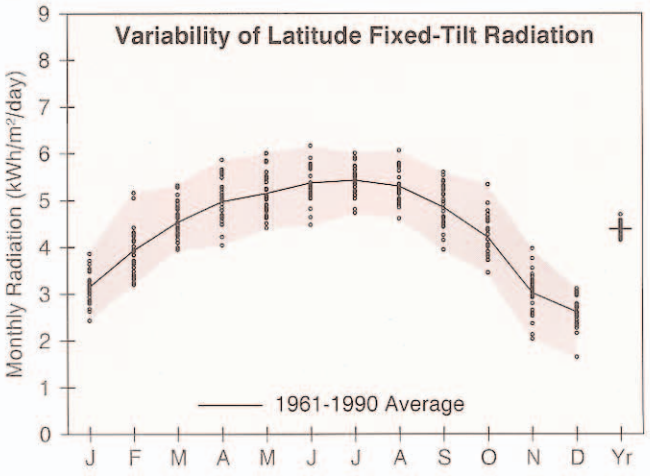


Allentown, PA

WBAN NO. 14737

LATITUDE: 40.65° N
LONGITUDE: 75.43° W
ELEVATION: 117 meters
MEAN PRESSURE: 1003 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±11%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.9	2.7	3.7	4.7	5.4	6.0	5.9	5.2	4.2	3.1	2.0	1.6	3.9
	Min/Max	1.6/2.2	2.3/3.4	3.3/4.2	4.0/5.4	4.7/6.3	5.0/6.8	5.2/6.5	4.6/5.9	3.6/4.7	2.6/3.7	1.6/2.3	1.3/1.7	3.7/4.1
Latitude -15	Average	2.8	3.6	4.4	5.1	5.5	5.8	5.8	5.5	4.8	4.0	2.7	2.3	4.4
	Min/Max	2.2/3.4	3.0/4.7	3.9/5.1	4.2/6.0	4.7/6.4	4.8/6.7	5.1/6.5	4.8/6.3	4.0/5.5	3.3/5.0	1.9/3.5	1.6/2.7	4.2/4.7
Latitude	Average	3.1	3.9	4.5	5.0	5.2	5.4	5.4	5.3	4.9	4.2	3.0	2.6	4.4
	Min/Max	2.4/3.9	3.2/5.2	4.0/5.3	4.0/5.9	4.4/6.0	4.5/6.2	4.7/6.0	4.6/6.1	3.9/5.6	3.5/5.3	2.0/4.0	1.6/3.1	4.2/4.7
Latitude +15	Average	3.3	4.0	4.4	4.6	4.6	4.7	4.8	4.8	4.6	4.2	3.1	2.8	4.2
	Min/Max	2.5/4.2	3.3/5.4	3.8/5.2	3.7/5.5	3.9/5.3	3.9/5.3	4.2/5.3	4.2/5.5	3.7/5.4	3.4/5.4	2.0/4.2	1.7/3.3	3.9/4.5
90	Average	3.1	3.6	3.4	3.0	2.6	2.5	2.6	2.9	3.3	3.4	2.8	2.6	3.0
	Min/Max	2.4/4.0	2.8/5.0	2.8/4.0	2.5/3.6	2.3/2.9	2.2/2.7	2.4/2.8	2.6/3.3	2.6/3.8	2.7/4.4	1.7/3.8	1.4/3.2	2.8/3.2

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±11%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.6	3.7	4.9	6.0	6.8	7.4	7.3	6.7	5.5	4.2	2.6	2.1	5.0
	Min/Max	2.1/3.2	3.0/4.9	4.1/5.8	4.7/7.5	5.6/8.3	5.8/8.7	6.2/8.5	5.8/7.8	4.3/6.4	3.4/5.4	1.8/3.4	1.4/2.5	4.7/5.4
Latitude -15	Average	3.3	4.4	5.4	6.4	6.9	7.4	7.4	6.9	6.0	4.8	3.2	2.7	5.4
	Min/Max	2.5/4.1	3.5/5.9	4.6/6.6	4.9/7.9	5.6/8.5	5.8/8.7	6.2/8.6	5.9/8.2	4.6/7.1	3.9/6.3	2.1/4.3	1.6/3.2	5.0/5.9
Latitude	Average	3.6	4.6	5.5	6.3	6.7	7.1	7.1	6.8	6.0	5.0	3.4	2.9	5.4
	Min/Max	2.7/4.5	3.7/6.3	4.6/6.7	4.8/7.9	5.4/8.3	5.5/8.4	5.9/8.3	5.8/8.0	4.6/7.1	4.0/6.6	2.2/4.7	1.7/3.6	5.0/5.9
Latitude +15	Average	3.8	4.7	5.4	6.0	6.2	6.6	6.6	6.5	5.9	5.1	3.5	3.1	5.3
	Min/Max	2.8/4.8	3.7/6.4	4.5/6.7	4.6/7.6	5.1/7.8	5.1/7.8	5.5/7.7	5.5/7.6	4.5/7.0	4.0/6.7	2.2/4.8	1.8/3.8	4.9/5.8

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.8	4.7	5.6	6.4	7.0	7.5	7.5	7.0	6.0	5.1	3.6	3.1	5.6
	Min/Max	2.9/4.8	3.7/6.4	4.6/6.8	4.9/8.0	5.7/8.6	5.9/8.9	6.3/8.7	6.0/8.2	4.7/7.2	4.0/6.7	2.2/4.9	1.8/3.8	5.2/6.1

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	2.0	2.4	2.5	2.7	2.9	3.2	3.2	3.0	2.7	2.6	1.9	1.7	2.6
	Min/Max	1.4/2.8	1.5/3.6	1.9/3.6	1.6/3.8	2.0/4.2	1.9/4.4	2.2/4.1	2.2/3.9	1.7/3.5	1.7/3.9	0.8/3.0	0.6/2.4	2.2/3.0
1-Axis, N-S Horiz Axis	Average	1.5	2.1	2.8	3.5	3.8	4.2	4.2	3.9	3.2	2.5	1.4	1.1	2.9
	Min/Max	1.0/2.0	1.4/3.2	2.1/4.0	2.1/5.0	2.6/5.5	2.5/5.7	2.8/5.4	2.9/5.0	2.0/4.2	1.6/3.8	0.6/2.3	0.4/1.6	2.5/3.3
1-Axis, N-S Tilt=Latitude	Average	2.2	2.8	3.4	3.7	3.7	3.9	4.0	4.0	3.7	3.3	2.1	1.8	3.2
	Min/Max	1.5/3.0	1.8/4.3	2.5/4.7	2.2/5.3	2.5/5.4	2.4/5.3	2.7/5.2	3.0/5.2	2.3/4.8	2.1/4.9	0.9/3.3	0.7/2.5	2.8/3.7
2-Axis	Average	2.4	2.9	3.4	3.8	3.9	4.3	4.3	4.1	3.7	3.3	2.2	2.0	3.4
	Min/Max	1.6/3.2	1.9/4.4	2.5/4.7	2.3/5.4	2.7/5.7	2.6/5.8	2.9/5.6	3.1/5.3	2.3/4.8	2.1/5.0	1.0/3.5	0.7/2.7	2.9/3.8

Average Climatic Conditions

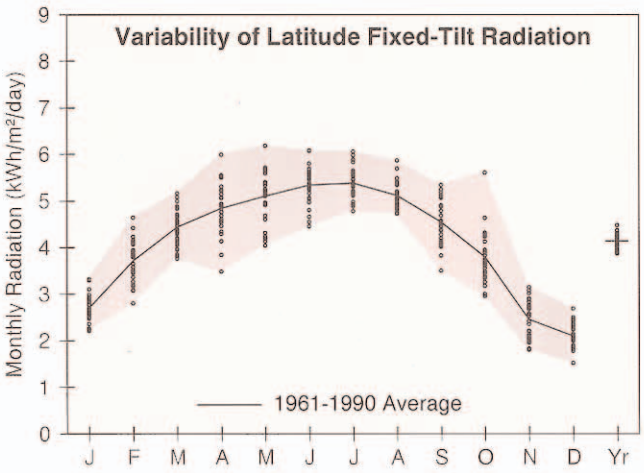
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.0	-1.5	4.1	9.8	15.7	20.8	23.4	22.3	18.2	11.8	6.2	-0.1	10.7
Daily Minimum Temp	-7.3	-6.2	-1.2	3.8	9.6	14.9	17.6	16.7	12.3	5.8	1.2	-4.2	5.3
Daily Maximum Temp	1.3	3.2	9.3	15.8	21.8	26.7	29.2	27.9	23.9	17.7	11.0	4.0	16.0
Record Minimum Temp	-24.4	-21.7	-18.3	-8.9	-2.2	3.9	8.9	5.0	-1.1	-6.1	-11.7	-22.2	-24.4
Record Maximum Temp	22.2	24.4	30.0	33.9	36.1	37.8	40.6	37.8	37.2	32.2	27.2	22.2	40.6
HDD, Base 18.3°C	661	556	441	255	102	6	0	4	46	207	365	572	3214
CDD, Base 18.3°C	0	0	0	0	21	79	157	128	41	4	0	0	429
Relative Humidity (%)	69	67	62	61	66	68	69	72	74	72	70	71	68
Wind Speed (m/s)	4.6	4.6	4.9	4.8	4.1	3.7	3.2	3.2	3.3	3.6	4.3	4.4	4.1

