

# California Solar and New Solar Home Initiatives —The Rater's Role

## California Energy Rater and Energy Building Consultant Track

Wednesday, February 20, 2008 — Session 8 — 10:30-12:00 a.m.



2008 RESNET Conference—"A Changing Climate - An Emerging Opportunity"



# WELCOME

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# Solar Development and History

Solar planning has been part of the building industry for several millennium.



Sometimes it has been Passive Solar such as the Anasazi Cliff Dwellings in New Mexico.



# Solar Development and History—(CONTINUED)

Other times it has been very active legislation.



The Justinian Code, which was established as Law in AD 529-534.

Provided for Solar Access Rights.



## Solar Development and History—(CONTINUED)

The Greeks learned that Homes that faced South were warmer in the Winter.

The Romans improved the plan and added windows of glass or mica on the South elevation of the home.



# Solar Development and History—(CONTINUED)

A Roman 'Heliocaminus'—Sun furnace.

These ruins formed part of the Baths at Hadrian's Villa Adriana.



A Bath Complex that employed Windows on the SW Side.

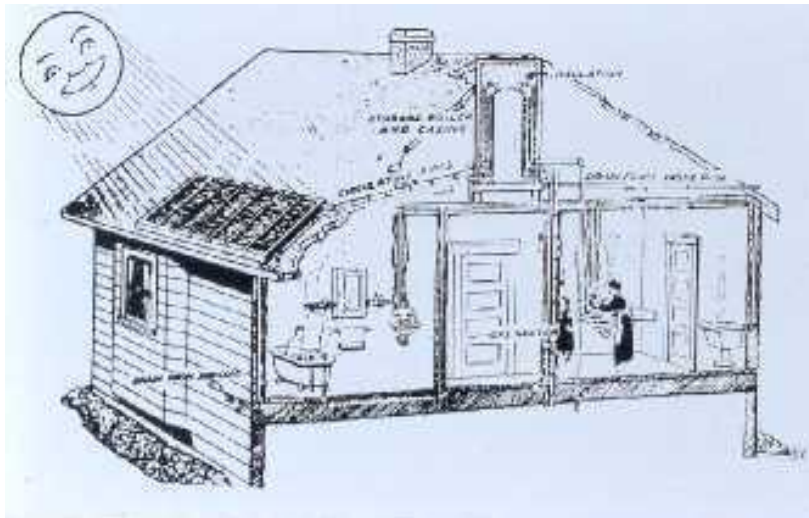




# Solar

## Timeline 1909-1918—(CONTINUED)

Between 1909 and 1918 Bailey sold more than 4,000 Day and Night Solar Hot Water Heaters.







# Solar

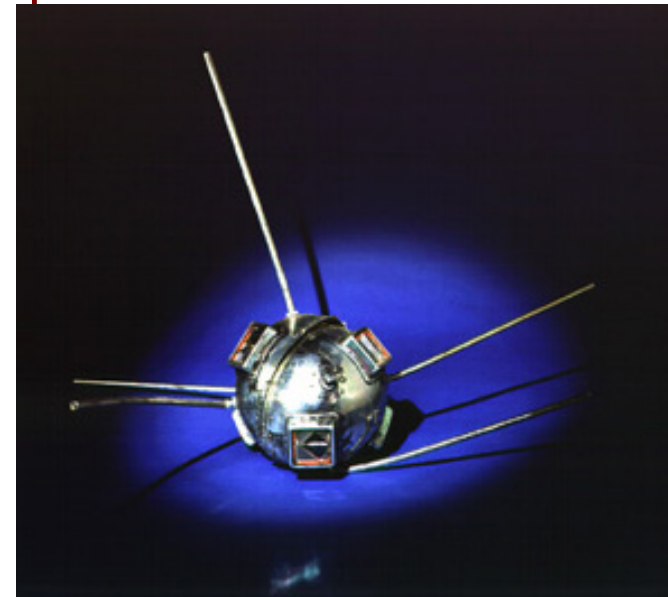
## Timeline 1956-1958—(CONTINUED)

**1956** -- William Cherry of U.S. Signal Corps Laboratories approaches RCA Labs' Paul Rappaport and Joseph Loferski about developing photovoltaic cells for proposed Earth-orbiting satellites.

**1957** -- Hoffman Electronics achieves 8% efficient photovoltaic cells.

**1958** -- T. Mandelkorn of U.S. Signal Corps Laboratories fabricates n-on-p (negative layer on positive layer) silicon photovoltaic cells, making them more resistant to radiation; this is critically important for cells used in space.

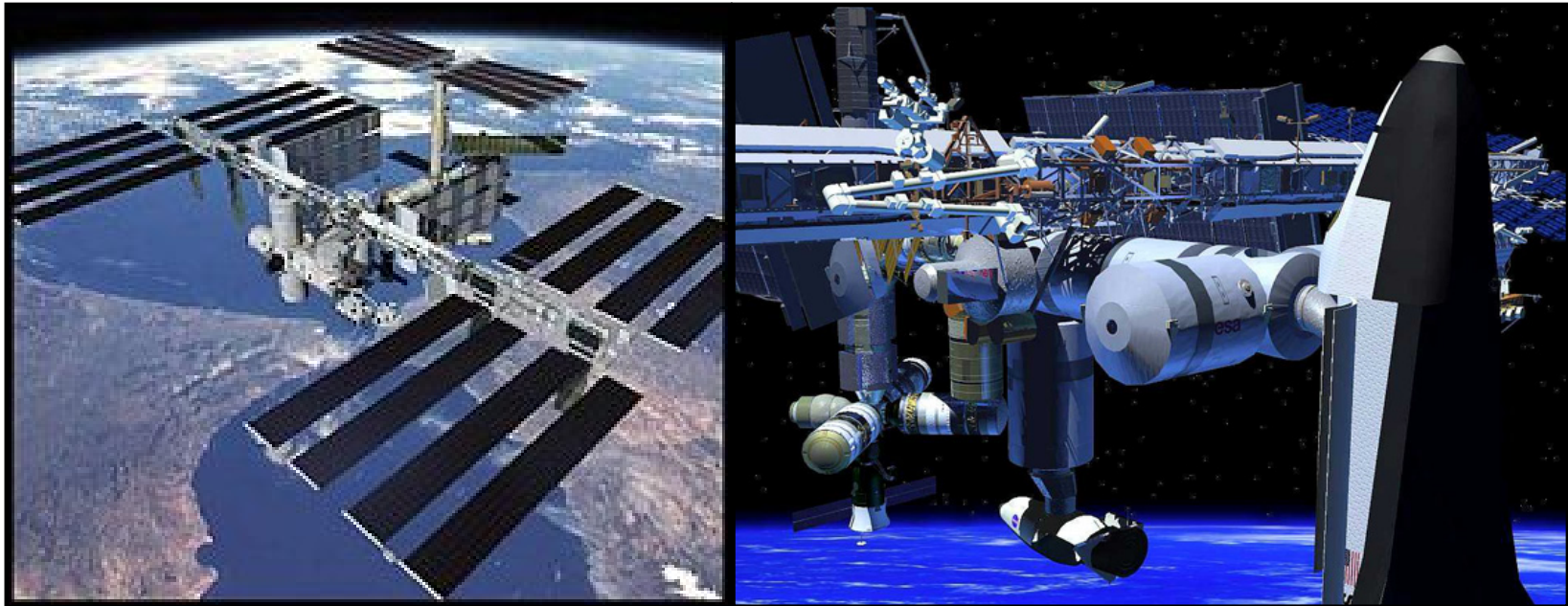
Hoffman Electronics achieves **9% efficient** photovoltaic cells





