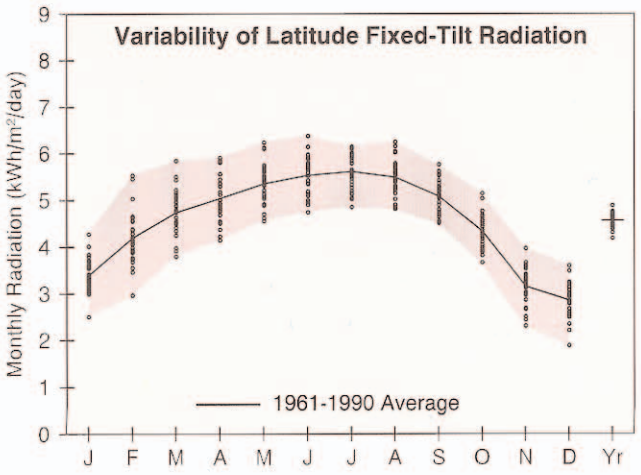


Boston, MA

WBAN NO. 14739

LATITUDE: 42.37° N
LONGITUDE: 71.03° W
ELEVATION: 5 meters
MEAN PRESSURE: 1015 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	1.9	2.7	3.7	4.7	5.6	6.1	6.1	5.4	4.3	3.0	1.9	1.5	3.9
	Min/Max	1.5/2.2	2.2/3.3	3.2/4.4	4.0/5.4	4.8/6.4	5.3/7.0	5.2/6.6	4.8/6.0	3.9/4.7	2.7/3.5	1.5/2.2	1.2/1.8	3.7/4.1
Latitude -15	Average	3.0	3.8	4.6	5.2	5.7	6.0	6.0	5.7	5.0	4.1	2.8	2.5	4.5
	Min/Max	2.2/3.7	2.8/5.0	3.7/5.6	4.3/6.0	4.8/6.6	5.2/6.9	5.2/6.6	5.0/6.5	4.5/5.7	3.5/4.8	2.1/3.5	1.7/3.1	4.2/4.8
Latitude	Average	3.4	4.2	4.7	5.0	5.3	5.5	5.6	5.5	5.1	4.3	3.1	2.9	4.6
	Min/Max	2.5/4.3	3.0/5.5	3.8/5.8	4.1/5.9	4.6/6.2	4.7/6.4	4.8/6.1	4.8/6.2	4.5/5.8	3.7/5.1	2.3/4.0	1.9/3.6	4.2/4.9
Latitude +15	Average	3.6	4.3	4.6	4.7	4.7	4.8	4.9	5.0	4.9	4.4	3.3	3.1	4.4
	Min/Max	2.6/4.6	3.0/5.8	3.7/5.8	3.8/5.5	4.1/5.5	4.1/5.5	4.3/5.3	4.4/5.7	4.3/5.5	3.7/5.2	2.4/4.2	2.0/3.9	4.0/4.7
90	Average	3.4	3.9	3.7	3.1	2.8	2.6	2.8	3.1	3.5	3.6	3.0	2.9	3.2
	Min/Max	2.4/4.5	2.6/5.3	2.8/4.9	2.6/3.7	2.5/3.2	2.4/2.9	2.5/3.0	2.8/3.5	3.1/4.0	3.0/4.3	2.1/3.8	1.8/3.8	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	2.7	3.8	5.1	6.2	7.1	7.7	7.7	7.0	5.7	4.2	2.6	2.2	5.2
	Min/Max	2.0/3.5	2.8/5.1	3.9/6.2	5.0/7.4	5.7/8.6	6.4/9.2	6.1/8.8	5.8/8.0	5.0/6.7	3.5/5.0	2.0/3.3	1.5/2.7	4.8/5.5
Latitude -15	Average	3.6	4.7	5.7	6.5	7.3	7.7	7.8	7.3	6.3	5.0	3.4	2.9	5.7
	Min/Max	2.6/4.6	3.2/6.3	4.3/7.1	5.2/7.9	5.8/8.8	6.3/9.3	6.2/8.9	6.1/8.4	5.5/7.4	4.1/6.0	2.4/4.3	1.9/3.7	5.2/6.1
Latitude	Average	3.9	5.0	5.9	6.5	7.1	7.4	7.5	7.1	6.4	5.2	3.6	3.2	5.7
	Min/Max	2.8/5.0	3.4/6.8	4.4/7.3	5.1/7.8	5.6/8.5	6.1/8.9	5.9/8.6	5.9/8.3	5.5/7.5	4.3/6.3	2.6/4.7	2.0/4.1	5.2/6.2
Latitude +15	Average	4.1	5.1	5.8	6.2	6.6	6.9	7.0	6.8	6.2	5.2	3.7	3.4	5.6
	Min/Max	2.9/5.3	3.4/7.0	4.3/7.3	4.9/7.5	5.2/8.0	5.6/8.3	5.5/8.0	5.6/7.9	5.4/7.3	4.3/6.3	2.6/4.8	2.1/4.4	5.0/6.1