Bradford, PA

WBAN NO. 04751

LATITUDE: 41.80° N
LONGITUDE: 78.63° W
ELEVATION: 600 meters
MEAN PRESSURE: 940 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	2.6	3.6	4.6	5.4	5.9	5.8	5.0	3.9	2.8	1.7	1.4	3.7
	Min/Max	1.5/2.0	2.2/3.0	3.2/4.0	3.5/5.5	4.4/6.4	5.0/6.7	5.2/6.6	4.7/5.7	3.2/4.5	2.4/3.7	1.4/2.0	1.2/1.6	3.5/3.9
Latitude -15	Average	2.4	3.4	4.3	5.0	5.4	5.8	5.8	5.3	4.5	3.6	2.3	1.9	4.2
	Min/Max	2.0/2.9	2.7/4.2	3.7/5.0	3.6/6.1	4.3/6.6	4.8/6.6	5.2/6.5	4.9/6.1	3.5/5.3	2.9/5.2	1.7/2.8	1.5/2.4	3.9/4.5
Latitude	Average	2.7	3.7	4.4	4.8	5.1	5.3	5.4	5.1	4.5	3.8	2.4	2.1	4.1
	Min/Max	2.2/3.3	2.8/4.6	3.8/5.2	3.5/6.0	4.0/6.2	4.4/6.1	4.8/6.1	4.7/5.9	3.5/5.3	3.0/5.6	1.8/3.1	1.5/2.7	3.9/4.5
Latitude +15	Average	2.8	3.8	4.4	4.5	4.5	4.6	4.7	4.6	4.3	3.8	2.5	2.2	3.9
	Min/Max	2.3/3.5	2.8/4.8	3.7/5.1	3.2/5.6	3.6/5.5	3.9/5.3	4.2/5.3	4.3/5.3	3.3/5.1	2.9/5.7	1.8/3.3	1.5/2.8	3.6/4.3
90	Average	2.7	3.5	3.6	3.0	2.7	2.5	2.6	2.9	3.1	3.1	2.2	2.1	2.8
	Min/Max	2.1/3.4	2.5/4.5	2.9/4.2	2.2/3.9	2.2/3.1	2.3/2.8	2.5/2.9	2.6/3.3	2.4/3.7	2.3/4.7	1.5/3.0	1.3/2.7	2.6/3.1

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	3.5	4.7	5.9	6.8	7.5	7.4	6.5	5.1	3.7	2.1	1.7	4.8
	Min/Max	1.8/2.8	2.7/4.3	4.0/5.5	4.0/7.4	5.2/8.4	5.9/8.9	6.3/8.6	5.8/7.7	3.9/6.2	2.8/5.5	1.6/2.7	1.3/2.2	4.4/5.2
Latitude -15	Average	2.8	4.1	5.2	6.2	6.9	7.5	7.5	6.8	5.6	4.3	2.6	2.1	5.1
	Min/Max	2.2/3.5	3.0/5.2	4.4/6.3	4.1/7.9	5.3/8.6	5.8/8.9	6.3/8.6	6.1/8.0	4.2/6.8	3.2/6.6	1.8/3.3	1.5/2.8	4.8/5.6
Latitude	Average	3.0	4.3	5.4	6.1	6.7	7.2	7.2	6.6	5.6	4.5	2.7	2.3	5.1
	Min/Max	2.4/3.8	3.1/5.5	4.4/6.4	4.0/7.9	5.1/8.3	5.6/8.6	6.1/8.3	5.9/7.9	4.2/6.9	3.3/6.9	1.9/3.6	1.5/3.0	4.8/5.7
Latitude +15	Average	3.1	4.4	5.3	5.9	6.3	6.7	6.8	6.3	5.5	4.4	2.8	2.4	5.0
	Min/Max	2.5/4.0	3.2/5.7	4.3/6.4	3.8/7.6	4.7/7.8	5.2/8.0	5.7/7.8	5.6/7.5	4.0/6.7	3.2/7.0	1.9/3.7	1.6/3.1	4.6/5.5

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

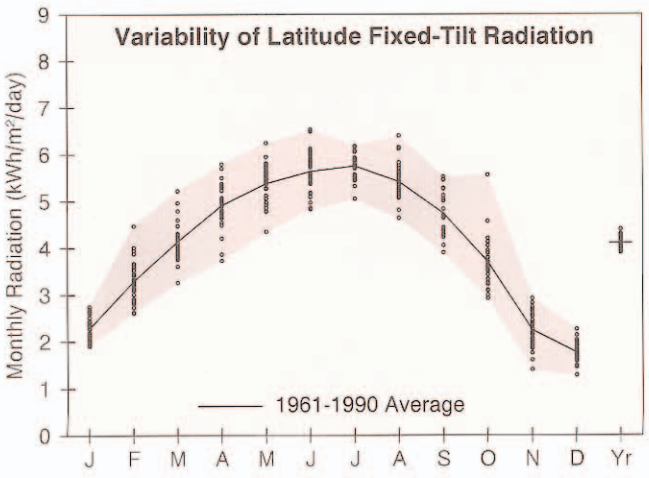
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.2	4.4	5.4	6.2	7.0	7.7	7.6	6.8	5.7	4.5	2.8	2.4	5.3
	Min/Max	2.5/4.0	3.2/5.7	4.4/6.5	4.1/8.0	5.3/8.7	6.0/9.1	6.4/8.8	6.1/8.1	4.2/6.9	3.3/7.0	1.9/3.7	1.6/3.2	4.9/5.8

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	1.8	2.2	2.6	2.9	3.3	3.2	2.8	2.4	2.2	1.2	0.9	2.2
	Min/Max	0.8/2.0	1.0/2.9	1.5/3.3	1.1/3.9	1.6/4.2	1.9/4.4	2.3/4.2	2.3/3.8	1.4/3.4	1.2/4.2	0.4/2.0	0.3/1.5	2.0/2.6
1-Axis, N-S Horiz Axis	Average	0.9	1.5	2.4	3.3	3.8	4.3	4.3	3.7	2.9	2.1	0.9	0.6	2.6
	Min/Max	0.5/1.3	0.9/2.5	1.7/3.6	1.4/4.9	2.1/5.5	2.5/5.8	3.0/5.5	2.9/4.9	1.7/4.0	1.1/4.0	0.4/1.5	0.2/1.0	2.3/3.0
1-Axis, N-S Tilt=Latitude	Average	1.4	2.1	2.9	3.5	3.7	4.1	4.1	3.8	3.3	2.7	1.4	1.0	2.8
	Min/Max	0.9/2.1	1.2/3.4	2.0/4.4	1.5/5.3	2.1/5.4	2.4/5.4	2.9/5.3	3.0/5.1	1.9/4.6	1.4/5.2	0.5/2.2	0.3/1.6	2.6/3.3
2-Axis	Average	1.5	2.2	2.9	3.6	3.9	4.4	4.4	3.9	3.3	2.7	1.5	1.1	3.0
	Min/Max	0.9/2.2	1.2/3.5	2.0/4.4	1.5/5.3	2.2/5.7	2.6/5.9	3.1/5.7	3.1/5.3	1.9/4.6	1.4/5.2	0.5/2.3	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)	-7.1	-6.1	-0.4	5.7	11.5	16.1	18.4	17.6	13.8	8.1	2.3	-4.0	6.3
Daily Minimum Temp	-11.2	-10.9	-5.5	0.0	5.0	9.7	12.2	11.4	7.9	2.7	-1.8	-7.8	0.9
Daily Maximum Temp	-3.0	-1.3	4.6	11.4	17.9	22.4	24.7	23.7	19.7	13.5	6.3	-0.3	11.7
Record Minimum Temp	-32.8	-32.2	-27.8	-14.4	-7.8	-3.3	0.6	-3.3	-3.9	-12.2	-18.9	-28.9	-32.8
Record Maximum Temp	15.6	16.7	25.6	29.4	30.0	31.1	34.4	33.3	29.4	25.6	22.8	20.6	34.4
HDD, Base 18.3°C	787	683	582	378	217	81	38	54	142	317	482	692	4454
CDD, Base 18.3°C	0	0	0	0	5	13	42	31	6	0	0	0	96
Relative Humidity (%)	78	75	73	68	70	75	77	79	81	77	80	81	76
Wind Speed (m/s)	4.4	4.1	4.2	4.1	3.5	3.1	2.6	2.6	2.9	3.4	4.1	4.3	3.6