# Solar Timeline TODAY—(CONTINUED)

## Space—Life Support and Systems Management





# Solar Timeline TODAY—(CONTINUED)

## Business





# Solar Timeline TODAY—(CONTINUED)



Homes



# New Solar Homes Partnership Program



<http://www.gosolarcalifornia.org/>

Solar Information | Solar for NEW Homes | Solar for Your EXISTING Home | Solar for NON-Residential Buildings | Solar for Low-Income & Affordable Housing | Solar for Municipal Utility Customers | News, Calendar & Search

## Go Solar California!

**Awarded Silver Award**  
by  
**California State Information Officers' Council**

California has set a goal to create 3,000 megawatts of new, solar-produced electricity by 2017. From this page, you'll be able to go to the websites for solar on new or existing homes and solar for businesses, schools and public buildings.

The California Energy Commission funds solar electricity systems on **NEW** homes.

The California Public Utilities Commission funds solar electricity systems on **businesses** and **EXISTING** homes.

Information in Spanish • Chinese • Japanese • Korean • Tagalog • Vietnamese

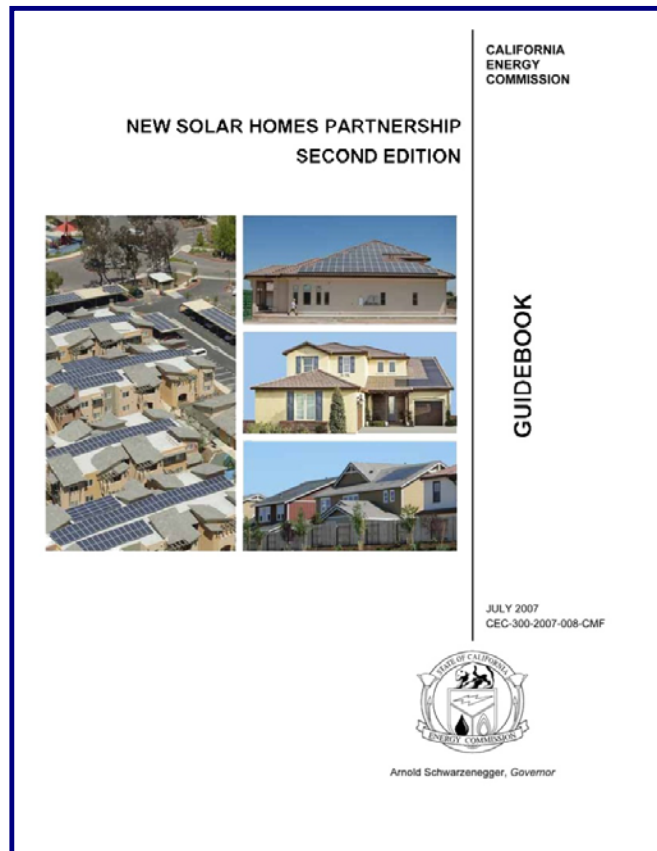
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# New Solar Homes Partnership Program—(CONTINUED)

The Final guidebook can be downloaded:

<http://www.gosolarcalifornia.ca.gov/documents/index.html>





# Solar PV Components

## **Solar Panels (Modules), (PV), (Arrays)**

Come in many types.

