.1	-31.1	-32.8	-14.4	-5.0	3.3	6.7	3.9	-3.3	-11.1	-26.7	-32.2	-36.1
Record Maximum Temp	15.0	18.9	28.3	33.9	34.4	39.4	39.4	37.8	36.1	35.0	22.8	18.3	39.4
HDD, Base 18.3°C	892	720	579	312	129	22	6	15	83	276	517	804	4354
CDD, Base 18.3°C	0	0	0	0	21	78	134	97	11	4	0	0	346
Relative Humidity (%)	74	76	76	68	65	67	73	76	76	72	78	79	73
Wind Speed (m/s)	5.9	5.5	5.9	5.9	5.4	4.9	4.0	3.8	4.3	4.9	5.4	5.6	5.1



Sioux City, IA

WBAN NO. 14943

LATITUDE: 42.40° N
LONGITUDE: 96.38° W
ELEVATION: 336 meters
MEAN PRESSURE: 976 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	2.8	3.8	4.9	5.8	6.6	6.5	5.7	4.4	3.2	2.0	1.6	4.1
	Min/Max	1.6/2.1	2.3/3.2	3.0/4.5	3.9/5.5	4.5/6.7	5.7/7.2	5.8/7.3	5.0/6.3	3.6/5.3	2.8/3.8	1.6/2.3	1.4/1.8	3.8/4.4
Latitude -15	Average	3.1	3.9	4.7	5.4	5.9	6.4	6.5	6.1	5.2	4.4	3.0	2.6	4.8
	Min/Max	2.3/3.6	2.8/4.8	3.4/5.8	4.2/6.2	4.5/6.8	5.6/7.1	5.7/7.3	5.3/6.9	4.0/6.5	3.6/5.3	2.1/3.8	2.2/3.2	4.3/5.3
Latitude	Average	3.6	4.3	4.9	5.3	5.5	5.9	6.0	5.8	5.3	4.7	3.4	3.0	4.8
	Min/Max	2.6/4.2	3.0/5.4	3.4/6.0	4.1/6.0	4.2/6.4	5.1/6.5	5.2/6.8	5.1/6.6	4.0/6.7	3.8/5.8	2.2/4.3	2.4/3.8	4.3/5.3
Latitude +15	Average	3.9	4.4	4.8	4.9	4.9	5.1	5.3	5.3	5.1	4.7	3.5	3.2	4.6
	Min/Max	2.7/4.5	3.0/5.6	3.3/5.9	3.7/5.6	3.7/5.7	4.4/5.6	4.6/5.9	4.6/6.0	3.7/6.4	3.7/5.9	2.3/4.6	2.6/4.1	4.0/5.1
90	Average	3.7	4.0	3.8	3.3	2.9	2.7	2.9	3.3	3.7	3.9	3.2	3.1	3.4
	Min/Max	2.6/4.3	2.7/5.0	2.5/4.8	2.5/3.7	2.3/3.2	2.5/2.9	2.5/3.2	2.9/3.7	2.7/4.7	3.0/4.9	2.0/4.2	2.4/3.9	2.9/3.7

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	2.9	4.0	5.3	6.6	7.6	8.6	8.7	7.7	6.2	4.6	2.9	2.4	5.6
	Min/Max	2.1/3.4	2.7/5.0	3.6/6.6	4.8/7.8	5.4/9.1	7.2/9.9	7.6/10.1	6.4/8.9	4.5/8.0	3.8/5.8	1.9/3.7	1.9/2.9	5.0/6.3
Latitude -15	Average	3.8	4.8	6.0	7.0	7.8	8.7	8.9	8.1	6.8	5.5	3.7	3.1	6.2
	Min/Max	2.7/4.4	3.1/6.2	3.9/7.6	5.0/8.4	5.5/9.4	7.2/9.9	7.6/10.3	6.7/9.4	4.9/9.0	4.4/7.0	2.3/4.8	2.5/3.9	5.4/7.0
Latitude	Average	4.2	5.1	6.1	6.9	7.6	8.3	8.5	8.0	6.9	5.8	3.9	3.5	6.2
	Min/Max	2.9/4.9	3.2/6.7	4.0/7.8	4.9/8.3	5.3/9.1	6.8/9.6	7.3/9.9	6.5/9.2	4.9/9.1	4.5/7.3	2.4/5.2	2.7/4.4	5.4/7.0
Latitude +15	Average	4.4	5.2	6.0	6.6	7.1	7.8	8.0	7.6	6.7	5.8	4.1	3.6	6.1
	Min/Max	3.0/5.2	3.3/6.8	3.9/7.7	4.7/8.0	5.0/8.6	6.4/8.9	6.9/9.3	6.2/8.8	4.7/8.9	4.5/7.4	2.4/5.4	2.8/4.7	5.2/6.9

