WEATHER ANALYSIS REPORT FOR CITY OF PHILADELPHIA

Arch631-Enviromental System

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WEATHER DATA SUMMARY

LOCATION: Philadelphia International Ap, PA, USA
Latitude/Longitude: 39.87° North, 75.23° West, **Time Zone from Greenwich** -5
Data Source: TMY3 724080 WMO Station Number, **Elevation** 2 m

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	212	260	323	364	398	422	394	416	354	299	227	191	Wh/sq.m
Direct Normal Radiation (Avg Hourly)	326	332	332	330	310	324	277	346	338	354	295	296	Wh/sq.m
Diffuse Radiation (Avg Hourly)	94	104	137	152	182	187	196	180	145	126	109	90	Wh/sq.m
Global Horiz Radiation (Max Hourly)	505	710	859	924	954	978	928	911	845	722	545	458	Wh/sq.m
Direct Normal Radiation (Max Hourly)	930	930	905	953	847	882	845	923	857	936	923	916	Wh/sq.m
Diffuse Radiation (Max Hourly)	274	361	404	462	454	495	477	453	481	336	286	240	Wh/sq.m
Global Horiz Radiation (Avg Daily Total)	2016	2730	3819	4779	5655	6252	5714	5626	4365	3269	2224	1766	Wh/sq.m
Direct Normal Radiation (Avg Daily Total)	3085	3491	3922	4324	4385	4791	4026	4681	4169	3847	2889	2732	Wh/sq.m
Diffuse Radiation (Avg Daily Total)	902	1082	1622	1994	2603	2775	2851	2447	1788	1382	1073	834	Wh/sq.m
Global Horiz Illumination (Avg Hourly)	22669	27899	34669	39330	42874	45654	42650	44596	38121	31956	24083	20394	lux
Direct Normal Illumination (Avg Hourly)	29342	31402	31978	32382	30664	32309	27804	34524	33358	33695	27124	26246	lux
Dry Bulb Temperature (Avg Monthly)	-1	0	7	12	18	22	25	23	20	12	7	3	degrees C
Dew Point Temperature (Avg Monthly)	-7	-6	0	3	10	15	18	17	14	5	2	-4	degrees C
Relative Humidity (Avg Monthly)	68	59	60	56	64	70	69	70	71	67	72	60	percent
Wind Direction (Monthly Mode)	310	300	300	310	70	240	240	230	0	240	280	300	degrees
Wind Speed (Avg Monthly)	5	3	4	4	3	3	3	4	3	3	4	4	m/s
Ground Temperature (Avg Monthly of 3 Depths)	4	3	4	5	11	15	19	21	20	17	13	8	degrees C

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COMFORT MODEL

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COMFORT MODELS:

Human Thermal comfort can be defined primarily by dry bulb temperature and humidity, although different sources have slightly different definitions. Select the model you wish to use:

- (•) **California Energy Code Comfort Model, 2013 (DEFAULT)**

  For the purpose of sizing residential heating and cooling systems the indoor Dry Bulb Design Conditions should be between 68°F (20°C) to 75°F (23.9°C). No Humidity limits are specified in the Code, so 80% Relative Humidity and 66°F (18.9°C) Wet Bulb is used for the upper limit and 27°F (-2.8°C) Dew Point is used for the lower limit (but these can be changed on the Criteria screen).

- ( ) **ASHRAE Standard 55 and Current Handbook of Fundamentals Model**

  Thermal comfort is based on dry bulb temperature, clothing level (clo), metabolic activity (met), air velocity, humidity, and mean radiant temperature. Indoors it is assumed that mean radiant temperature is close to dry bulb temperature. The zone in which most people are comfortable is calculated using the PMV (Predicted Mean Vote) model. In residential settings people adapt clothing to match the season and feel comfortable in higher air velocities and so have wider comfort range than in buildings with centralized HVAC systems.

- ( ) **ASHRAE Handbook of Fundamentals Comfort Model up through 2005**

  For people dressed in normal winter clothes, Effective Temperatures of 68°F (20°C) to 74°F (23.3°C) (measured at 50% relative humidity), which means the temperatures decrease slightly as humidity rises. The upper humidity limit is 64°F (17.8°C) Wet Bulb and a lower Dew Point of 36F (2.2°C). If people are dressed in light weight summer clothes then this comfort zone shifts 5°F (2.8°C) warmer.

- ( ) **Adaptive Comfort Model in ASHRAE Standard 55-2010**

  In naturally ventilated spaces where occupants can open and close windows, their thermal response will depend in part on the outdoor climate, and may have a wider comfort range than in buildings with centralized HVAC systems. This model assumes occupants adapt their clothing to thermal conditions, and are sedentary (1.0 to 1.3 met). There must be no mechanical Cooling System, but this method does not apply if a Mechanical Heating System is in operation.