**Inverters**

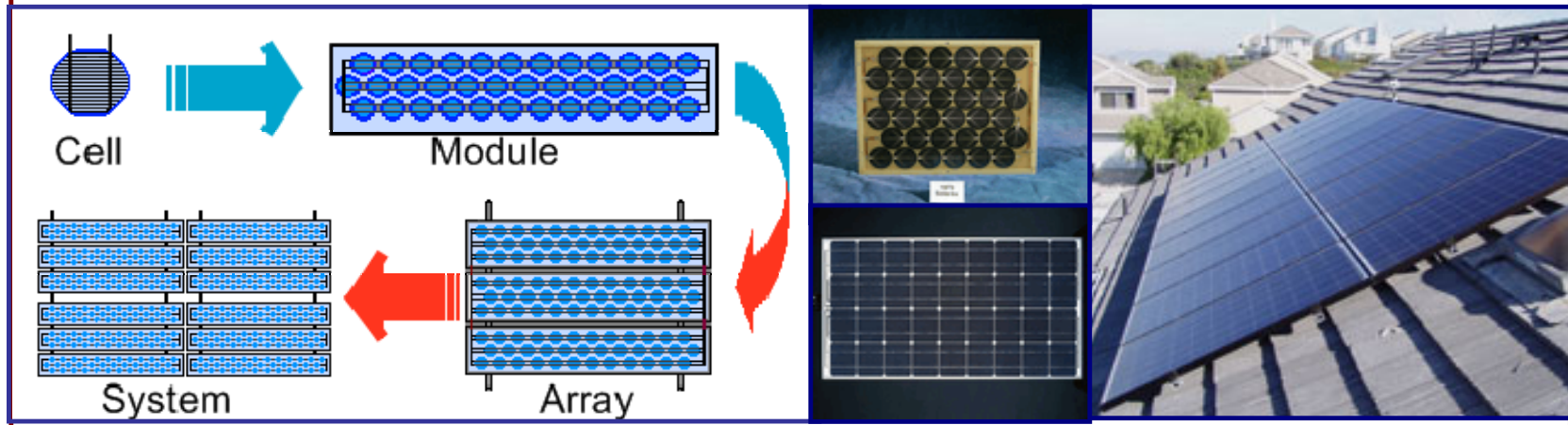
**Performance Meters**



# Solar PV Components—(Continued)

## The Photovoltaic Panels

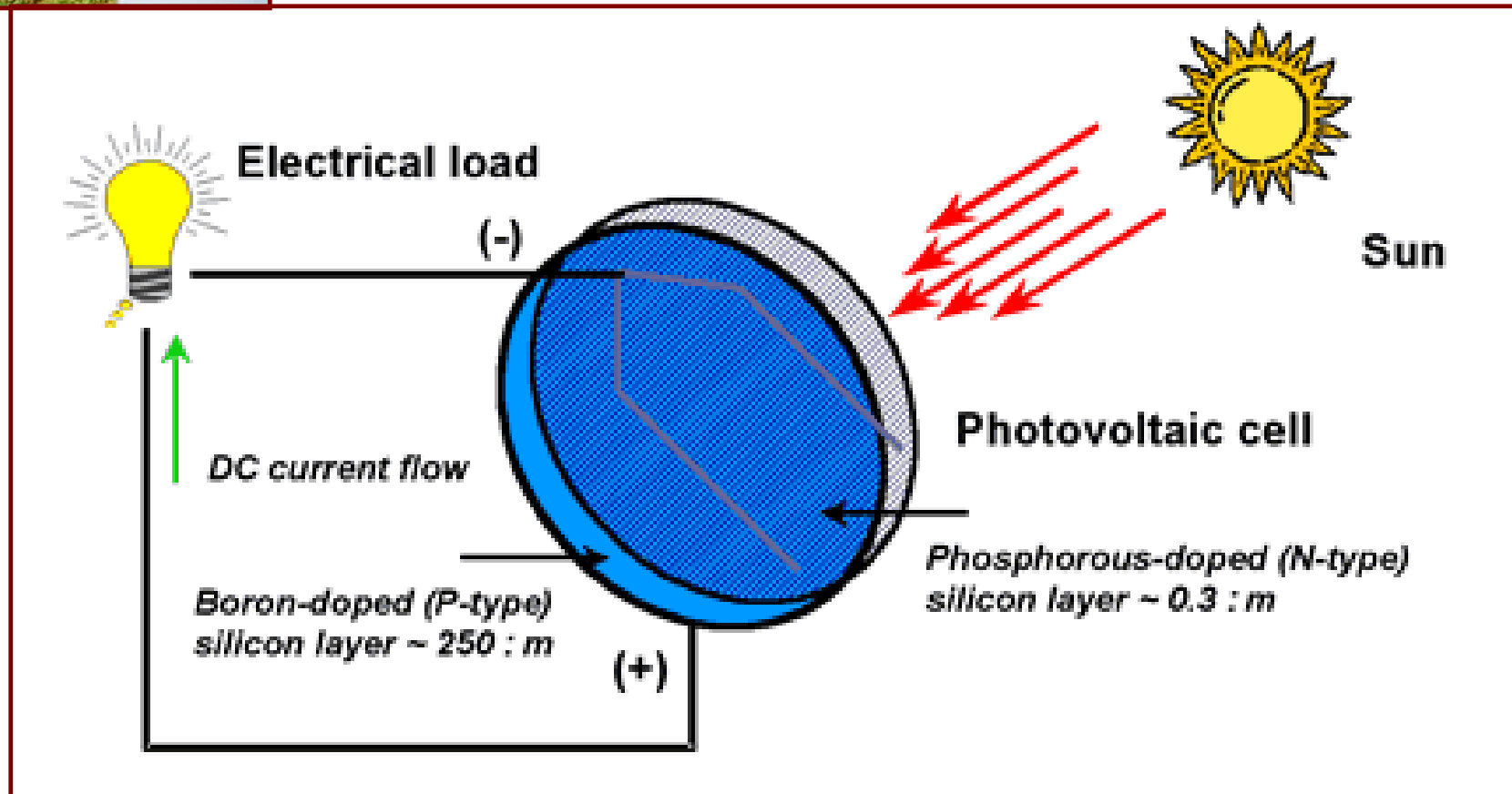
Photovoltaic panels, PV, are made of semiconductor materials.







# Solar PV Components—(Continued)





## Solar PV Components—(Continued)

PV installer verifies that the same number of each make and model number of PV modules used in the expected performance calculations are installed in the field.

HERS rater must verify that make, model, and count of modules are consistent with CF-1R-PV.



# Solar PV Components—(Continued)

## The Inverter

An inverter takes DC electricity from the solar panels or batteries, and converts it into the AC electricity used by common household appliances.





# Solar PV Components—(Continued)



## The Inverter

Verify that the make and model of inverters used in the expected performance calculations are installed in the field.



# Solar PV Components—(Continued)

## Performance Meters

Measures and displays output AC power.





# Solar PV Components—(Continued)

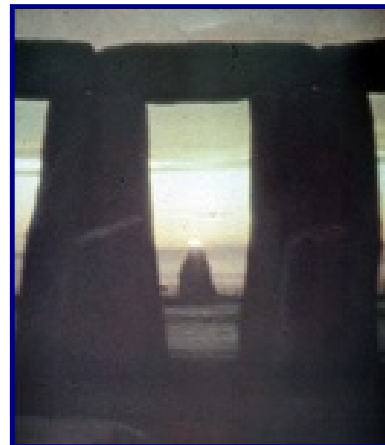


## Performance Meter

Verify that either a separate system performance meter or an inverter with an integral system performance meter is installed.



# The Rater's Role





# CF-1R

# NSHP-Tier 1

## 6. T-24 Documentation

CF-1R that shows a savings of 15 percent or more, of the combined space heating, space cooling and water heating energy compared to Title 24.

Every builder supplied appliance is labeled "*Energystar*".

Solar water heating may be used to assist in meeting the requirements.