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	4.4	5.2	6.1	7.0	7.9	8.9	9.0	8.1	6.9	5.8	4.1	3.7	6.4
	Min/Max	3.1/5.2	3.3/6.8	4.0/7.8	5.1/8.4	5.6/9.5	7.3/10.2	7.8/10.5	6.7/9.4	4.9/9.1	4.5/7.4	2.5/5.4	2.9/4.7	5.6/7.3

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	2.6	2.8	2.9	3.3	3.6	4.3	4.5	4.0	3.5	3.3	2.4	2.1	3.3
	Min/Max	1.2/3.5	1.1/4.1	1.5/4.3	1.7/4.3	1.9/4.9	3.1/5.3	3.5/5.6	2.8/4.9	1.9/5.2	2.2/4.5	1.0/3.5	1.4/3.1	2.5/4.0
1-Axis, N-S Horiz Axis	Average	1.8	2.4	3.2	4.2	4.8	5.7	5.9	5.2	4.1	3.2	1.8	1.4	3.6
	Min/Max	0.9/2.4	0.9/3.7	1.7/4.8	2.3/5.6	2.5/6.5	4.1/7.1	4.7/7.4	3.6/6.4	2.3/6.3	2.2/4.4	0.7/2.7	0.9/2.0	2.9/4.4
1-Axis, N-S Tilt=Latitude	Average	2.8	3.3	3.9	4.5	4.7	5.4	5.7	5.4	4.7	4.1	2.7	2.3	4.1
	Min/Max	1.3/3.7	1.3/5.0	2.0/5.8	2.4/6.0	2.5/6.4	3.9/6.7	4.5/7.2	3.8/6.7	2.7/7.2	2.8/5.7	1.1/4.0	1.5/3.3	3.2/5.0
2-Axis	Average	3.0	3.4	3.9	4.5	5.0	5.9	6.1	5.6	4.7	4.1	2.8	2.5	4.3
	Min/Max	1.4/4.0	1.3/5.1	2.0/5.8	2.5/6.1	2.7/6.8	4.2/7.3	4.8/7.7	3.9/6.8	2.7/7.2	2.8/5.8	1.2/4.2	1.6/3.6	3.3/5.2

Average Climatic Conditions

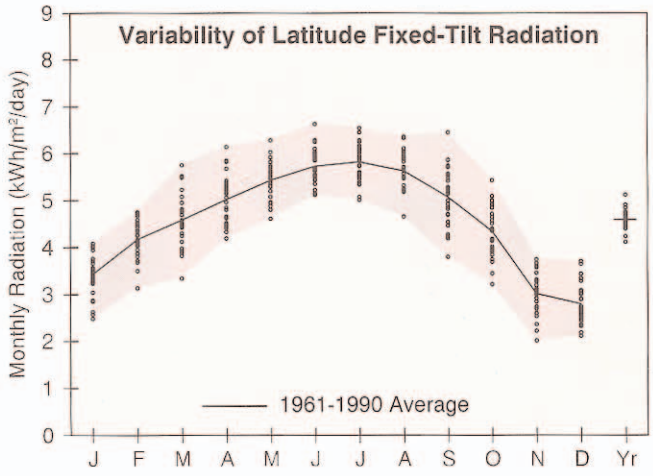
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-7.9	-4.7	2.1	10.1	16.4	21.6	24.3	22.7	17.4	11.0	2.4	-5.7	9.2
Daily Minimum Temp	-13.5	-10.1	-3.5	3.5	10.0	15.3	18.2	16.7	11.1	4.2	-3.1	-10.7	3.2
Daily Maximum Temp	-2.4	0.7	7.7	16.8	22.9	27.8	30.3	28.6	23.8	17.8	8.0	-0.6	15.1
Record Minimum Temp	-32.2	-32.2	-30.0	-18.9	-3.9	3.3	5.6	2.8	-4.4	-10.6	-22.8	-31.1	-32.2
Record Maximum Temp	21.1	21.7	32.8	36.1	38.9	42.2	41.7	40.0	38.9	33.9	27.2	20.0	42.2
HDD, Base 18.3°C	814	644	503	247	95	11	0	7	57	232	477	744	3829
CDD, Base 18.3°C	0	0	0	0	36	107	184	141	31	4	0	0	504
Relative Humidity (%)	72	72	70	62	62	65	69	72	71	66	72	76	69
Wind Speed (m/s)	5.2	5.1	5.7	5.9	5.4	4.8	4.2	4.1	4.4	4.7	5.0	5.1	5.0