CRITERIA: (Metric Units)

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California Energy Code Comfort Model, 2013 (select Help for definitions)

1. COMFORT: (using California Energy Code Model)
- 20.0 Comfort Low - Min. Comfort Dry Bulb Temp (°C)
- 23.9 Comfort High - Max. Comfort Dry Bulb Temp, up to 50% RH (°C)
- 80.0 Max. Relative Humidity (measured at Min. Comfort Temp) (%)
- 18.9 Max. Wet Bulb Temperature (°C)
- -2.8 Min. Dew Point Temperature (°C)

2. SUN SHADING ZONE: (Defaults to Comfort Low)
- 20.0 Min. Dry Bulb Temperature when Need for Shading Begins (°C)
- 315.5 Min. Global Horiz. Radiation when Need for Shading Begins (Wh/sq.m)

3. HIGH THERMAL MASS ZONE:
- 8.3 Max. Outdoor Temperature Difference above Comfort High (°C)
- 1.7 Min. Nighttime Temperature Difference below Comfort High (°C)

4. HIGH THERMAL MASS WITH NIGHT FLUSHING ZONE:
- 16.7 Max. Outdoor Temperature Difference above Comfort High (°C)
- 1.7 Min. Nighttime Temperature Difference below Comfort High (°C)

5. DIRECT EVAPORATIVE COOLING ZONE: (Defined by Comfort Zone)
- 20.0 Max. Wet Bulb set by Max. Comfort Zone Wet Bulb (°C)
- 6.6 Min. Wet Bulb set by Min. Comfort Zone Wet Bulb (°C)

7. NATURAL VENTILATION COOLING ZONE:
- 2.0 Terrain Category to modify Wind Speed (2=suburban)
- 0.2 Min. Indoor Velocity to Effect Indoor Comfort (m/s)
- 1.5 Max. Comfortable Velocity (per ASHRAE Std. 55) (m/s)
- 3.6 Max. Perceived Temperature Reduction (°C)
- 90.0 Max. Relative Humidity (%)
- 22.8 Max. Wet Bulb Temperature (°C)

8. FAN-FORCED VENTILATION COOLING ZONE:
- 0.8 Max. Mechanical Ventilation Velocity (m/s)
- 3.0 Max. Perceived Temperature Reduction (°C)
- (Min Vel, Max RH, Max WB match Natural Ventilation)

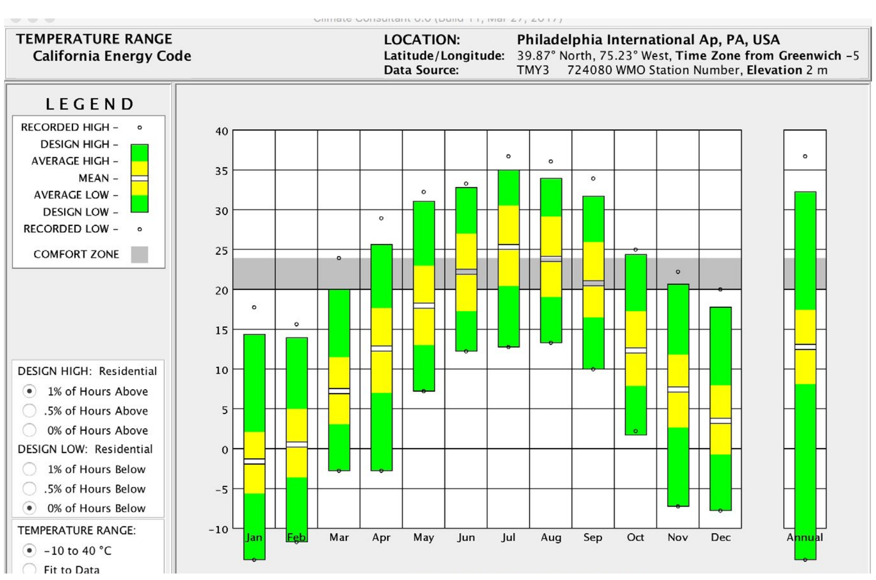
9. INTERNAL HEAT GAIN ZONE (lights, people, equipment):
- 12.8 Balance Point Temperature below which Heating is Needed (°C)