Erie, PA

WBAN NO. 14860

LATITUDE: 42.08° N
LONGITUDE: 80.18° W
ELEVATION: 225 meters
MEAN PRESSURE: 990 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	3.4	4.6	5.7	6.3	6.2	5.3	4.1	2.7	1.6	1.3	3.8
	Min/Max	1.4/1.8	2.1/3.0	2.9/4.0	3.7/5.3	4.7/6.5	5.4/7.2	5.5/6.7	4.7/6.1	3.5/4.5	2.4/3.7	1.2/1.9	1.1/1.4	3.6/4.0
Latitude -15	Average	2.1	3.1	4.0	5.0	5.7	6.1	6.2	5.6	4.7	3.5	2.1	1.6	4.2
	Min/Max	1.8/2.5	2.5/4.1	3.3/5.0	3.9/5.9	4.7/6.7	5.3/7.1	5.4/6.7	4.9/6.6	3.9/5.4	2.9/5.1	1.4/2.7	1.3/2.0	4.0/4.4
Latitude	Average	2.3	3.3	4.1	4.9	5.4	5.6	5.8	5.4	4.7	3.7	2.2	1.8	4.1
	Min/Max	1.9/2.8	2.6/4.5	3.3/5.2	3.7/5.8	4.3/6.2	4.8/6.5	5.1/6.2	4.6/6.4	3.9/5.5	2.9/5.6	1.4/2.9	1.3/2.3	3.9/4.4
Latitude +15	Average	2.4	3.4	4.0	4.5	4.8	4.9	5.0	4.9	4.5	3.7	2.3	1.8	3.9
	Min/Max	2.0/2.9	2.6/4.7	3.1/5.1	3.4/5.4	3.9/5.5	4.2/5.6	4.4/5.4	4.2/5.8	3.7/5.3	2.8/5.7	1.4/3.0	1.3/2.4	3.6/4.1
90	Average	2.2	3.0	3.2	3.0	2.8	2.6	2.8	3.1	3.2	3.0	2.0	1.6	2.7
	Min/Max	1.8/2.8	2.3/4.3	2.3/4.0	2.4/3.6	2.3/3.1	2.4/2.9	2.6/3.0	2.6/3.6	2.7/3.8	2.2/4.7	1.1/2.7	1.1/2.2	2.5/2.9

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	1.9	3.1	4.4	6.0	7.2	8.0	8.0	6.9	5.4	3.6	1.9	1.5	4.8
	Min/Max	1.6/2.3	2.4/4.1	3.5/5.6	4.2/7.1	5.5/8.7	6.6/9.6	6.8/8.8	5.9/8.4	4.2/6.4	2.8/5.5	1.3/2.5	1.1/1.8	4.6/5.2
Latitude -15	Average	2.3	3.6	4.9	6.3	7.4	8.0	8.1	7.2	5.9	4.2	2.3	1.8	5.2
	Min/Max	1.9/2.9	2.8/5.0	3.8/6.3	4.4/7.6	5.5/8.9	6.6/9.6	6.9/8.9	6.1/8.9	4.6/7.1	3.2/6.6	1.4/3.1	1.3/2.3	4.9/5.6
Latitude	Average	2.5	3.8	4.9	6.2	7.1	7.7	7.8	7.1	5.9	4.3	2.5	1.9	5.2
	Min/Max	2.0/3.1	2.9/5.3	3.8/6.5	4.3/7.6	5.3/8.6	6.3/9.2	6.6/8.6	6.0/8.7	4.6/7.2	3.3/6.9	1.4/3.3	1.3/2.5	4.9/5.6
Latitude +15	Average	2.6	3.8	4.9	6.0	6.7	7.2	7.3	6.7	5.8	4.3	2.5	1.9	5.0
	Min/Max	2.0/3.2	2.9/5.4	3.7/6.4	4.1/7.3	5.0/8.1	5.9/8.6	6.2/8.1	5.6/8.3	4.4/7.0	3.2/7.0	1.4/3.4	1.3/2.6	4.7/5.5

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	2.6	3.8	5.0	6.3	7.5	8.2	8.3	7.3	6.0	4.4	2.5	1.9	5.3
	Min/Max	2.1/3.3	2.9/5.4	3.8/6.5	4.4/7.7	5.6/9.0	6.8/9.8	7.0/9.1	6.1/8.9	4.6/7.2	3.3/7.0	1.4/3.4	1.3/2.6	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	1.0	1.6	2.1	2.8	3.3	3.9	3.9	3.3	2.7	2.1	1.1	0.6	2.4
	Min/Max	0.5/1.5	0.9/2.5	1.4/3.5	1.4/3.8	2.1/4.5	2.7/5.1	2.7/4.7	2.5/4.6	1.8/3.6	1.2/4.2	0.3/1.9	0.1/1.3	2.1/2.8
1-Axis, N-S Horiz Axis	Average	0.7	1.3	2.3	3.5	4.4	5.0	5.1	4.2	3.2	2.0	0.8	0.4	2.7
	Min/Max	0.3/1.0	0.8/2.1	1.5/3.8	1.7/4.8	2.7/5.9	3.5/6.6	3.6/6.0	3.1/5.9	2.0/4.3	1.1/4.0	0.3/1.4	0.1/0.8	2.5/3.2
1-Axis, N-S Tilt=Latitude	Average	1.1	1.9	2.7	3.7	4.3	4.7	4.9	4.4	3.6	2.6	1.2	0.7	3.0
	Min/Max	0.5/1.6	1.0/3.0	1.8/4.6	1.8/5.2	2.6/5.8	3.3/6.3	3.5/5.8	3.2/6.1	2.3/4.9	1.5/5.2	0.4/2.1	0.1/1.3	2.7/3.5
2-Axis	Average	1.1	1.9	2.8	3.8	4.5	5.2	5.2	4.5	3.6	2.7	1.3	0.7	3.1
	Min/Max	0.5/1.7	1.1/3.0	1.8/4.6	1.8/5.2	2.8/6.2	3.6/6.8	3.7/6.3	3.3/6.3	2.3/4.9	1.5/5.3	0.4/2.2	0.1/1.4	2.8/3.7

Average Climatic Conditions

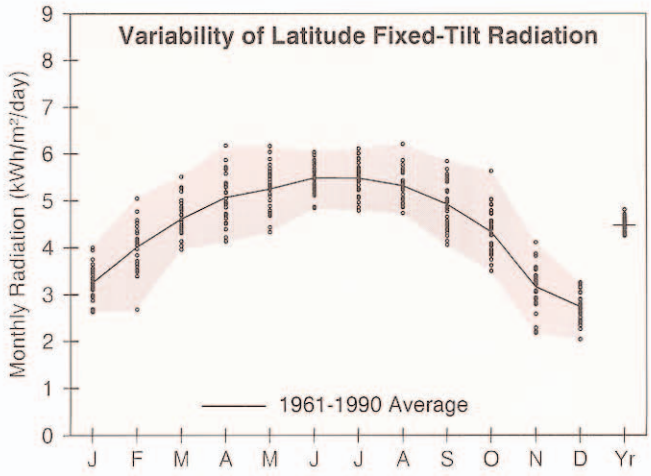
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.7	-3.4	2.2	7.8	13.8	19.2	21.8	21.2	17.8	11.8	6.2	-0.3	9.6
Daily Minimum Temp	-7.7	-7.8	-2.2	3.2	8.8	14.2	17.0	16.6	13.3	7.6	2.8	-3.8	5.2
Daily Maximum Temp	0.3	0.9	6.4	12.5	18.8	24.1	26.6	25.8	22.3	16.1	9.7	3.2	13.9
Record Minimum Temp	-26.7	-27.2	-22.8	-11.1	-3.3	0.0	6.7	2.8	0.6	-4.4	-13.9	-21.1	-27.2
Record Maximum Temp	18.3	19.4	27.2	31.7	32.2	37.8	37.2	33.9	34.4	31.1	26.7	23.9	37.8
HDD, Base 18.3°C	682	610	501	315	149	29	0	7	49	206	363	577	3488
CDD, Base 18.3°C	0	0	0	0	9	54	111	95	33	4	0	0	306
Relative Humidity (%)	74	75	72	68	69	71	72	74	74	71	72	75	72
Wind Speed (m/s)	6.1	5.5	5.6	5.3	4.8	4.5	4.2	4.2	4.6	5.2	6.1	6.2	5.2