Waterloo, IA

WBAN NO. 94910

LATITUDE: 42.55° N
LONGITUDE: 92.40° W
ELEVATION: 265 meters
MEAN PRESSURE: 985 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	2.7	3.6	4.7	5.7	6.4	6.3	5.5	4.3	3.0	1.9	1.5	4.0
	Min/Max	1.5/2.2	2.3/3.0	3.0/4.3	4.1/5.6	4.9/6.5	5.7/7.4	5.5/7.0	4.7/6.1	3.5/5.1	2.4/3.6	1.5/2.1	1.3/1.9	3.7/4.4
Latitude -15	Average	3.0	3.8	4.4	5.1	5.8	6.2	6.3	5.9	5.0	4.1	2.7	2.5	4.6
	Min/Max	2.2/3.5	3.0/4.3	3.3/5.5	4.3/6.2	4.9/6.7	5.6/7.2	5.4/7.1	4.9/6.6	3.8/6.3	3.1/5.0	1.9/3.3	1.9/3.2	4.2/5.1
Latitude	Average	3.4	4.2	4.6	5.0	5.4	5.7	5.8	5.6	5.1	4.3	3.0	2.8	4.6
	Min/Max	2.5/4.1	3.1/4.8	3.3/5.8	4.2/6.1	4.6/6.3	5.1/6.6	5.0/6.5	4.7/6.4	3.8/6.4	3.2/5.4	2.0/3.7	2.1/3.7	4.1/5.1
Latitude +15	Average	3.7	4.3	4.5	4.6	4.8	5.0	5.1	5.1	4.8	4.4	3.1	3.0	4.4
	Min/Max	2.6/4.4	3.2/5.0	3.2/5.7	3.8/5.7	4.1/5.5	4.4/5.7	4.4/5.7	4.2/5.8	3.6/6.2	3.2/5.5	2.0/3.9	2.2/4.0	3.9/4.9
90	Average	3.5	3.9	3.6	3.1	2.8	2.7	2.8	3.2	3.5	3.6	2.8	2.9	3.2
	Min/Max	2.4/4.3	2.8/4.6	2.5/4.4	2.6/3.8	2.5/3.2	2.5/3.0	2.5/3.1	2.7/3.5	2.6/4.5	2.6/4.6	1.7/3.6	2.1/3.9	2.8/3.5

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	2.8	3.9	4.9	6.2	7.4	8.2	8.3	7.4	5.9	4.3	2.6	2.2	5.3
	Min/Max	2.0/3.3	2.8/4.5	3.4/6.2	5.0/7.9	5.9/8.7	7.2/10.1	6.9/9.8	6.0/8.6	4.3/7.6	3.1/5.4	1.7/3.1	1.6/2.9	4.8/6.1
Latitude -15	Average	3.6	4.7	5.5	6.6	7.5	8.3	8.4	7.7	6.5	5.1	3.2	2.9	5.8
	Min/Max	2.5/4.4	3.3/5.5	3.8/7.2	5.3/8.4	6.0/9.0	7.1/10.1	7.0/9.9	6.2/9.0	4.6/8.5	3.6/6.5	2.0/4.0	2.1/3.8	5.1/6.7
Latitude	Average	4.0	5.0	5.6	6.5	7.3	7.9	8.1	7.6	6.5	5.3	3.4	3.2	5.9
	Min/Max	2.8/4.8	3.4/5.8	3.8/7.4	5.2/8.4	5.8/8.7	6.8/9.8	6.7/9.6	6.0/8.9	4.6/8.6	3.7/6.8	2.1/4.4	2.3/4.3	5.1/6.8
Latitude +15	Average	4.2	5.1	5.6	6.2	6.9	7.4	7.6	7.2	6.3	5.3	3.5	3.3	5.7
	Min/Max	2.8/5.1	3.5/5.9	3.7/7.3	4.9/8.1	5.5/8.2	6.4/9.1	6.3/9.0	5.7/8.4	4.4/8.4	3.7/6.9	2.2/4.5	2.4/4.6	5.0/6.6