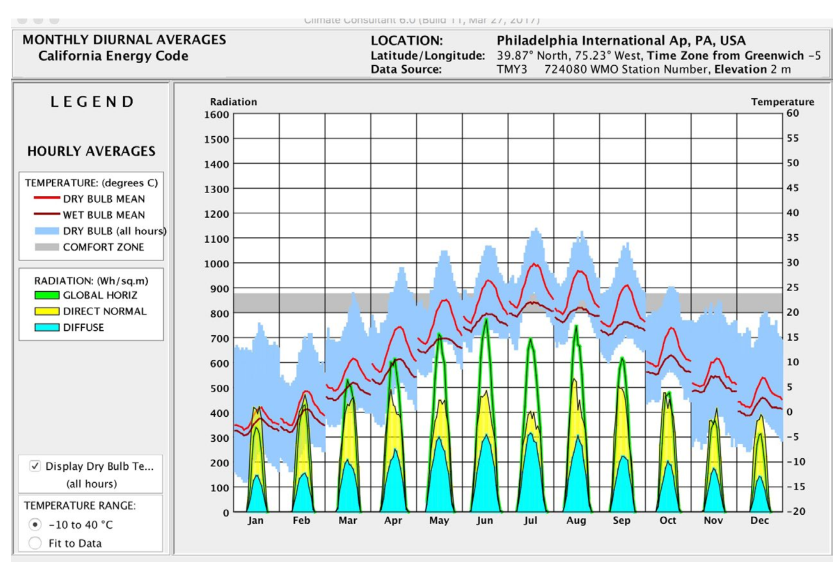
10. PASSIVE SOLAR DIRECT GAIN LOW MASS ZONE:
- 157.7 Min. South Window Radiation for 5.56°C Temperature Rise (Wh/sq.m)
- 3.0 Thermal Time Lag for Low Mass Buildings (hours)

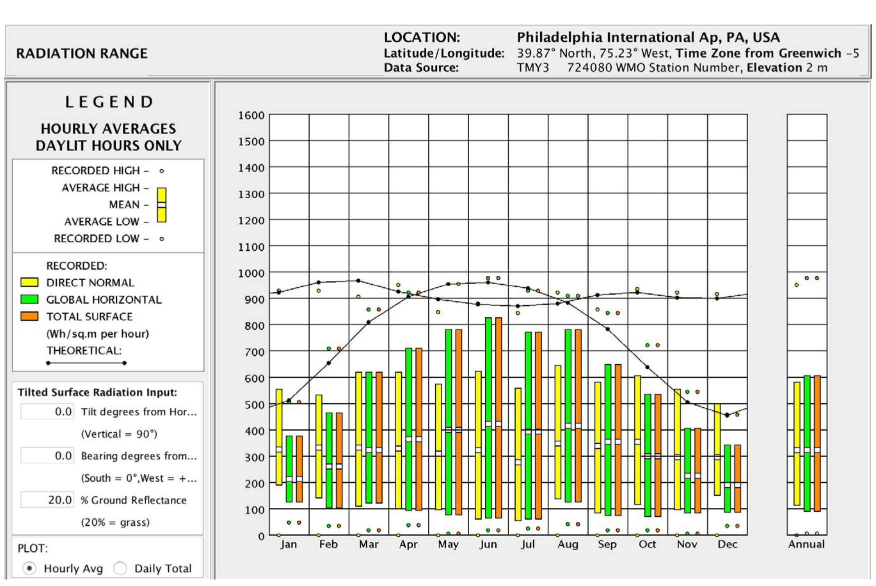
11. PASSIVE SOLAR DIRECT GAIN HIGH MASS ZONE:
- 157.7 Min. South Window Radiation for 5.56°C Temperature Rise (Wh/sq.m)
- 12.0 Thermal Time Lag for High Mass Buildings (hours)

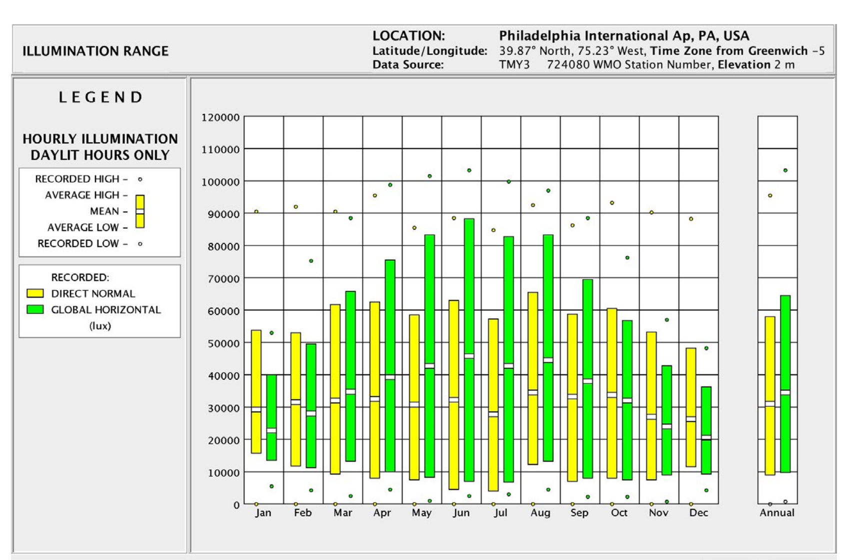
12. WIND PROTECTION OF OUTDOOR SPACES:
- 8.5 Velocity above which Wind Protection is Desirable (m/s)
- 11.1 Dry Bulb Temperature Above or Below Comfort Zone (°C)