Harrisburg, PA

WBAN NO. 14751

LATITUDE: 40.22° N
LONGITUDE: 76.85° W
ELEVATION: 106 meters
MEAN PRESSURE: 1005 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	4.8	5.5	6.1	5.9	5.3	4.3	3.2	2.0	1.6	3.9
	Min/Max	1.7/2.3	2.2/3.3	3.3/4.3	4.1/5.7	4.7/6.4	5.4/6.7	5.2/6.6	4.7/6.0	3.7/4.8	2.8/3.8	1.6/2.4	1.4/1.8	3.7/4.2
Latitude -15	Average	2.9	3.7	4.5	5.2	5.6	6.0	5.9	5.5	4.9	4.1	2.9	2.4	4.5
	Min/Max	2.4/3.5	2.6/4.6	3.9/5.3	4.3/6.3	4.6/6.6	5.2/6.6	5.2/6.6	4.9/6.4	4.1/5.7	3.4/5.2	2.1/3.6	1.9/2.8	4.2/4.8
Latitude	Average	3.2	4.0	4.6	5.1	5.3	5.5	5.5	5.3	4.9	4.3	3.2	2.7	4.5
	Min/Max	2.6/4.0	2.7/5.1	4.0/5.5	4.1/6.2	4.3/6.2	4.8/6.0	4.8/6.1	4.7/6.2	4.1/5.8	3.5/5.6	2.2/4.1	2.0/3.3	4.2/4.8
Latitude +15	Average	3.5	4.1	4.5	4.7	4.7	4.8	4.8	4.8	4.7	4.4	3.3	2.9	4.3
	Min/Max	2.8/4.3	2.7/5.3	3.8/5.4	3.8/5.7	3.8/5.5	4.2/5.2	4.2/5.3	4.3/5.7	3.8/5.6	3.5/5.7	2.2/4.3	2.1/3.5	4.0/4.6
90	Average	3.2	3.6	3.4	3.0	2.6	2.5	2.6	2.9	3.3	3.5	2.9	2.7	3.0
	Min/Max	2.5/4.2	2.3/4.9	2.8/4.2	2.5/3.6	2.3/3.0	2.3/2.7	2.3/2.8	2.6/3.3	2.7/4.0	2.7/4.7	1.9/3.9	1.9/3.3	2.8/3.3

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	3.8	5.0	6.2	7.0	7.6	7.5	6.8	5.6	4.3	2.8	2.2	5.1
	Min/Max	2.2/3.4	2.7/4.9	4.2/6.2	4.8/7.9	5.5/8.5	6.3/8.7	6.3/8.5	6.0/8.1	4.6/6.7	3.6/5.7	1.9/3.6	1.7/2.7	4.8/5.6
Latitude -15	Average	3.4	4.5	5.6	6.6	7.1	7.6	7.5	7.0	6.1	5.0	3.4	2.8	5.6
	Min/Max	2.7/4.3	3.0/5.8	4.7/6.9	5.0/8.4	5.6/8.6	6.3/8.6	6.3/8.6	6.2/8.5	4.9/7.4	4.0/6.7	2.3/4.5	2.0/3.4	5.2/6.1
Latitude	Average	3.7	4.8	5.7	6.5	6.8	7.3	7.2	6.9	6.2	5.2	3.6	3.1	5.6
	Min/Max	2.9/4.7	3.1/6.2	4.7/7.1	4.9/8.3	5.4/8.4	6.0/8.3	6.0/8.3	6.0/8.4	4.9/7.5	4.1/7.1	2.4/4.9	2.2/3.8	5.2/6.1
Latitude +15	Average	3.9	4.9	5.6	6.2	6.4	6.8	6.8	6.5	6.0	5.2	3.7	3.2	5.4
	Min/Max	3.0/5.0	3.1/6.3	4.6/7.0	4.7/8.0	5.0/7.9	5.6/7.8	5.6/7.8	5.7/7.9	4.7/7.3	4.1/7.1	2.4/5.1	2.3/4.0	5.1/6.0

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

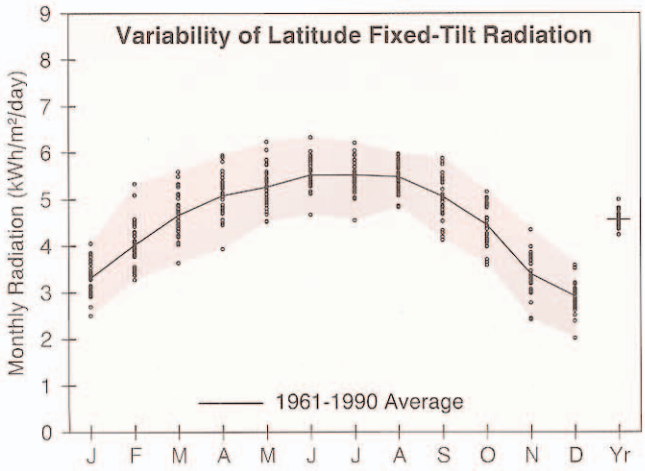
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.9	4.9	5.7	6.6	7.1	7.8	7.6	7.0	6.2	5.3	3.8	3.3	5.8
	Min/Max	3.1/5.0	3.1/6.3	4.7/7.1	5.0/8.4	5.7/8.7	6.4/8.9	6.4/8.7	6.2/8.5	4.9/7.5	4.1/7.1	2.4/5.1	2.3/4.0	5.4/6.3

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	Average	2.1	2.4	2.6	2.9	3.0	3.4	3.3	3.0	2.8	2.7	2.0	1.8	2.7
Horiz Axis	Min/Max	1.5/3.0	0.9/3.4	2.0/3.7	1.6/4.1	1.7/4.2	2.3/4.2	2.4/4.1	2.4/4.3	1.9/3.8	1.7/4.2	0.9/3.1	1.0/2.5	2.4/3.1
1-Axis, N-S	Average	1.5	2.2	3.0	3.7	4.0	4.4	4.3	3.9	3.3	2.7	1.6	1.2	3.0
Horiz Axis	Min/Max	1.1/2.1	0.9/3.1	2.2/4.2	2.2/5.4	2.3/5.6	3.0/5.5	3.1/5.4	3.0/5.5	2.2/4.5	1.8/4.2	0.7/2.5	0.6/1.7	2.7/3.5
1-Axis, N-S	Average	2.3	2.9	3.5	3.9	3.9	4.2	4.1	4.0	3.8	3.4	2.3	1.9	3.4
Tilt=Latitude	Min/Max	1.6/3.3	1.1/4.1	2.7/5.0	2.3/5.7	2.3/5.4	2.8/5.2	2.9/5.2	3.1/5.7	2.5/5.1	2.2/5.3	1.0/3.5	1.0/2.7	3.0/3.9
2-Axis	Average	2.5	3.0	3.5	4.0	4.1	4.5	4.4	4.2	3.8	3.5	2.4	2.1	3.5
	Min/Max	1.7/3.5	1.2/4.2	2.7/5.0	2.3/5.8	2.4/5.8	3.1/5.6	3.2/5.5	3.2/5.8	2.5/5.2	2.2/5.4	1.1/3.7	1.1/2.9	3.1/4.1