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	4.1	5.1	5.9	6.6	7.4	7.9	7.9	7.3	6.4	5.3	3.8	3.4	5.9
	Min/Max	2.9/5.3	3.4/7.0	4.4/7.3	5.2/7.9	5.8/8.9	6.5/9.5	6.3/9.1	6.1/8.5	5.6/7.5	4.3/6.3	2.6/4.9	2.1/4.4	5.4/6.4

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	2.7	2.8	2.9	3.2	3.5	3.5	3.3	3.1	2.8	2.2	2.1	2.9
	Min/Max	1.6/3.1	1.5/4.2	1.9/3.6	1.9/4.0	2.0/4.4	2.5/4.7	2.3/4.5	2.2/4.2	2.5/3.9	2.1/3.6	1.3/3.1	1.0/2.8	2.4/3.2
1-Axis, N-S Horiz Axis	Average	1.7	2.3	3.1	3.7	4.2	4.5	4.6	4.2	3.6	2.7	1.6	1.3	3.1
	Min/Max	1.0/2.1	1.3/3.6	2.0/3.9	2.5/5.0	2.6/5.8	3.2/6.1	2.8/5.9	2.8/5.3	2.8/4.6	2.0/3.4	0.9/2.3	0.6/1.8	2.7/3.4
1-Axis, N-S Tilt=Latitude	Average	2.6	3.2	3.7	4.0	4.2	4.3	4.4	4.3	4.1	3.5	2.4	2.2	3.6
	Min/Max	1.7/3.4	1.7/5.0	2.5/4.8	2.6/5.4	2.6/5.7	3.0/5.8	2.7/5.7	2.9/5.5	3.3/5.3	2.6/4.4	1.4/3.4	1.0/2.9	3.0/3.9
2-Axis	Average	2.8	3.3	3.7	4.0	4.4	4.7	4.7	4.5	4.1	3.5	2.5	2.3	3.7
	Min/Max	1.8/3.6	1.8/5.1	2.5/4.8	2.7/5.5	2.7/6.0	3.3/6.3	2.9/6.1	3.0/5.7	3.3/5.3	2.7/4.5	1.5/3.6	1.1/3.2	3.2/4.1

Average Climatic Conditions

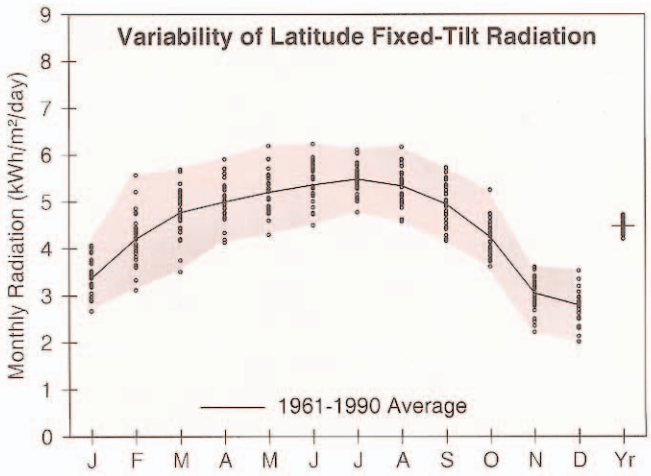
Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-1.9	-0.9	3.7	8.9	14.6	19.8	23.1	22.2	18.2	12.7	7.4	0.9	10.7
Daily Minimum Temp	-5.8	-5.0	-0.4	4.6	9.9	15.1	18.4	17.8	13.8	8.3	3.5	-2.9	6.4
Daily Maximum Temp	2.1	3.1	7.7	13.3	19.2	24.6	27.7	26.6	22.7	17.1	11.2	4.7	15.0
Record Minimum Temp	-24.4	-20.0	-14.4	-8.9	1.1	7.2	10.0	8.3	3.3	-2.2	-9.4	-21.7	-24.4
Record Maximum Temp	17.2	21.1	27.2	34.4	35.0	37.8	38.9	38.9	37.8	32.2	25.6	22.8	38.9
HDD, Base 18.3°C	627	540	454	282	123	18	0	3	40	178	328	541	3134
CDD, Base 18.3°C	0	0	0	0	6	63	147	122	37	3	0	0	377
Relative Humidity (%)	62	62	63	63	67	68	68	71	72	68	67	65	67
Wind Speed (m/s)	6.2	6.1	6.1	5.9	5.5	5.1	4.9	4.8	5.1	5.4	5.8	6.1	5.6