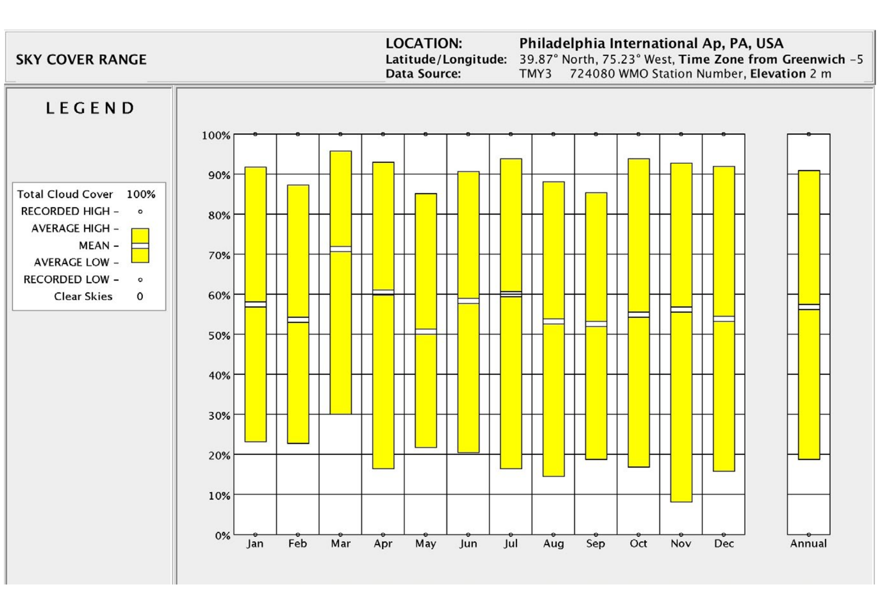
Restore Default Values Recalculate Back Next