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-1.9	-0.4	5.1	10.9	16.6	21.6	24.3	23.4	19.1	12.6	6.9	0.9	11.6
Daily Minimum Temp	-6.0	-4.8	0.0	5.1	10.6	15.9	18.7	17.9	13.6	7.0	2.3	-3.0	6.4
Daily Maximum Temp	2.2	4.0	10.2	16.7	22.5	27.3	29.9	28.8	24.6	18.2	11.4	4.8	16.7
Record Minimum Temp	-22.8	-20.6	-15.0	-7.2	-0.6	4.4	9.4	7.2	-1.1	-5.0	-10.6	-22.2	-22.8
Record Maximum Temp	22.8	23.9	30.0	33.9	36.1	37.8	41.7	38.3	38.9	36.1	28.9	23.9	41.7
HDD, Base 18.3°C	627	524	410	223	82	5	0	0	33	183	343	541	2971
CDD, Base 18.3°C	0	0	0	0	27	103	184	158	56	6	0	0	534
Relative Humidity (%)	64	63	61	59	65	68	69	72	74	70	69	66	67
Wind Speed (m/s)	3.8	3.8	4.1	4.1	3.3	3.0	2.8	2.6	2.7	3.0	3.5	3.6	3.4



Philadelphia, PA

WBAN NO. 13739

LATITUDE: 39.88° N
LONGITUDE: 75.25° W
ELEVATION: 9 meters
MEAN PRESSURE: 1016 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±11%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.0	2.8	3.8	4.8	5.5	6.1	6.0	5.4	4.4	3.2	2.1	1.7	4.0
	Min/Max	1.6/2.3	2.5/3.4	3.2/4.4	3.9/5.5	4.8/6.5	5.2/7.0	5.0/6.7	4.8/5.8	3.7/4.9	2.8/3.6	1.8/2.5	1.4/1.9	3.8/4.3
Latitude -15	Average	2.9	3.7	4.5	5.2	5.6	6.0	5.9	5.7	5.0	4.2	3.0	2.6	4.5
	Min/Max	2.3/3.5	3.1/4.8	3.6/5.4	4.1/6.0	4.8/6.6	5.1/6.9	4.9/6.7	5.0/6.2	4.1/5.8	3.4/4.8	2.3/3.8	1.8/3.1	4.2/4.9
Latitude	Average	3.3	4.0	4.7	5.1	5.3	5.5	5.5	5.5	5.1	4.4	3.4	2.9	4.6
	Min/Max	2.5/4.1	3.3/5.3	3.6/5.6	3.9/5.9	4.5/6.2	4.7/6.3	4.6/6.2	4.8/6.0	4.1/5.9	3.6/5.2	2.4/4.3	2.0/3.6	4.2/5.0
Latitude +15	Average	3.5	4.1	4.6	4.7	4.7	4.8	4.8	5.0	4.8	4.5	3.5	3.1	4.3
	Min/Max	2.6/4.4	3.3/5.6	3.5/5.5	3.6/5.5	4.0/5.5	4.1/5.4	4.0/5.4	4.4/5.4	3.9/5.7	3.6/5.2	2.5/4.6	2.1/3.9	4.0/4.8
90	Average	3.3	3.5	3.4	3.0	2.6	2.5	2.6	3.0	3.4	3.6	3.1	2.9	3.1
	Min/Max	2.3/4.2	2.8/5.1	2.6/4.1	2.4/3.5	2.3/3.0	2.2/2.7	2.3/2.8	2.7/3.2	2.7/4.0	2.8/4.2	2.1/4.1	1.8/3.6	2.8/3.4

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±11%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.8	3.8	5.1	6.2	7.0	7.7	7.5	6.9	5.8	4.4	3.0	2.4	5.2
	Min/Max	2.1/3.5	3.1/5.2	3.9/6.1	4.7/7.6	5.7/8.5	6.1/9.1	5.8/8.6	5.8/7.8	4.7/6.7	3.5/5.2	2.1/3.8	1.7/2.9	4.9/5.7
Latitude -15	Average	3.5	4.5	5.7	6.6	7.1	7.7	7.5	7.2	6.3	5.2	3.6	3.0	5.7
	Min/Max	2.6/4.4	3.6/6.2	4.3/6.9	4.8/8.0	5.8/8.7	6.1/9.1	5.8/8.7	6.0/8.1	5.0/7.4	4.0/6.1	2.5/4.8	2.1/3.7	5.2/6.3
Latitude	Average	3.8	4.8	5.8	6.5	6.8	7.3	7.3	7.1	6.3	5.4	3.9	3.3	5.7
	Min/Max	2.8/4.8	3.8/6.6	4.3/7.0	4.7/8.0	5.6/8.4	5.8/8.7	5.6/8.4	5.8/7.9	5.0/7.5	4.2/6.3	2.7/5.2	2.2/4.1	5.2/6.3
Latitude +15	Average	4.0	4.9	5.7	6.2	6.4	6.8	6.8	6.7	6.2	5.4	4.1	3.5	5.6
	Min/Max	2.9/5.1	3.8/6.8	4.2/6.9	4.5/7.7	5.2/7.9	5.4/8.1	5.2/7.8	5.5/7.6	4.8/7.3	4.1/6.4	2.7/5.4	2.3/4.4	5.1/6.2

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	4.0	4.9	5.8	6.6	7.2	7.8	7.7	7.3	6.4	5.4	4.1	3.5	5.9
	Min/Max	2.9/5.2	3.8/6.8	4.3/7.0	4.8/8.1	5.8/8.8	6.2/9.3	5.9/8.8	6.0/8.1	5.1/7.5	4.2/6.4	2.7/5.4	2.3/4.4	5.4/6.5

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±11%

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	2.8	2.9	3.1	3.5	3.4	3.3	3.0	2.9	2.3	2.0	2.8
	Min/Max	1.5/3.0	1.6/3.8	1.7/3.8	1.5/4.0	2.1/4.3	2.5/4.6	2.0/4.2	2.3/4.0	2.0/3.8	1.9/3.6	1.2/3.4	1.1/2.8	2.5/3.4
1-Axis, N-S Horiz Axis	Average	1.7	2.3	3.1	3.7	4.0	4.6	4.4	4.2	3.6	2.8	1.8	1.4	3.1
	Min/Max	1.0/2.3	1.4/3.5	2.0/4.3	2.0/5.2	2.7/5.7	3.2/5.9	2.7/5.4	2.9/5.1	2.4/4.5	1.9/3.6	0.9/2.7	0.8/1.9	2.8/3.7
1-Axis, N-S Tilt=Latitude	Average	2.5	3.1	3.7	4.0	3.9	4.3	4.2	4.3	4.0	3.6	2.6	2.2	3.5
	Min/Max	1.6/3.3	1.9/4.6	2.3/5.0	2.1/5.5	2.7/5.5	3.0/5.6	2.5/5.2	3.0/5.2	2.7/5.1	2.4/4.5	1.3/3.8	1.2/3.0	3.1/4.2
2-Axis	Average	2.7	3.2	3.7	4.0	4.2	4.7	4.5	4.4	4.0	3.6	2.7	2.4	3.7
	Min/Max	1.7/3.6	2.0/4.7	2.3/5.0	2.2/5.6	2.8/5.8	3.3/6.1	2.7/5.6	3.1/5.4	2.7/5.1	2.4/4.6	1.4/4.0	1.3/3.3	3.3/4.3

Average Climatic Conditions

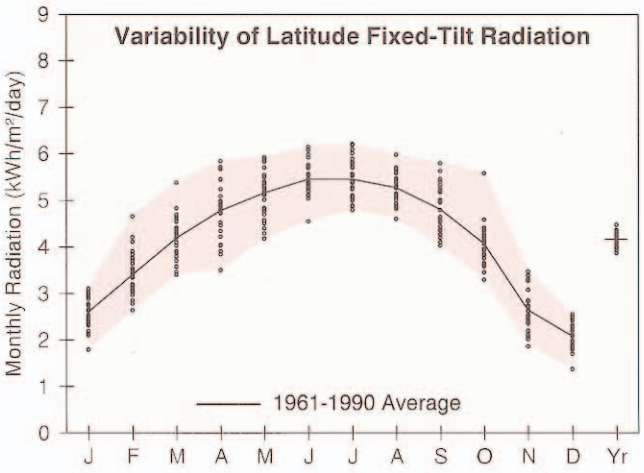
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-0.9	0.6	5.8	11.3	17.2	22.1	24.8	24.2	20.1	13.6	8.0	2.1	12.4
Daily Minimum Temp	-5.1	-4.0	0.7	5.6	11.5	16.6	19.6	19.1	14.8	8.0	3.1	-2.2	7.3
Daily Maximum Temp	3.3	5.0	10.9	17.0	22.8	27.6	30.1	29.2	25.3	19.1	12.8	6.3	17.4
Record Minimum Temp	-21.7	-20.0	-13.9	-7.2	-2.2	6.7	10.6	6.7	1.7	-3.9	-9.4	-17.2	-21.7
Record Maximum Temp	23.3	23.3	30.6	34.4	36.1	37.8	40.0	38.3	37.8	35.6	27.2	22.2	40.0
HDD, Base 18.3°C	596	498	389	210	68	3	0	0	18	157	310	503	2752
CDD, Base 18.3°C	0	0	0	0	32	116	202	181	71	9	0	0	612
Relative Humidity (%)	66	64	62	60	65	68	70	70	72	71	68	68	67
Wind Speed (m/s)	4.6	4.8	5.0	4.8	4.3	3.9	3.6	3.6	3.8	3.9	4.3	4.5	4.2