CF-1R—(Continued)

## NSHP-Tier 2

### 7. T-24 Documentation

CF-1R that shows a savings of 35 percent or more, of the combined space heating, space cooling and water heating energy.

**And**

40 percent of the savings must be from the air conditioning energy compared to current T24.

Every builder supplied appliance is labeled “*Energystar*”.

Solar water heating may be used to assist in meeting the requirements.



# CF-1R—(Continued)

## NSHP-Tier 2

TDV (kBtu/sf-yr)	Standard Design	Facing North	Margin	Facing East	Margin	Facing South	Margin	Facing West	Margin
Space Heating	17.93	12.69	5.24	12.97	4.96	13.40	4.53	13.09	4.84
Space Cooling	15.61	5.36	10.25	6.30	9.31	5.11	10.50	6.13	9.48
Fans	3.21	1.89	1.32	2.14	1.08	1.87	1.34	2.10	1.12
Domestic Hot Water	10.97	9.29	1.68	9.29	1.68	9.29	1.68	9.29	1.68
Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Totals</b>	<b>47.73</b>	<b>29.22</b>	<b>18.50</b>	<b>30.70</b>	<b>17.03</b>	<b>29.68</b>	<b>18.05</b>	<b>30.60</b>	<b>17.12</b>
<b>Percent better than Standard:</b>		<b>38.8%</b>		<b>35.7%</b>		<b>37.8%</b>		<b>35.9%</b>	
<b>BUILDING COMPLIES - HERS VERIFICATION REQUIRED</b>									

CF-1R shows that home is 35.7% better than T 24.  
Is the COOLING 40% better than Standard Design?

$$9.31/15.61 = .5964 \text{ or } 59.6\%$$

Look at the other orientations!  
North—65.7%; South—67.3%; West—60.7%



**CF-1R**—(Continued)

# **CF-1R Preparation**

## **The CF-1R must:**

Show the measures used to meet the energy savings requirements,

Provide the listing of measures requiring field verification.

By prepared Certified Energy Plans Examiners (CEPE) recognized by CABEC.

Be uploaded digitally into the data registry of a 'California' HERS Provider.



## System Size Justification

System 5kW or less is assumed to be in compliance.

System over 5kW requires justification. See Appendix 2.



# Raters NSHP Verification Process

Verify all HERS Measures that specified on the CF-1R.

Verify the Mandatory Measures.

Building Envelope

Equipment Efficiencies

Windows, U-factors, SHGC, Size and Orientation.

Residential Lighting

Shading, Thermal Mass And Radiant Barriers



# PV Modules



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# PV Modules—(CONTINUED)



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# PV Modules—(CONTINUED)



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# PV Modules—(CONTINUED)



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# PV Modules—(CONTINUED)



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# PV Modules—(CONTINUED)



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# Inverter(s)



Verify that the make and model of inverters used in the expected performance calculations are installed in the field.



# Inverter(s)—(CONTINUED)





# Inverter(s)—(CONTINUED)



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# Inverter(s)—(CONTINUED)



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# Verification Process

## Visual inspection/verification

- Verify Equipment
- Check if CFI
- Verify array tilt & azimuth (CFI or actual)

## Shading analysis

- Check if minimally shaded
- Verify 2:1 D/H ratio of roof obstructions
- Verify D/H ratio or altitude angle of planted/planned trees
- Verify D/H ratio of existing or planned neighboring buildings

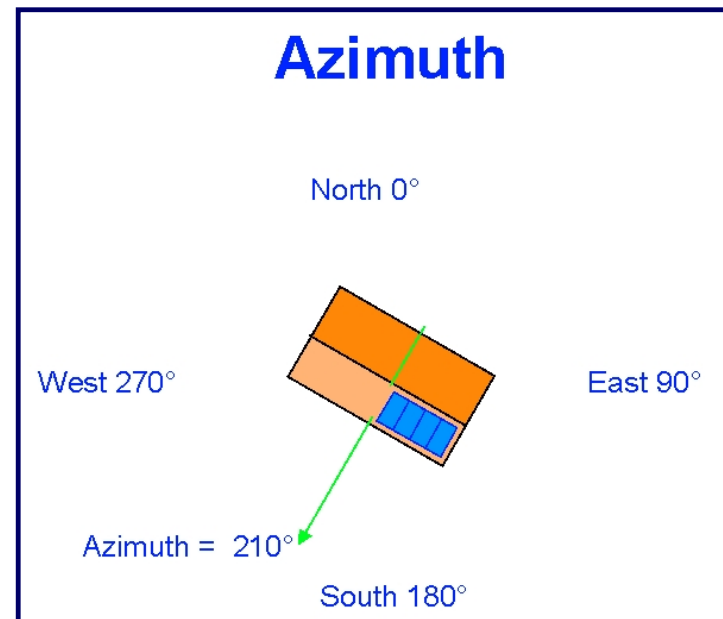
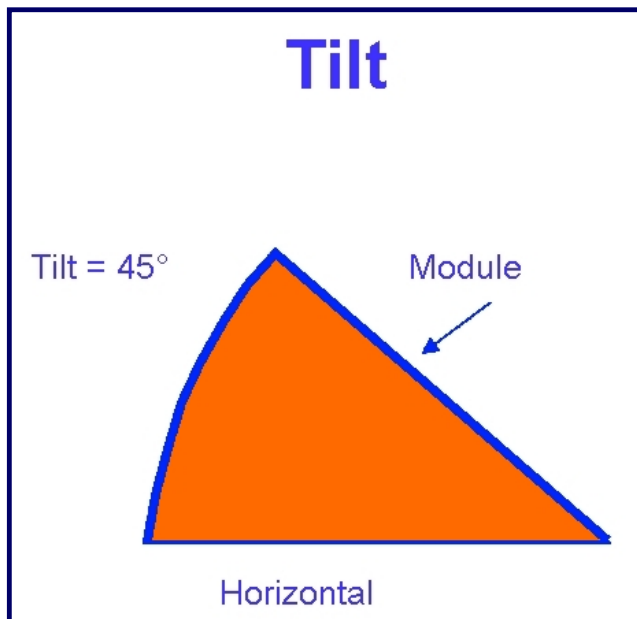
## Performance diagnostics

- Measure solar irradiance in plane parallel to array
- Measure ambient temperature in the shade
- Verify system output  $\geq$  expected output at measured conditions





# Tilt & Azimuth





## CA Flexible Install Criteria

For each system using the CFI criteria, HERS rater must verify that modules are installed with azimuth and tilt within the acceptable ranges.