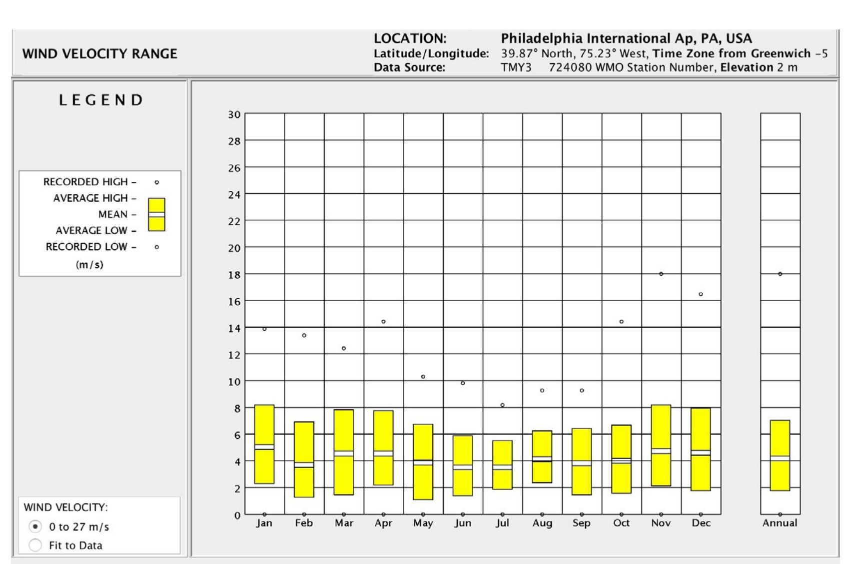


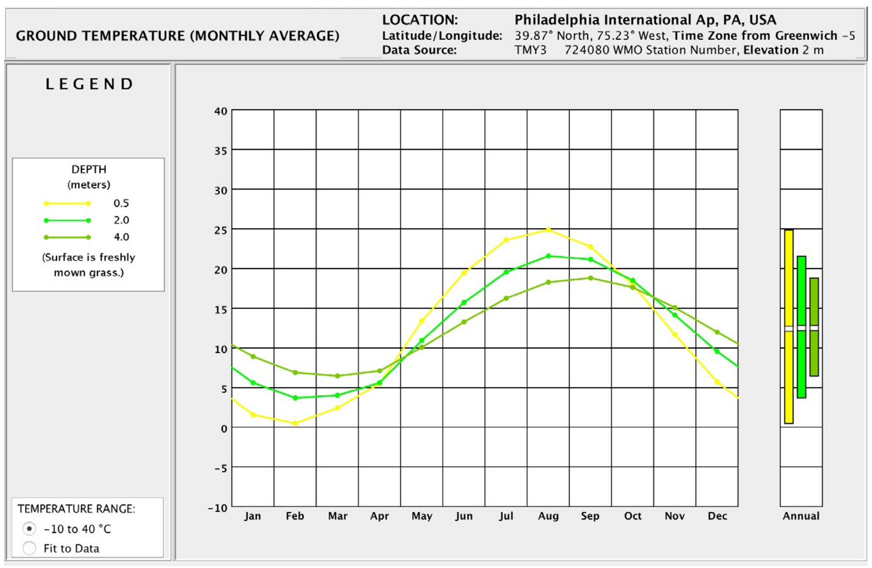


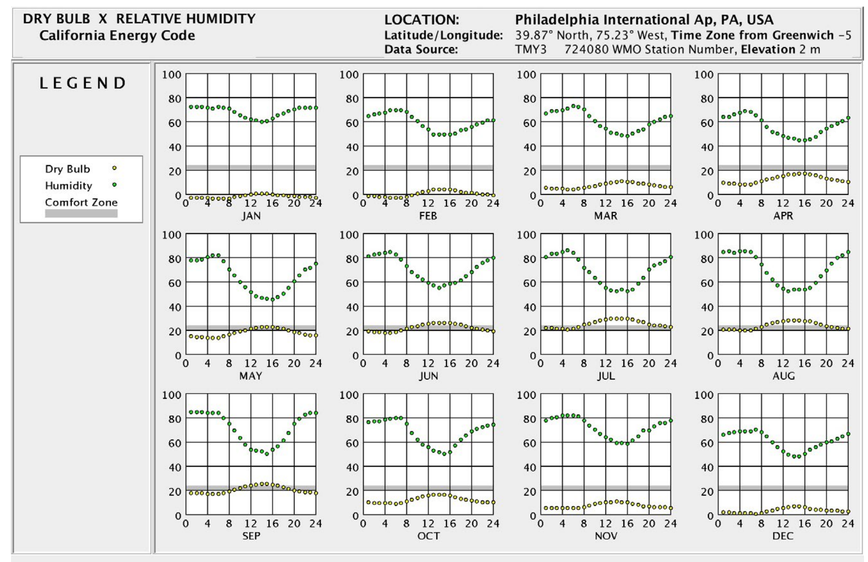


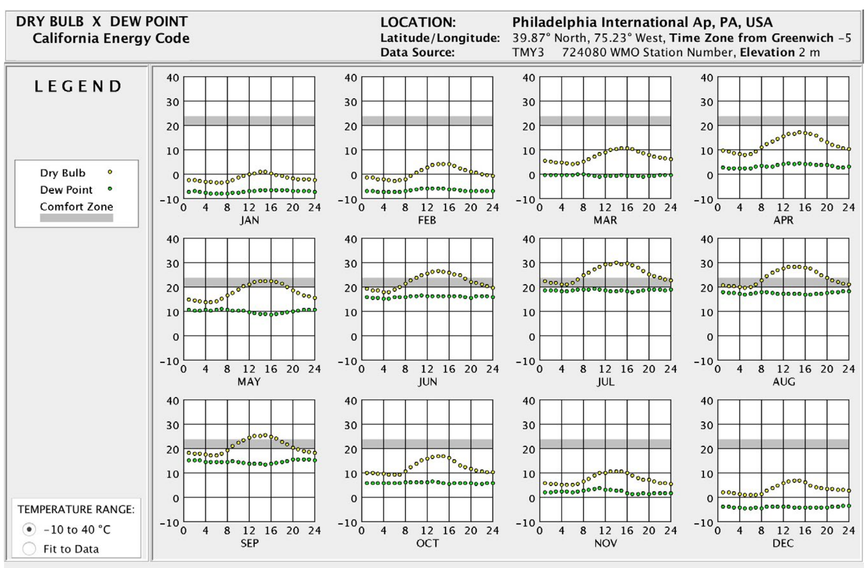