Pittsburgh, PA

WBAN NO. 94823

LATITUDE: 40.50° N
LONGITUDE: 80.22° W
ELEVATION: 373 meters
MEAN PRESSURE: 973 millibars

STATION TYPE: Primary



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	3.5	4.6	5.5	6.1	5.9	5.2	4.2	3.0	1.8	1.4	3.8
	Min/Max	1.4/2.0	2.2/3.1	3.0/4.2	3.5/5.4	4.5/6.2	5.1/6.8	5.2/6.7	4.7/5.8	3.7/4.9	2.5/3.8	1.5/2.1	1.2/1.6	3.6/4.0
Latitude -15	Average	2.4	3.2	4.1	4.9	5.5	5.9	5.9	5.5	4.8	3.8	2.4	1.9	4.2
	Min/Max	1.7/2.8	2.5/4.2	3.4/5.2	3.7/5.9	4.5/6.3	4.9/6.7	5.2/6.7	4.8/6.2	4.1/5.7	3.1/5.2	1.8/3.1	1.3/2.3	3.9/4.5
Latitude	Average	2.6	3.4	4.2	4.8	5.2	5.4	5.5	5.3	4.8	4.1	2.6	2.1	4.2
	Min/Max	1.8/3.1	2.6/4.7	3.4/5.4	3.5/5.8	4.2/5.9	4.6/6.1	4.8/6.2	4.6/6.0	4.0/5.8	3.3/5.6	1.9/3.5	1.4/2.5	3.9/4.5
Latitude +15	Average	2.7	3.5	4.1	4.4	4.6	4.7	4.8	4.8	4.6	4.1	2.7	2.2	3.9
	Min/Max	1.8/3.3	2.6/4.9	3.3/5.3	3.2/5.4	3.7/5.3	4.0/5.3	4.2/5.4	4.2/5.4	3.8/5.6	3.3/5.7	1.9/3.6	1.4/2.7	3.6/4.2
90	Average	2.5	3.0	3.1	2.9	2.6	2.5	2.6	2.9	3.2	3.3	2.3	2.0	2.7
	Min/Max	1.7/3.2	2.2/4.5	2.5/4.0	2.1/3.5	2.2/3.0	2.2/2.8	2.4/2.9	2.6/3.3	2.7/3.9	2.7/4.6	1.5/3.2	1.1/2.5	2.5/2.9

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	2.2	3.2	4.4	5.7	6.8	7.5	7.4	6.7	5.5	4.0	2.3	1.7	4.8
	Min/Max	1.6/2.6	2.5/4.3	3.6/5.9	4.1/7.3	5.3/8.1	6.0/8.8	6.3/8.6	5.6/7.7	4.5/6.6	3.2/5.6	1.7/3.0	1.2/2.1	4.4/5.3
Latitude -15	Average	2.7	3.7	4.9	6.0	6.9	7.5	7.4	6.9	5.9	4.7	2.8	2.1	5.1
	Min/Max	1.8/3.3	2.8/5.2	3.9/6.6	4.2/7.7	5.3/8.2	5.9/8.8	6.3/8.7	5.7/8.1	4.8/7.2	3.7/6.6	1.9/3.7	1.3/2.6	4.7/5.7
Latitude	Average	2.9	3.9	5.0	6.0	6.6	7.2	7.2	6.8	6.0	4.8	2.9	2.3	5.1
	Min/Max	1.9/3.5	2.9/5.6	4.0/6.8	4.1/7.6	5.1/8.0	5.7/8.4	6.0/8.4	5.6/7.9	4.8/7.3	3.8/6.9	2.0/4.0	1.4/2.8	4.7/5.7
Latitude +15	Average	3.0	4.0	4.9	5.7	6.2	6.7	6.7	6.4	5.8	4.8	3.0	2.3	5.0
	Min/Max	2.0/3.7	2.9/5.7	3.9/6.7	3.8/7.3	4.8/7.5	5.3/7.8	5.6/7.8	5.3/7.5	4.7/7.1	3.8/6.9	2.0/4.2	1.4/3.0	4.5/5.5

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

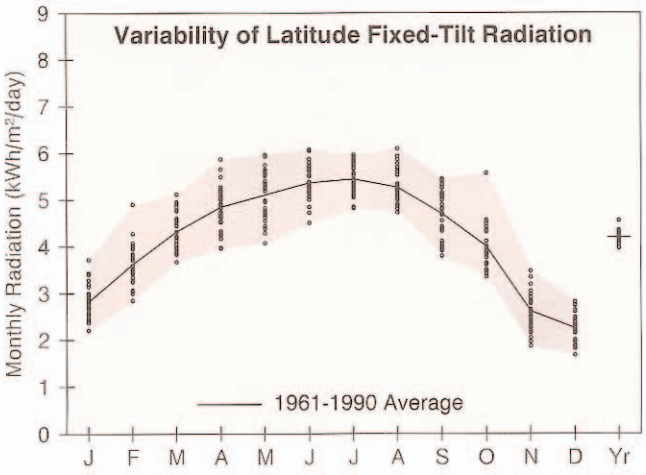
Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.0	4.0	5.0	6.1	7.0	7.7	7.6	6.9	6.0	4.9	3.0	2.4	5.3
	Min/Max	2.0/3.7	2.9/5.7	4.0/6.8	4.2/7.7	5.3/8.3	6.1/8.9	6.4/8.8	5.7/8.1	4.9/7.3	3.9/7.0	2.0/4.2	1.4/3.0	4.8/5.8

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	1.4	1.7	2.0	2.4	2.8	3.1	3.0	2.8	2.6	2.4	1.4	1.0	2.2
	Min/Max	0.6/2.0	0.9/2.8	1.2/3.5	1.2/3.6	1.6/3.9	2.0/4.0	2.1/4.2	1.8/3.6	1.8/3.5	1.6/4.0	0.7/2.4	0.3/1.7	1.9/2.7
1-Axis, N-S Horiz Axis	Average	1.0	1.5	2.2	3.1	3.6	4.1	4.0	3.7	3.1	2.3	1.1	0.7	2.5
	Min/Max	0.4/1.5	0.8/2.4	1.4/3.9	1.5/4.6	2.1/5.1	2.7/5.2	2.8/5.5	2.4/4.7	2.1/4.1	1.6/3.9	0.5/1.8	0.2/1.1	2.2/3.1
1-Axis, N-S Tilt=Latitude	Average	1.5	2.0	2.7	3.3	3.6	3.9	3.8	3.7	3.5	3.0	1.6	1.1	2.8
	Min/Max	0.7/2.2	1.0/3.3	1.7/4.6	1.6/4.9	2.1/5.0	2.5/4.9	2.7/5.2	2.4/4.8	2.4/4.6	2.0/5.0	0.8/2.7	0.3/1.7	2.4/3.4
2-Axis	Average	1.6	2.0	2.7	3.3	3.8	4.2	4.1	3.9	3.5	3.0	1.7	1.2	2.9
	Min/Max	0.8/2.3	1.0/3.4	1.7/4.6	1.6/4.9	2.2/5.3	2.8/5.3	2.9/5.6	2.5/5.0	2.4/4.6	2.0/5.0	0.8/2.8	0.4/1.9	2.5/3.5