Worchester, MA

WBAN NO. 94746

LATITUDE: 42.27° N
LONGITUDE: 71.87° W
ELEVATION: 301 meters
MEAN PRESSURE: 979 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	2.8	3.8	4.7	5.5	6.0	5.9	5.2	4.2	3.0	1.9	1.5	3.9
	Min/Max	1.6/2.2	2.2/3.4	3.0/4.3	4.0/5.4	4.6/6.4	5.0/6.8	5.3/6.6	4.6/5.9	3.7/4.7	2.7/3.5	1.5/2.1	1.3/1.8	3.7/4.0
Latitude -15	Average	3.0	3.8	4.6	5.1	5.5	5.8	5.9	5.6	4.9	4.0	2.8	2.4	4.5
	Min/Max	2.4/3.5	2.9/5.0	3.5/5.4	4.2/6.0	4.6/6.6	4.9/6.8	5.2/6.6	4.8/6.4	4.2/5.7	3.5/4.9	2.0/3.2	1.8/3.0	4.2/4.7
Latitude	Average	3.4	4.2	4.8	5.0	5.2	5.4	5.5	5.3	5.0	4.3	3.0	2.8	4.5
	Min/Max	2.7/4.1	3.1/5.6	3.5/5.7	4.1/5.9	4.3/6.2	4.5/6.2	4.8/6.1	4.6/6.2	4.2/5.7	3.6/5.3	2.2/3.6	2.0/3.5	4.2/4.7
Latitude +15	Average	3.6	4.4	4.7	4.6	4.6	4.6	4.8	4.8	4.7	4.3	3.2	3.0	4.3
	Min/Max	2.8/4.4	3.2/5.9	3.4/5.7	3.8/5.5	3.8/5.5	3.9/5.4	4.2/5.3	4.2/5.6	4.0/5.5	3.6/5.3	2.3/3.8	2.1/3.8	4.0/4.5
90	Average	3.5	4.0	3.8	3.1	2.7	2.6	2.7	3.0	3.4	3.5	2.9	2.8	3.2
	Min/Max	2.7/4.3	2.8/5.5	2.6/4.9	2.5/3.6	2.3/3.2	2.3/2.9	2.5/2.9	2.7/3.5	2.8/4.0	2.9/4.4	2.0/3.5	2.0/3.7	3.0/3.4

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	2.7	3.9	5.1	6.1	6.9	7.5	7.5	6.8	5.6	4.1	2.6	2.2	5.1
	Min/Max	2.2/3.3	3.0/5.2	3.7/6.1	4.7/7.4	5.4/8.4	5.9/8.9	6.3/8.7	5.7/7.9	4.7/6.5	3.5/5.1	1.9/3.0	1.6/2.7	4.8/5.4
Latitude -15	Average	3.5	4.7	5.7	6.4	7.0	7.5	7.6	7.1	6.2	4.9	3.2	2.9	5.6
	Min/Max	2.8/4.3	3.5/6.4	4.1/6.9	4.9/8.0	5.5/8.6	5.8/8.9	6.3/8.8	5.8/8.4	5.1/7.3	4.1/6.1	2.3/3.8	2.0/3.7	5.2/5.9
Latitude	Average	3.9	5.0	5.9	6.4	6.8	7.2	7.3	6.9	6.2	5.1	3.5	3.1	5.6
	Min/Max	3.0/4.8	3.6/6.8	4.1/7.1	4.8/7.9	5.3/8.4	5.6/8.6	6.1/8.5	5.7/8.2	5.1/7.3	4.2/6.4	2.5/4.2	2.2/4.1	5.2/6.0
Latitude +15	Average	4.1	5.1	5.8	6.1	6.4	6.7	6.8	6.6	6.0	5.1	3.6	3.3	5.5
	Min/Max	3.2/5.0	3.7/7.0	4.0/7.1	4.6/7.6	4.9/7.9	5.2/8.0	5.7/7.9	5.4/7.8	4.9/7.2	4.2/6.5	2.5/4.3	2.3/4.3	5.1/5.8