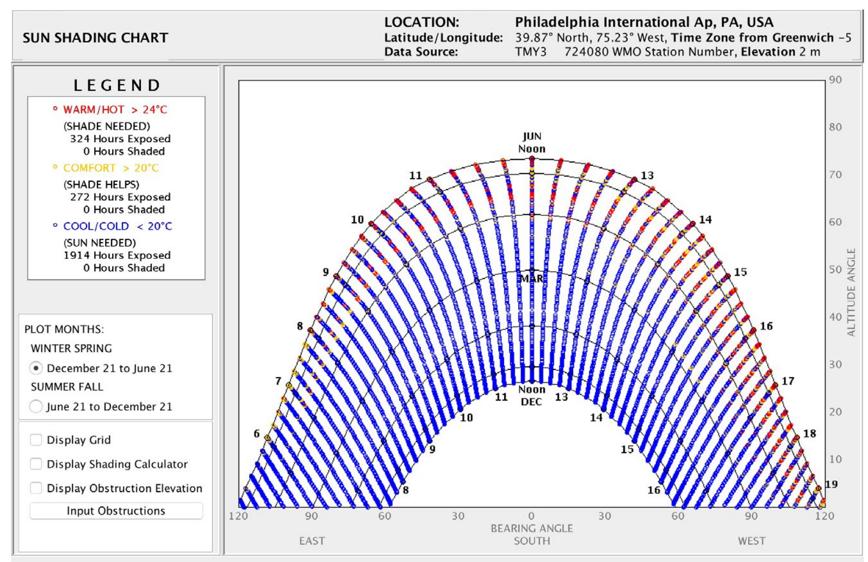


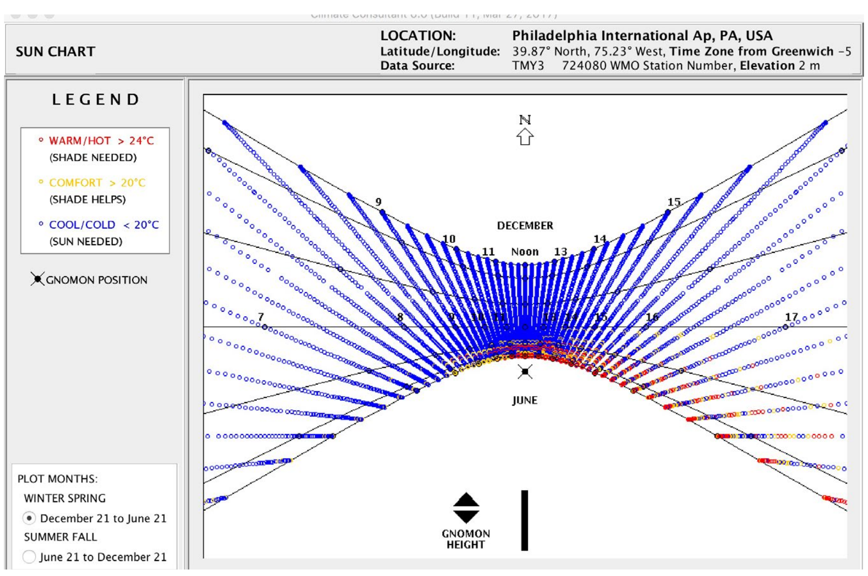


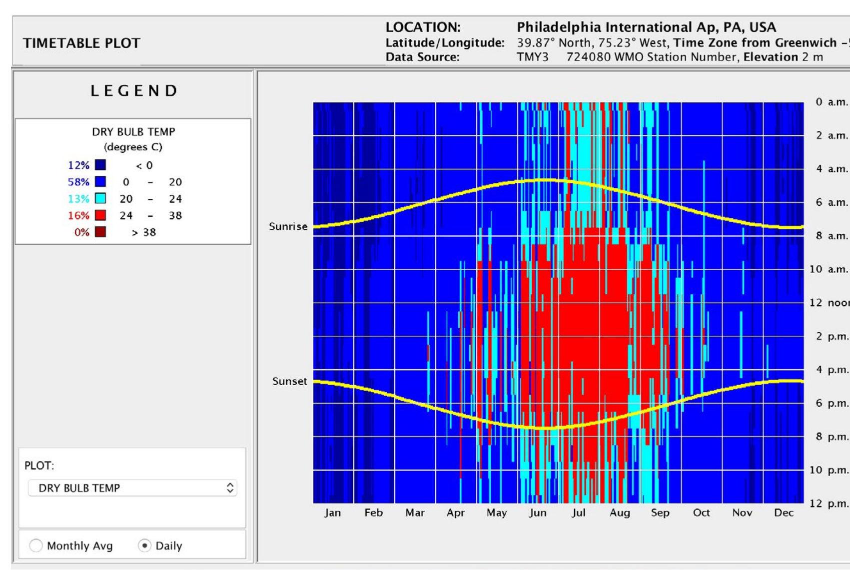


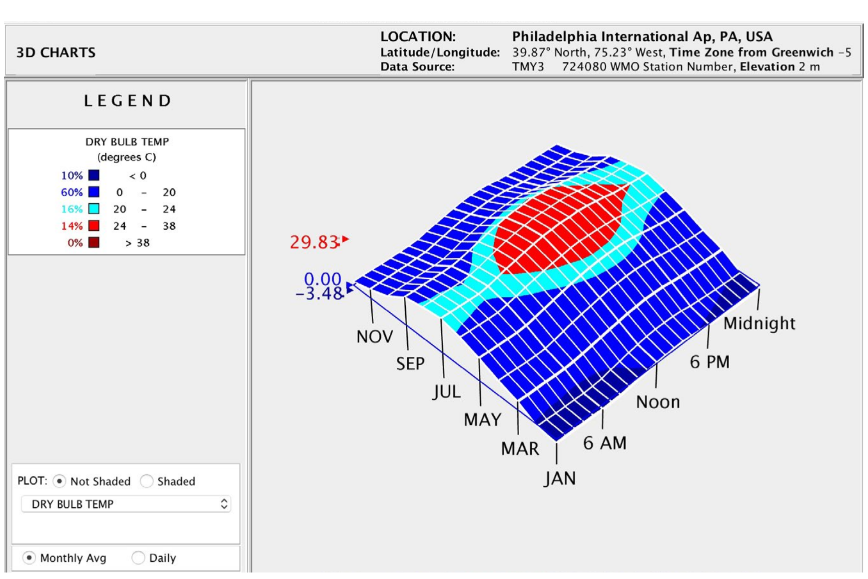