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	4.2	5.1	5.6	6.6	7.6	8.5	8.6	7.8	6.5	5.3	3.6	3.4	6.1
	Min/Max	2.9/5.1	3.5/5.9	3.8/7.4	5.3/8.5	6.1/9.1	7.3/10.4	7.1/10.1	6.2/9.1	4.6/8.6	3.7/6.9	2.2/4.6	2.4/4.6	5.3/7.0

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	2.3	2.6	2.5	2.9	3.4	3.9	4.0	3.6	3.1	2.9	1.9	1.9	2.9
	Min/Max	1.4/3.3	1.3/3.5	1.1/4.0	1.9/4.5	2.2/4.5	2.9/5.6	2.7/5.2	2.4/4.7	1.7/4.8	1.7/4.1	0.8/2.7	1.2/3.0	2.3/3.7
1-Axis, N-S Horiz Axis	Average	1.6	2.2	2.8	3.7	4.5	5.1	5.3	4.7	3.7	2.8	1.4	1.2	3.3
	Min/Max	1.0/2.3	1.0/3.0	1.2/4.4	2.5/5.8	2.9/5.9	3.8/7.4	3.6/7.0	3.2/6.2	2.0/5.7	1.6/4.0	0.6/2.0	0.7/1.9	2.6/4.2
1-Axis, N-S Tilt=Latitude	Average	2.5	3.1	3.4	3.9	4.4	4.9	5.1	4.9	4.3	3.6	2.2	2.0	3.7
	Min/Max	1.5/3.7	1.5/4.2	1.5/5.3	2.6/6.2	2.8/5.8	3.6/7.0	3.5/6.8	3.3/6.4	2.3/6.6	2.1/5.2	0.9/3.1	1.2/3.1	2.9/4.7
2-Axis	Average	2.7	3.1	3.4	4.0	4.7	5.3	5.5	5.0	4.3	3.6	2.3	2.1	3.8
	Min/Max	1.7/3.9	1.5/4.3	1.5/5.3	2.7/6.3	3.0/6.1	3.9/7.6	3.7/7.3	3.4/6.6	2.3/6.6	2.1/5.2	1.0/3.2	1.3/3.4	3.0/4.9

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-9.7	-6.6	1.2	9.1	15.7	20.6	22.8	21.3	16.6	10.1	2.1	-6.5	8.1
Daily Minimum Temp	-14.8	-11.9	-3.9	2.8	9.3	14.2	16.8	15.0	10.0	3.6	-3.2	-11.3	2.2
Daily Maximum Temp	-4.6	-1.4	6.3	15.2	22.0	26.9	28.8	27.5	23.2	16.6	7.3	-1.7	13.8
Record Minimum Temp	-35.0	-33.9	-36.7	-20.0	-3.9	3.3	5.6	3.3	-5.6	-11.7	-27.2	-32.8	-36.7
Record Maximum Temp	14.4	18.9	30.6	37.8	34.4	39.4	40.6	40.6	36.7	35.0	26.1	18.3	40.6
HDD, Base 18.3°C	868	698	531	278	113	15	6	16	71	261	488	770	4114
CDD, Base 18.3°C	0	0	0	0	31	83	145	108	19	4	0	0	390
Relative Humidity (%)	73	74	73	66	66	68	72	74	74	70	75	77	72
Wind Speed (m/s)	5.2	5.0	5.6	5.6	4.9	4.4	3.8	3.8	4.1	4.5	5.0	5.1	4.7