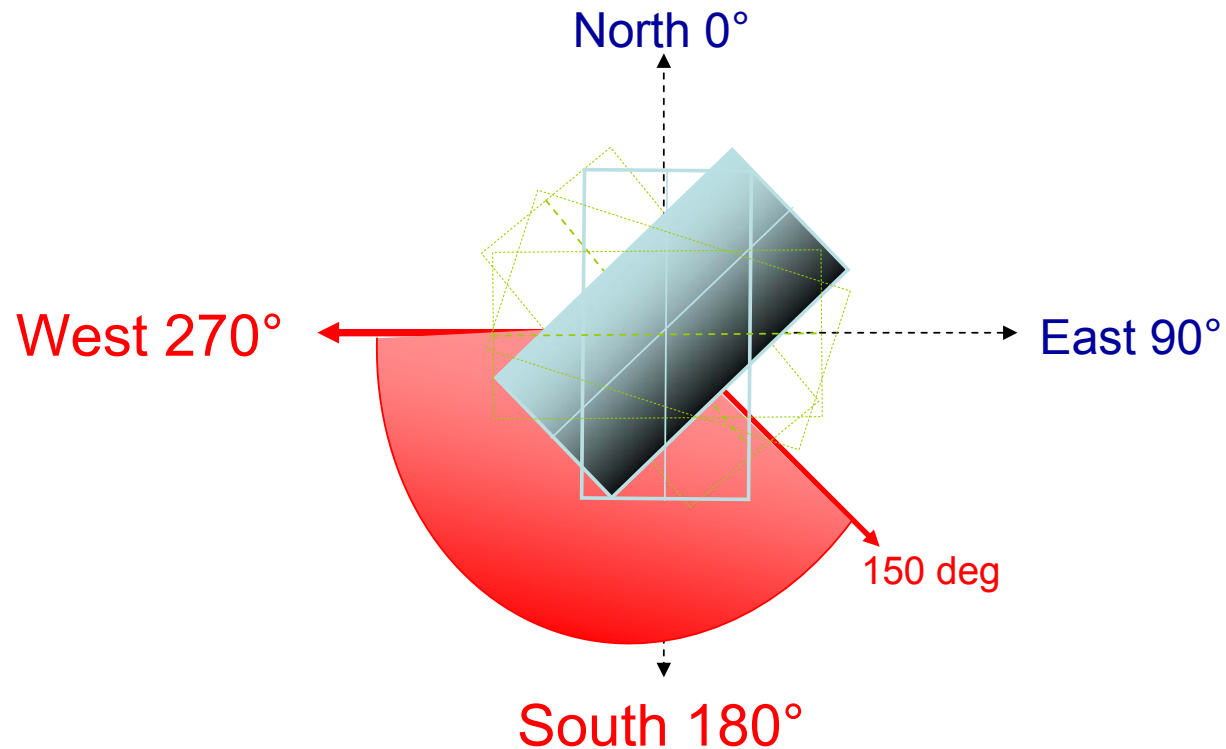
**(150°-270°, 1:12-7:12)**

Note that each solar system using the CFI criteria must meet the minimal shading criterion.



# CA Flexible Install Criteria

- *Azimuth*
- *Roof Pitch (1:12 - 7:12)*
- *Minimal Shading*





## Verifying Azimuth Using a Compass



Compass measurements must be corrected for magnetic declination.

Determine the array azimuth angle between compass north and the direction that the PV modules face.

Stay 15-20 feet away from any objects containing iron or steel.



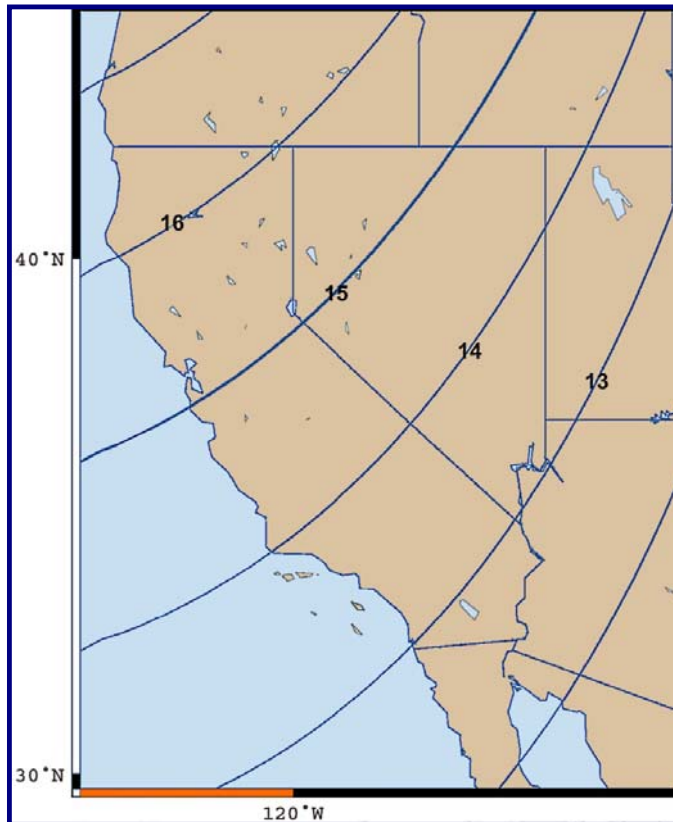
## Determining Magnetic Declination For Compass Corrections

Go to the NOAA Website (see resource section) to determine actual declination for the zipcode where the PV panels are installed.

<http://www.ngdc.noaa.gov/seg/geomag/jsp/Declination.jsp>



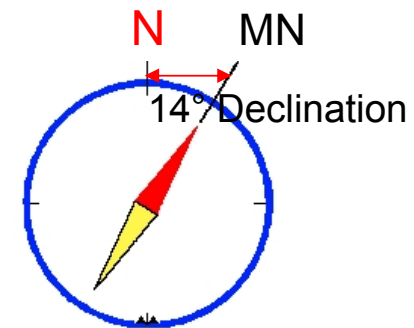
# Magnetic Declination



Magnetic declination is the angle between the local magnetic field (the direction the north end of a compass points) and true north.

The declination is positive when the magnetic north is east of true north.