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	4.1	5.1	5.9	6.5	7.1	7.7	7.7	7.1	6.2	5.2	3.6	3.4	5.8
	Min/Max	3.2/5.1	3.7/7.0	4.1/7.1	4.9/8.0	5.6/8.7	6.0/9.1	6.5/8.9	5.9/8.4	5.1/7.3	4.2/6.5	2.5/4.3	2.3/4.4	5.4/6.2

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	2.2	2.5	2.6	2.8	3.0	3.3	3.3	3.1	2.9	2.7	2.0	1.9	2.7
	Min/Max	1.5/2.9	1.6/3.9	1.7/3.4	1.7/3.9	1.9/4.3	1.9/4.4	2.3/4.4	2.1/4.1	2.0/3.8	1.9/3.8	1.1/2.7	0.9/2.7	2.3/3.0
1-Axis, N-S Horiz Axis	Average	1.5	2.2	2.9	3.5	3.9	4.3	4.3	4.0	3.4	2.5	1.4	1.2	2.9
	Min/Max	1.0/2.0	1.4/3.4	1.8/3.7	2.0/5.0	2.5/5.5	2.5/5.7	3.0/5.7	2.8/5.3	2.3/4.4	1.8/3.6	0.8/2.0	0.6/1.7	2.6/3.2
1-Axis, N-S Tilt=Latitude	Average	2.4	3.0	3.5	3.8	3.8	4.1	4.1	4.1	3.9	3.3	2.2	2.0	3.3
	Min/Max	1.6/3.2	2.0/4.6	2.2/4.5	2.2/5.4	2.5/5.4	2.4/5.4	2.9/5.5	2.8/5.4	2.7/5.1	2.4/4.6	1.3/3.0	1.0/2.8	2.9/3.7
2-Axis	Average	2.6	3.1	3.5	3.8	4.1	4.4	4.5	4.2	3.9	3.4	2.3	2.1	3.5
	Min/Max	1.7/3.4	2.0/4.8	2.2/4.5	2.3/5.4	2.6/5.7	2.6/5.8	3.1/5.9	2.9/5.6	2.7/5.1	2.4/4.7	1.3/3.1	1.0/3.1	3.0/3.9

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-5.1	-4.0	0.9	6.9	13.1	17.9	20.9	20.0	15.7	10.0	4.1	-2.6	8.2
Daily Minimum Temp	-9.4	-8.6	-3.9	1.5	7.3	12.2	15.6	14.8	10.3	4.7	-0.4	-6.6	3.1
Daily Maximum Temp	-0.7	0.6	5.8	12.2	18.8	23.6	26.3	25.2	20.9	15.3	8.6	1.5	13.2
Record Minimum Temp	-28.3	-24.4	-20.0	-11.7	-2.2	2.2	6.1	3.3	-1.1	-6.7	-14.4	-25.0	-28.3
Record Maximum Temp	15.6	19.4	27.2	32.8	33.3	34.4	35.6	35.6	32.8	29.4	25.6	21.1	35.6
HDD, Base 18.3°C	727	626	539	343	167	38	3	14	87	258	427	648	3877
CDD, Base 18.3°C	0	0	0	0	3	25	84	66	7	0	0	0	185
Relative Humidity (%)	65	64	63	60	64	69	70	73	74	69	70	70	68
Wind Speed (m/s)	4.9	4.8	4.8	4.6	4.1	3.8	3.5	3.4	3.6	4.0	4.5	4.6	4.2