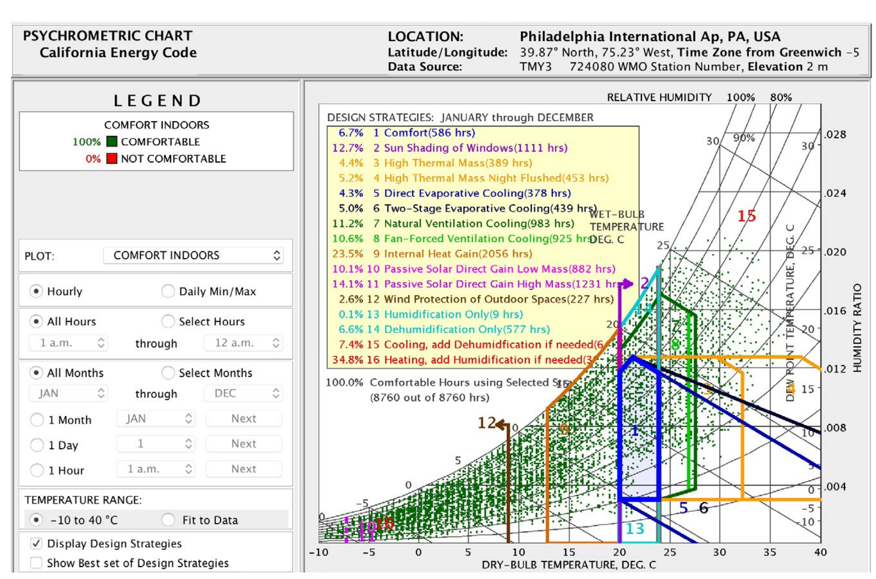


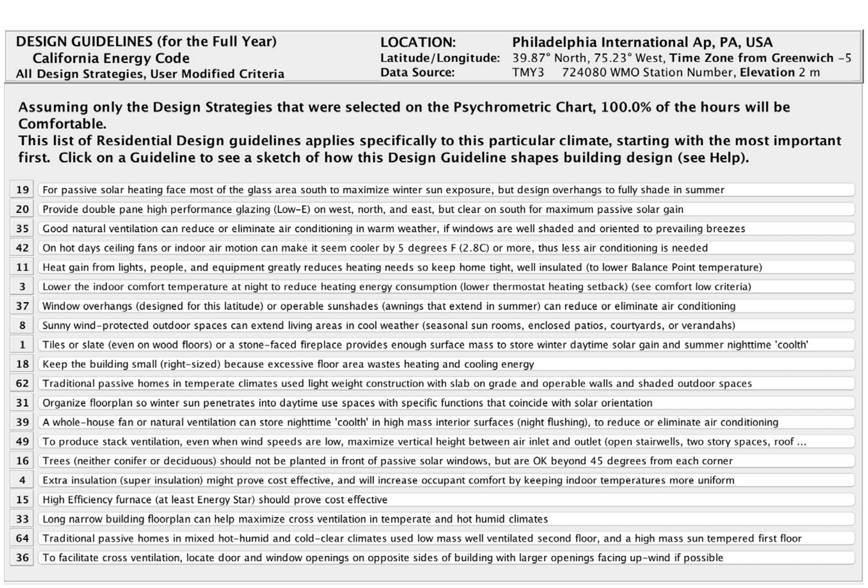











DESIGN GUIDELINES (for the Full Year)
California Energy Code
All Design Strategies, User Modified Criteria