All of the points in California are east declination.



Website:

<http://www.ngdc.noaa.gov/seg/geomag/declination.shtml>



## APPENDIX 4. F —Shading Verification





## APPENDIX 4. F Shading Verification—(CONTINUED)







# Examples

## Minimal Shading Criteria



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Examples—(Continued)

## Minimal Shading Criteria



1. Identify Shading object.
2. Where is South?
3. What is the relationship of the vent to the solar path and the lowest corner of the PV?



Examples—(Continued)

## Minimal Shading Criteria



**Does this satisfy the  
2:1 criteria?**



Examples—(Continued)

## Minimal Shading Criteria



Does this satisfy the  
2:1 criteria?

South Facing 180°



## Shading Analysis

# Mature Tree Height

If the **type of tree is unknown**, it must be **assumed to be large**.

The mature heights of trees used in the expected performance calculations are:

Small Trees--20 feet

Medium Trees--35 feet

Large Trees--50 feet



## Examples

# Mature Tree Height



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Examples—(Continued)

# Mature Tree Height





Examples—(Continued)

## Mature Tree Height



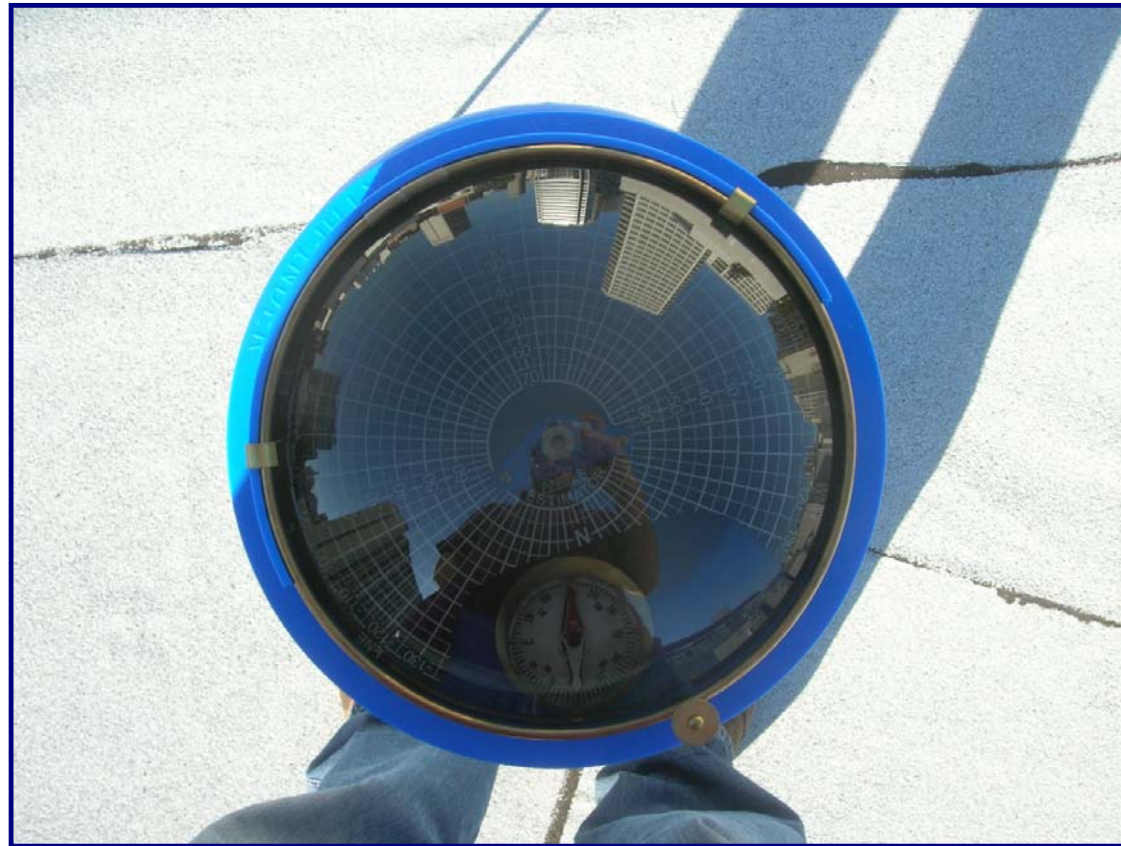
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# Shading Analysis Using Solar Pathfinder



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## Shading Analysis Using Solar Pathfinder

On-site shading conditions can be verified using a Solar Pathfinder.

Position at the point on the PV array that has the maximum shading. Corrections can be made if used from the ground.

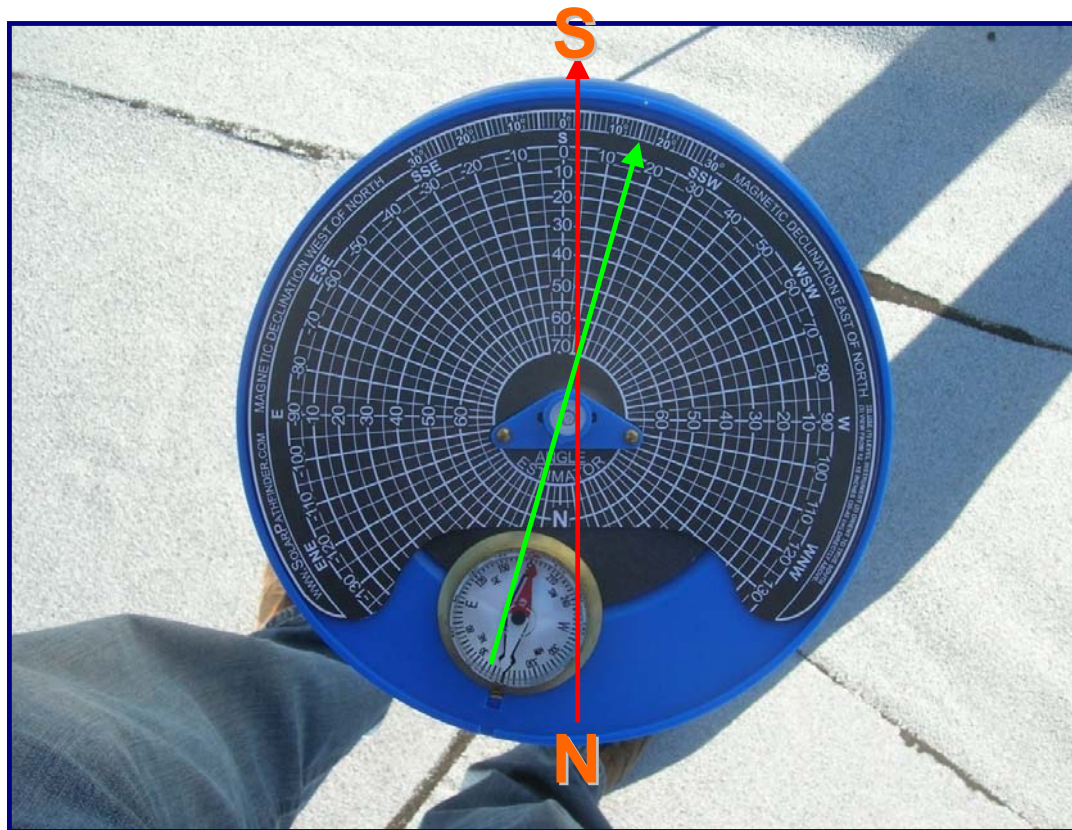
The instrument is **leveled** and **oriented with true north**.