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.3	-1.8	4.1	9.8	15.3	19.9	22.3	21.4	17.7	11.3	5.7	-0.3	10.2
Daily Minimum Temp	-7.5	-6.5	-1.2	3.8	9.1	13.8	16.4	15.7	11.9	5.7	1.2	-4.2	4.8
Daily Maximum Temp	0.9	2.7	9.4	15.7	21.4	26.1	28.1	27.1	23.5	16.9	10.2	3.7	15.5
Record Minimum Temp	-27.8	-24.4	-18.3	-10.0	-3.3	1.1	5.6	3.9	-0.6	-8.9	-18.3	-24.4	-27.8
Record Maximum Temp	20.6	20.6	27.8	31.7	32.8	36.7	39.4	37.8	36.1	30.6	27.8	23.3	39.4
HDD, Base 18.3°C	670	564	441	257	119	20	3	8	56	222	378	577	3316
CDD, Base 18.3°C	0	0	0	0	24	68	126	102	37	5	0	0	363
Relative Humidity (%)	70	67	64	60	63	66	69	71	72	68	70	72	68
Wind Speed (m/s)	4.7	4.5	4.7	4.5	3.9	3.5	3.2	3.0	3.2	3.6	4.2	4.6	4.0



Wilkes-Barre, PA

WBAN NO. 14777

LATITUDE: 41.33° N
LONGITUDE: 75.73° W
ELEVATION: 289 meters
MEAN PRESSURE: 983 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±11%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.8	2.5	3.6	4.6	5.4	6.0	5.9	5.2	4.1	2.9	1.8	1.4	3.8
	Min/Max	1.5/2.1	2.1/3.1	3.2/4.0	3.9/5.4	4.4/6.2	5.0/6.7	5.3/6.4	4.7/5.9	3.4/4.6	2.6/3.7	1.5/2.1	1.3/1.6	3.6/4.0
Latitude -15	Average	2.5	3.4	4.2	5.0	5.4	5.8	5.8	5.5	4.7	3.8	2.4	2.0	4.2
	Min/Max	2.0/3.3	2.7/4.4	3.7/4.9	4.1/6.0	4.3/6.3	4.9/6.6	5.2/6.4	4.9/6.3	3.8/5.4	3.2/5.1	1.8/3.1	1.6/2.5	4.0/4.5
Latitude	Average	2.8	3.6	4.3	4.8	5.1	5.4	5.4	5.3	4.7	4.0	2.6	2.2	4.2
	Min/Max	2.2/3.7	2.8/4.9	3.7/5.1	4.0/5.9	4.1/6.0	4.5/6.1	4.8/6.0	4.7/6.1	3.8/5.4	3.3/5.6	1.9/3.5	1.7/2.8	4.0/4.5
Latitude +15	Average	3.0	3.7	4.2	4.5	4.5	4.7	4.8	4.8	4.5	4.0	2.7	2.4	4.0
	Min/Max	2.3/4.0	2.9/5.2	3.5/5.0	3.6/5.4	3.6/5.3	3.9/5.2	4.2/5.2	4.3/5.5	3.6/5.2	3.3/5.7	1.8/3.6	1.7/3.0	3.7/4.3
90	Average	2.8	3.3	3.3	3.0	2.6	2.5	2.6	3.0	3.2	3.3	2.3	2.2	2.8
	Min/Max	2.1/3.9	2.5/4.8	2.6/3.8	2.5/3.6	2.2/3.0	2.3/2.7	2.4/2.8	2.7/3.3	2.6/3.7	2.7/4.7	1.5/3.3	1.5/2.9	2.6/3.1

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±11%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.4	3.4	4.6	5.8	6.7	7.4	7.4	6.6	5.3	3.9	2.3	1.8	4.8
	Min/Max	1.9/3.1	2.6/4.6	4.0/5.6	4.5/7.3	5.1/8.2	5.7/8.8	6.2/8.4	5.9/8.0	4.2/6.2	3.3/5.5	1.7/3.0	1.4/2.2	4.6/5.3
Latitude -15	Average	2.9	4.0	5.1	6.2	6.8	7.4	7.4	6.9	5.8	4.6	2.7	2.3	5.2
	Min/Max	2.3/3.9	3.1/5.6	4.4/6.3	4.7/7.8	5.1/8.4	5.6/8.8	6.2/8.4	6.1/8.4	4.5/6.8	3.7/6.6	1.9/3.7	1.7/2.9	4.9/5.7
Latitude	Average	3.2	4.2	5.2	6.1	6.6	7.1	7.1	6.8	5.8	4.8	2.9	2.5	5.2
	Min/Max	2.4/4.3	3.2/6.0	4.4/6.5	4.7/7.7	4.9/8.1	5.4/8.5	6.0/8.1	6.0/8.2	4.5/6.9	3.9/6.9	2.0/4.0	1.8/3.2	4.9/5.8
Latitude +15	Average	3.3	4.3	5.1	5.8	6.2	6.6	6.7	6.4	5.6	4.8	3.0	2.6	5.0
	Min/Max	2.5/4.6	3.3/6.1	4.3/6.4	4.4/7.4	4.6/7.6	5.0/7.9	5.6/7.6	5.7/7.8	4.3/6.7	3.8/7.0	2.0/4.2	1.8/3.3	4.7/5.6

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.3	4.3	5.2	6.2	6.9	7.6	7.6	7.0	5.8	4.8	3.0	2.6	5.4
	Min/Max	2.5/4.6	3.3/6.1	4.4/6.5	4.8/7.8	5.2/8.4	5.8/9.1	6.3/8.6	6.2/8.4	4.5/6.9	3.9/7.0	2.0/4.2	1.8/3.4	5.1/5.9

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.6	2.0	2.3	2.6	2.9	3.3	3.3	3.0	2.6	2.4	1.4	1.3	2.4
	Min/Max	1.0/2.5	1.2/3.3	1.5/3.3	1.5/3.8	1.5/4.1	1.9/4.5	2.3/4.1	2.4/4.2	1.6/3.4	1.6/4.1	0.6/2.4	0.6/1.9	2.1/2.9
1-Axis, N-S Horiz Axis	Average	1.1	1.7	2.5	3.3	3.7	4.2	4.3	3.9	3.0	2.3	1.1	0.8	2.7
	Min/Max	0.7/1.7	1.1/2.9	1.6/3.7	1.8/4.9	2.0/5.3	2.3/5.9	2.9/5.4	3.0/5.5	1.9/4.0	1.6/4.0	0.4/1.8	0.4/1.2	2.4/3.2
1-Axis, N-S Tilt=Latitude	Average	1.8	2.3	3.0	3.5	3.7	4.0	4.1	4.0	3.5	3.0	1.6	1.3	3.0
	Min/Max	1.1/2.7	1.5/3.9	1.9/4.4	2.0/5.2	1.9/5.2	2.2/5.6	2.8/5.1	3.1/5.6	2.2/4.6	2.0/5.2	0.6/2.7	0.6/2.0	2.7/3.6
2-Axis	Average	1.9	2.4	3.0	3.6	3.9	4.4	4.4	4.1	3.5	3.0	1.7	1.4	3.1
	Min/Max	1.1/2.9	1.5/4.0	1.9/4.4	2.0/5.3	2.0/5.5	2.4/6.1	3.0/5.5	3.2/5.8	2.2/4.6	2.1/5.2	0.7/2.9	0.7/2.2	2.8/3.8

Average Climatic Conditions

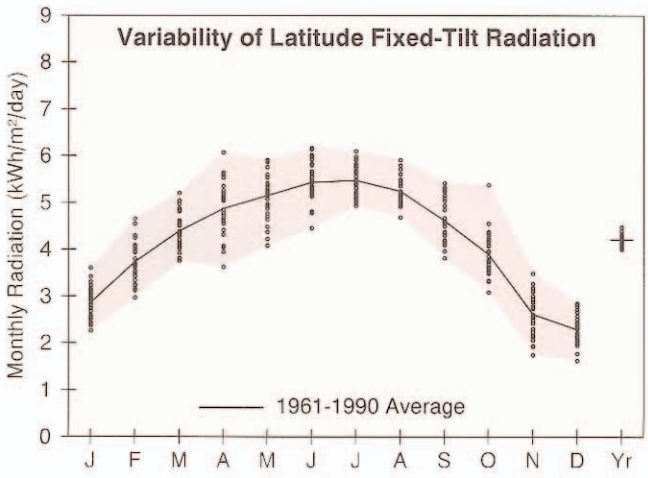
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.1	-2.9	2.7	8.9	14.9	19.6	22.1	21.1	17.0	10.8	5.2	-1.1	9.5
Daily Minimum Temp	-8.1	-7.2	-2.1	3.4	9.1	13.8	16.4	15.6	11.6	5.6	1.1	-4.8	4.6
Daily Maximum Temp	-0.1	1.4	7.5	14.3	20.7	25.3	27.7	26.5	22.4	16.1	9.3	2.6	14.5
Record Minimum Temp	-25.6	-26.7	-18.9	-10.0	-2.2	1.1	6.7	3.9	-1.1	-6.7	-12.8	-21.7	-26.7
Record Maximum Temp	19.4	21.7	28.3	33.3	33.9	35.0	37.8	34.4	35.0	28.3	26.7	18.9	37.8
HDD, Base 18.3°C	694	594	484	283	121	21	0	6	61	235	393	603	3495
CDD, Base 18.3°C	0	0	0	0	14	58	117	91	21	0	0	0	299
Relative Humidity (%)	70	68	64	60	64	70	71	73	75	71	72	73	69
Wind Speed (m/s)	3.9	3.9	4.2	4.2	3.8	3.5	3.2	3.1	3.3	3.5	3.8	3.9	3.7