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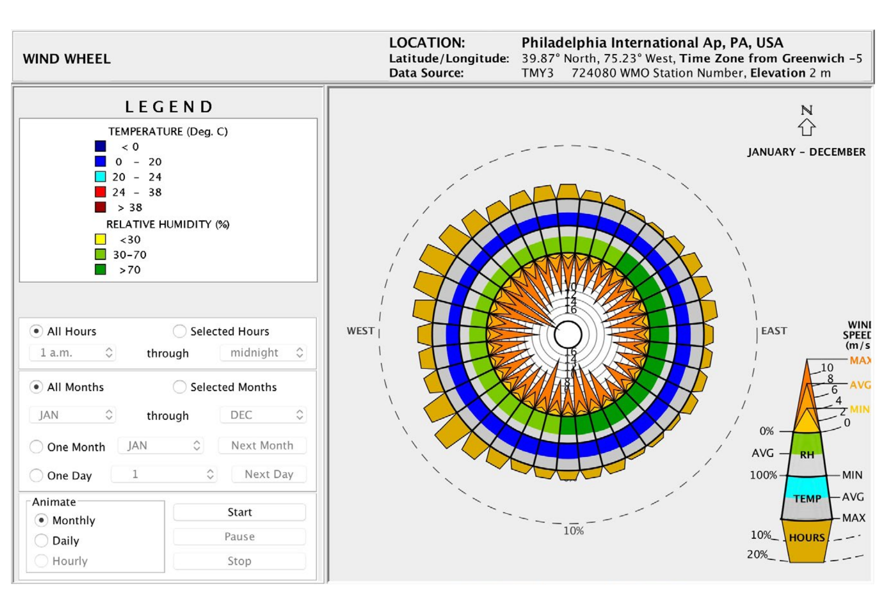
Assuming only the Design Strategies that were selected on the Psychrometric Chart, 100.0% of the hours will be Comfortable.
This list of Residential Design guidelines applies specifically to this particular climate, starting with the most important first. Click on a Guideline to see a sketch of how this Design Guideline shapes building design (see Help).

19	For passive solar heating face most of the glass area south to maximize winter sun exposure, but design overhangs to fully shade in summer
20	Provide double pane high performance glazing (Low-E) on west, north, and east, but clear on south for maximum passive solar gain
35	Good natural ventilation can reduce or eliminate air conditioning in warm weather, if windows are well shaded and oriented to prevailing breezes
42	On hot days ceiling fans or indoor air motion can make it seem cooler by 5 degrees F (2.8C) or more, thus less air conditioning is needed
11	Heat gain from lights, people, and equipment greatly reduces heating needs so keep home tight, well insulated (to lower Balance Point temperature)
3	Lower the indoor comfort temperature at night to reduce heating energy consumption (lower thermostat heating setback) (see comfort low criteria)
37	Window overhangs (designed for this latitude) or operable sunshades (awnings that extend in summer) can reduce or eliminate air conditioning
8	Sunny wind-protected outdoor spaces can extend living areas in cool weather (seasonal sun rooms, enclosed patios, courtyards, or verandahs)
1	Tiles or slate (even on wood floors) or a stone-faced fireplace provides enough surface mass to store winter daytime solar gain and summer nighttime 'coolth'
18	Keep the building small (right-sized) because excessive floor area wastes heating and cooling energy
62	Traditional passive homes in temperate climates used light weight construction with slab on grade and operable walls and shaded outdoor spaces
31	Organize floorplan so winter sun penetrates into daytime use spaces with specific functions that coincide with solar orientation
39	A whole-house fan or natural ventilation can store nighttime 'coolth' in high mass interior surfaces (night flushing), to reduce or eliminate air conditioning
49	To produce stack ventilation, even when wind speeds are low, maximize vertical height between air inlet and outlet (open stairwells, two story spaces, roof ...
16	Trees (neither conifer or deciduous) should not be planted in front of passive solar windows, but are OK beyond 45 degrees from each corner
4	Extra insulation (super insulation) might prove cost effective, and will increase occupant comfort by keeping indoor temperatures more uniform
15	High Efficiency furnace (at least Energy Star) should prove cost effective
33	Long narrow building floorplan can help maximize cross ventilation in temperate and hot humid climates
64	Traditional passive homes in mixed hot-humid and cold-clear climates used low mass well ventilated second floor, and a high mass sun tempered first floor
36	To facilitate cross ventilation, locate door and window openings on opposite sides of building with larger openings facing up-wind if possible



DESIGN STRATEGIES (Revised)

1. Design window openings in building toward the south at Philly to maximize passive solar gain in the window. But provide shading system along with the window system to allow users to reduce the solar energy into the building during the summer. It is better to design the shading system to follow the change of the sun angle through the day and the year to achieve the best result reducing the solar energy. Also, it is better to allow the shading system to be disabled or removed during the winder to allow the solar gain in the cold weather.

2. Water feathers (eg. fountain, water pond) and green spaces (eg. trees, grass, lawn) located around the concrete building will help cooler the ground temperature of the building and its adjacent environment. Shading system can be considered and added to the hottest area outside of the building to increase the comfort level near the concrete building. When design the shading system, the difference between sunlight direction and radiation need to be aware. Sunlight does not necessarily equal to radiation. radiation may not provide by direct sunlight. It can happen by reflection from glazing, for example.

3. If possible, allow window openings at the different direction of a building design to allow natural ventilation during the spring and fall seasons and help reduce the waste of cooling and heating energy provided by the air conditioner.