Using the **angle estimator grid** will give the information in the format used by the CEC PV Calculator.



# Shading Analysis—(Continued)

## Using Solar Pathfinder



Solar Pathfinder with the Angle Estimator Template.

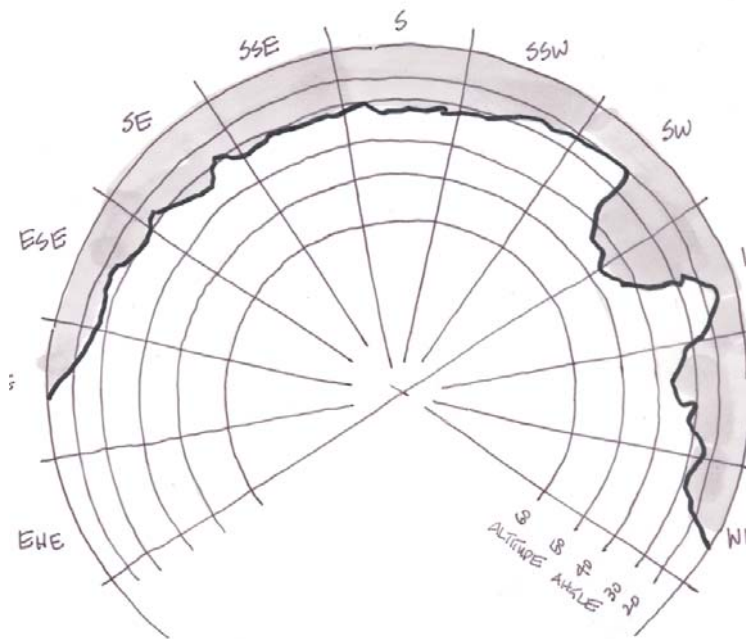
Note: the Pathfinder is set-up for 16° Declination.



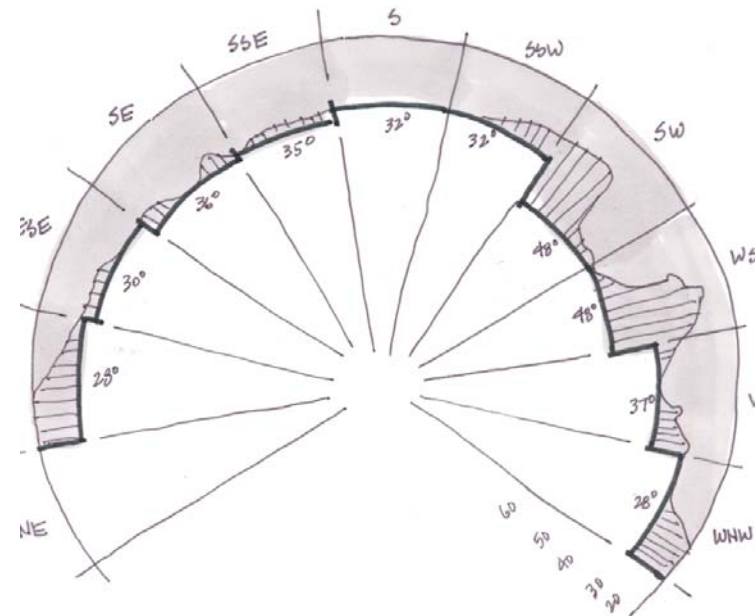
# Shading Analysis—(Continued)

## Using Solar Pathfinder

Scribed Angle Estimator



Shading by Sectors Completed





## Shading Analysis—(Continued)

# Using Solmetric SunEye



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## Shading Analysis—(Continued)

# Using Solometric SunEye

An electronic enhancement of the Solar Pathfinder uses a digital camera with a fisheye lens that is mounted looking up.

An image is taken that is automatically processed to produce data similar to the solar pathfinder.

The data must be downloaded to a computer and converted to the format used for determining expected performance.