Williamsport, PA

WBAN NO. 14778

LATITUDE: 41.27° N
LONGITUDE: 77.05° W
ELEVATION: 243 meters
MEAN PRESSURE: 998 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±11%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.8	2.6	3.6	4.6	5.4	6.0	5.9	5.1	4.0	2.9	1.8	1.4	3.8
	Min/Max	1.5/2.1	2.2/3.0	3.2/4.1	3.7/5.5	4.4/6.2	5.0/6.8	5.3/6.5	4.7/5.7	3.4/4.5	2.4/3.6	1.4/2.1	1.3/1.6	3.6/3.9
Latitude -15	Average	2.6	3.4	4.3	5.0	5.5	5.9	5.9	5.4	4.6	3.7	2.4	2.1	4.2
	Min/Max	2.1/3.2	2.8/4.2	3.7/5.0	3.8/6.2	4.4/6.3	4.8/6.7	5.3/6.6	4.9/6.1	3.8/5.3	3.0/5.0	1.7/3.1	1.5/2.5	4.0/4.5
Latitude	Average	2.9	3.7	4.4	4.9	5.1	5.4	5.5	5.2	4.6	3.9	2.6	2.3	4.2
	Min/Max	2.3/3.6	3.0/4.7	3.8/5.2	3.6/6.1	4.1/5.9	4.4/6.2	4.9/6.1	4.7/5.9	3.8/5.4	3.1/5.4	1.7/3.5	1.6/2.8	4.0/4.5
Latitude +15	Average	3.0	3.8	4.3	4.5	4.6	4.7	4.8	4.8	4.4	3.9	2.7	2.4	4.0
	Min/Max	2.3/3.9	3.0/4.9	3.6/5.1	3.3/5.7	3.6/5.2	3.9/5.3	4.3/5.3	4.3/5.4	3.6/5.2	3.0/5.4	1.7/3.7	1.6/3.0	3.8/4.2
90	Average	2.8	3.4	3.3	3.0	2.6	2.5	2.6	3.0	3.1	3.1	2.3	2.2	2.8
	Min/Max	2.1/3.8	2.7/4.5	2.7/3.9	2.2/3.8	2.2/3.0	2.3/2.8	2.5/2.9	2.7/3.3	2.5/3.7	2.4/4.5	1.5/3.3	1.5/2.9	2.7/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±11%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.4	3.5	4.7	5.9	6.7	7.5	7.4	6.4	5.1	3.7	2.2	1.8	4.8
	Min/Max	1.9/3.0	2.8/4.3	3.9/5.6	4.0/7.5	5.1/7.9	5.7/8.9	6.3/8.3	5.5/7.6	4.0/6.0	3.0/5.2	1.5/2.9	1.4/2.2	4.5/5.1
Latitude -15	Average	3.0	4.1	5.2	6.2	6.9	7.5	7.4	6.7	5.5	4.4	2.7	2.3	5.2
	Min/Max	2.3/3.8	3.2/5.2	4.3/6.3	4.2/8.0	5.1/8.1	5.6/8.9	6.3/8.4	5.7/8.0	4.3/6.6	3.4/6.3	1.8/3.7	1.6/2.9	4.9/5.6
Latitude	Average	3.2	4.3	5.3	6.1	6.6	7.2	7.1	6.6	5.6	4.5	2.9	2.5	5.2
	Min/Max	2.5/4.1	3.3/5.6	4.3/6.4	4.1/7.9	4.9/7.8	5.4/8.5	6.1/8.1	5.6/7.8	4.3/6.7	3.5/6.6	1.8/4.0	1.7/3.2	4.9/5.6
Latitude +15	Average	3.4	4.4	5.2	5.9	6.2	6.7	6.7	6.2	5.4	4.5	3.0	2.6	5.0
	Min/Max	2.5/4.4	3.3/5.7	4.2/6.3	3.8/7.7	4.6/7.4	5.0/7.9	5.6/7.6	5.2/7.4	4.1/6.5	3.5/6.6	1.8/4.1	1.7/3.4	4.7/5.4

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	3.4	4.4	5.3	6.2	6.9	7.6	7.5	6.8	5.6	4.6	3.0	2.6	5.3
	Min/Max	2.6/4.4	3.3/5.7	4.3/6.4	4.2/8.0	5.2/8.2	5.8/9.1	6.4/8.5	5.7/8.0	4.3/6.7	3.5/6.6	1.8/4.2	1.7/3.4	5.0/5.8

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±11%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.7	2.1	2.4	2.6	2.9	3.4	3.3	2.9	2.5	2.3	1.4	1.3	2.4
	Min/Max	1.2/2.3	1.1/3.0	1.7/3.3	1.2/4.0	1.4/3.9	1.9/4.4	2.3/4.0	2.1/4.0	1.5/3.3	1.5/3.9	0.5/2.4	0.5/2.1	2.1/2.8
1-Axis, N-S Horiz Axis	Average	1.2	1.8	2.6	3.3	3.8	4.3	4.3	3.7	2.8	2.1	1.1	0.8	2.7
	Min/Max	0.8/1.6	1.0/2.6	1.8/3.6	1.4/5.0	1.9/5.0	2.4/5.7	3.0/5.2	2.6/5.1	1.6/3.8	1.4/3.7	0.4/1.8	0.3/1.3	2.4/3.1
1-Axis, N-S Tilt=Latitude	Average	1.8	2.5	3.1	3.6	3.7	4.1	4.1	3.8	3.3	2.8	1.6	1.4	3.0
	Min/Max	1.2/2.5	1.3/3.6	2.2/4.3	1.5/5.3	1.9/4.9	2.3/5.4	2.8/5.0	2.6/5.2	1.9/4.3	1.8/4.8	0.6/2.6	0.5/2.2	2.6/3.5
2-Axis	Average	2.0	2.5	3.1	3.6	3.9	4.4	4.4	3.9	3.3	2.8	1.7	1.5	3.1
	Min/Max	1.3/2.7	1.4/3.7	2.2/4.3	1.5/5.4	2.0/5.2	2.4/5.9	3.0/5.3	2.7/5.4	1.9/4.4	1.8/4.8	0.6/2.8	0.6/2.3	2.7/3.6

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-3.8	-2.2	3.4	9.5	15.3	19.9	22.4	21.6	17.5	11.1	5.4	-0.6	9.9
Daily Minimum Temp	-8.3	-7.1	-1.9	3.4	8.8	13.7	16.4	15.8	11.7	5.3	0.9	-4.5	4.5
Daily Maximum Temp	0.7	2.6	8.7	15.6	21.7	26.1	28.4	27.3	23.2	16.9	9.9	3.3	15.4
Record Minimum Temp	-27.2	-25.0	-18.3	-9.4	-2.2	2.2	6.1	3.3	-2.2	-6.7	-13.3	-26.1	-27.2
Record Maximum Temp	20.6	21.7	30.6	33.3	35.0	38.9	39.4	37.8	38.9	32.8	28.3	19.4	39.4
HDD, Base 18.3°C	686	576	463	265	111	17	0	5	59	227	387	587	3382
CDD, Base 18.3°C	0	0	0	0	16	63	127	105	34	0	0	0	346
Relative Humidity (%)	70	68	65	61	67	73	74	77	79	75	73	72	71
Wind Speed (m/s)	4.0	3.9	4.1	4.2	3.5	3.2	2.8	2.7	2.8	3.0	3.7	3.9	3.5