# Site Verification



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# Checking Tilt and $w/m^3$



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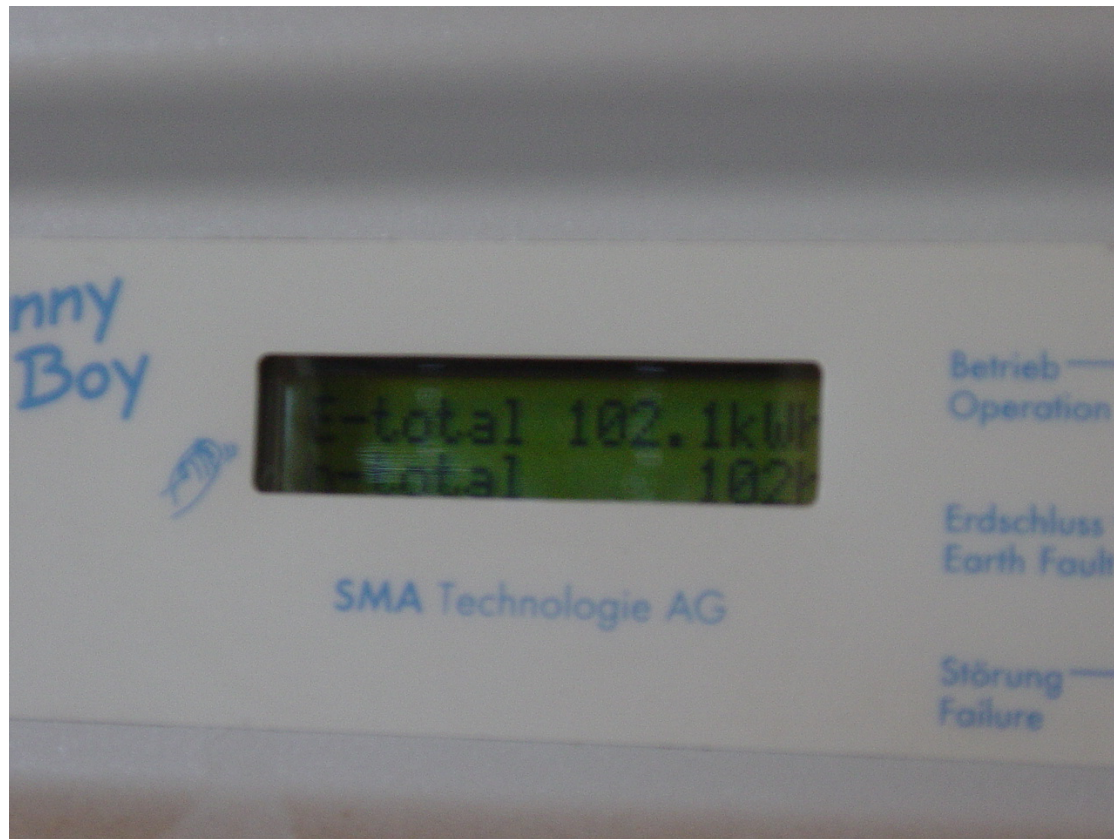


# Inverter in Garage





# Inverter





# Checking the CF-1R-PV



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Round Temperature Down

FIELD VERIFICATION TABLE

FVT105

L <sub>t</sub> (W/m <sup>2</sup> )	T=15	T=20	T=25	T=30	T=35	T=40	T=45	T=50	T=55	T=60	T=65	T=70	T=75	T=80	T=85	T=90	T=95	T=100	T=105	T=110	T=115	T=120
300	836	823	810	797	784	772	759	746	734	721	708	696	683	671	658	646	634	621	609	597	585	572
325	842	834	825	817	808	800	791	783	774	766	757	749	740	731	723	714	705	696	688	679	670	661
350	908	899	890	881	872	863	853	844	835	826	817	807	798	789	779	770	761	751	742	732	723	713
375	974	964	955	945	935	925	916	906	896	886	876	866	856	846	836	826	816	806	796	786	776	766
400	1040	1030	1019	1009	999	988	978	967	957	946	936	925	915	904	893	883	872	861	851	840	829	818
425													873	862	851	839	828	817	805	794	782	771
450												032	1020	1008	996	984	972	960	948	936	923	
475											090	1078	1065	1053	1040	1027	1014	1002	989	976		
500											149	1136	1123	1109	1096	1082	1069	1056	1042	1029		
525											207	1193	1179	1166	1152	1138	1124	1110	1095	1081		
550											265	1251	1236	1222	1207	1192	1178	1163	1148	1134		
575											323	1308	1293	1278	1262	1247	1232	1216	1201	1186		
600	1568	1552	1537	1522	1506	1491	1475	1459	1444	1428	1412	1397	1381	1365	1349	1333	1317	1301	1285	1269	1253	1237
625	1633	1617	1601	1585	1569	1553	1536	1520	1504	1488	1471	1455	1438	1422	1405	1389	1372	1356	1339	1322	1306	1289
650	1697	1681	1664	1648	1631	1614	1598	1581	1564	1547	1530	1513	1496	1479	1461	1444	1427	1410	1392	1375	1358	1340
675	1762	1744	1727	1710	1693	1675	1658	1641	1623	1606	1588	1570	1553	1535	1517	1499	1481	1463	1445	1427	1409	1391
700	1825	1808	1790	1772	1754	1736	1718	1700	1682	1664	1646	1628	1609	1591	1572	1554	1535	1517	1498	1479	1461	1442
725	1888	1871	1852	1834	1815	1797	1778	1759	1741	1722	1703	1684	1665	1646	1627	1608	1589	1570	1550	1531	1512	1492
750	1952	1933	1914	1895	1876	1857	1837	1818	1799	1779	1760	1740	1721	1701				1622	1602	1582	1562	1542
775	2015	1995	1975	1956	1936	1916	1896	1876	1856	1836	1816	1796	1776	1756				1674	1654	1633	1613	1592
800	2077	2057	2037	2016	1996	1975	1955	1934	1914	1893	1872	1852	1831	1810				1726	1705	1683	1662	1641
825	2139	2118	2097	2076	2055	2034	2013	1992	1971	1949	1928	1906	1885	1863				1777	1755	1733	1711	1690
850	2200	2179	2157	2136	2114	2092	2071	2049	2027	2005	1983	1961	1939	1917	1895	1872	1850	1828	1805	1783	1760	1738
875	2280	2239	2217	2195	2172	2150	2128	2105	2083	2060	2038	2015	1992	1969	1947	1924	1901	1878	1855	1832	1809	1785
900	2376	2376	2376	2253	2230	2207	2184	2161	2138	2115	2092	2068	2045	2022	1998	1975	1951	1928	1904	1880	1856	1833
925	2376	2376	2376	2376	2376	2376	2240	2217	2193	2169	2145	2121	2097	2073	2049	2025	2001	1977	1953	1928	1904	1879
950	2376	2376	2376	2376	2376	2376	2376	2376	2247	2223	2198	2174	2149	2125	2100	2075	2050	2026	2001	1976	1951	1926
975	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2251	2226	2201	2175	2150	2125	2099	2074	2048	2023	1997	1971
1000	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2251	2225	2199	2173	2147	2121	2095	2069	2043
1025	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2248	2222	2195	2168	2142	2115	2088	2061
1050	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2242	2215	2188	2160	2133	2105
1075	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2233	2205	2177	2149	
1100	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2250	2221	2192	
1125	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2235
1150	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376
1175	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376
1200	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376	2376

83° Ambient Temperature  
685 W/m<sup>2</sup>

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Round Irradiance Up

