
Shade Measurements for California Solar Rebates

Current requirements and upcoming changes

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California Rebates



CSI

CSI Incentive Calculator
(formerly EPBB Calculator)

"Major corners method"



NSHP

CEC PV Calculator

"Closest point method"

Multiple small municipal
utility programs



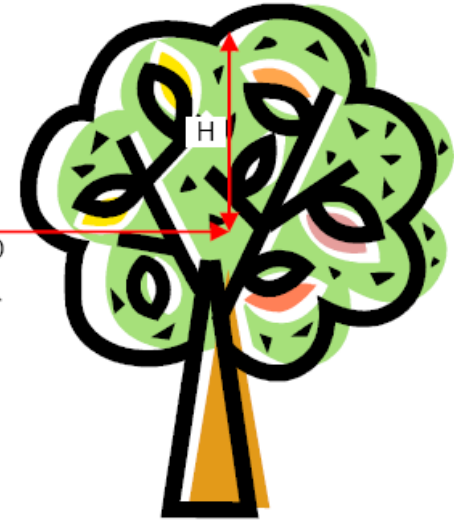
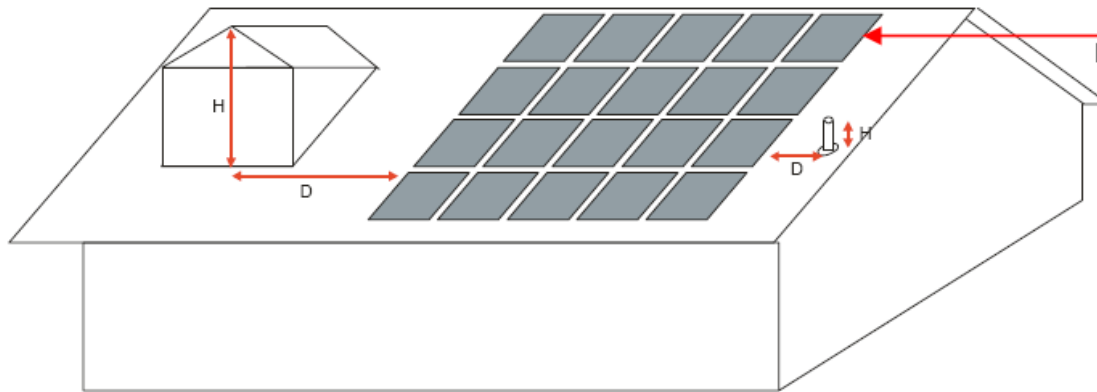
SB-1

New Requirements in July 2009



"Minimal Shading"

Minimum Shading if $D > (2 \times H)$



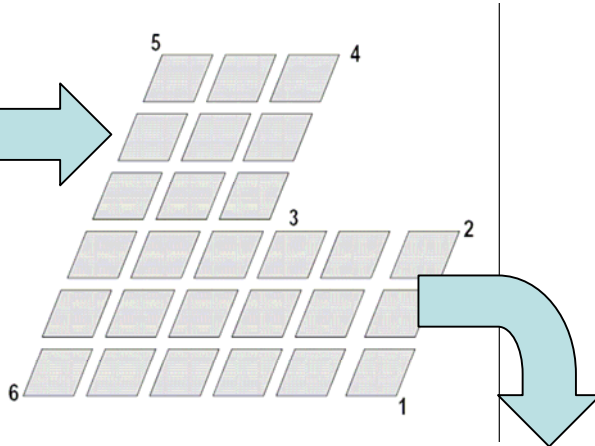
- D is distance to closest point on the array
- H is height above the array
- D/H ratio: more is better!
- Obstruction Elevation angle $\theta_r = \text{TAN}^{-1}(H/D)$: less is better!
- $D/H > 2$ is California Minimal Shading ~26 degrees
- $D/H > 3+$ is "shade free 9-3"

Shade Measurements

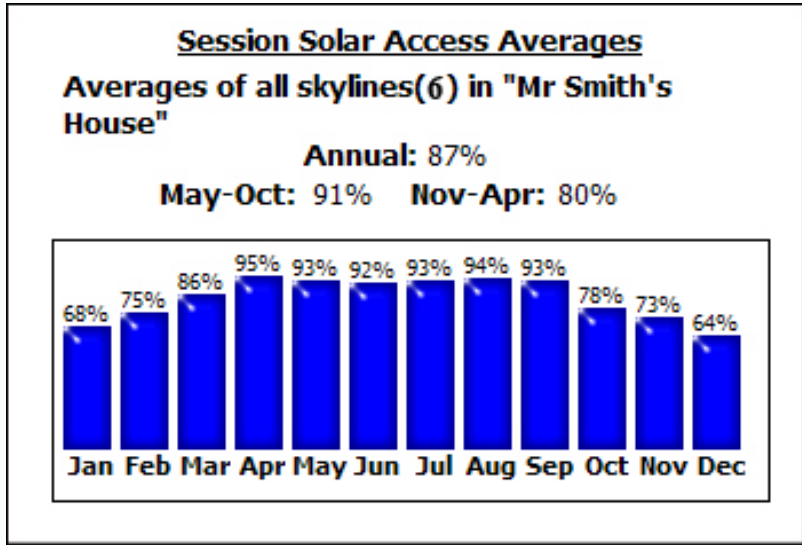


The SunEye

California CSI Incentive Calculator



"Major corners method"



Shading: Minimal Shading

Shading Derate Factors (%)

January	<input type="text" value="100"/>
February	<input type="text" value="100"/>
March	<input type="text" value="100"/>
April	<input type="text" value="100"/>
May	<input type="text" value="100"/>
June	<input type="text" value="100"/>
July	<input type="text" value="100"/>
August	<input type="text" value="100"/>
September	<input type="text" value="100"/>
October	<input type="text" value="100"/>
November	<input type="text" value="100"/>
December	<input type="text" value="100"/>

Array Tilt (degrees):

Array Azimuth (degrees):

North 0°
270° 90°
180°



CEC PV Calculator (NSHP)

User Input for Describing Shading

"Closest point method"

Orientation - Enter Shading Azimuth Here	Obstruction Type	Height* of Shading Obstruction	Horizontal Distance to Shading Obstruction	Shading Angle
1 ENE (Azimuth >55 to 78.75)	Small Tree (existing - mature)		40	
2 E (Azimuth >78.75 to 101.25)	Large Tree (existing - not mature)		60	
3 ESE (Azimuth >101.25 to 123.75)	On Roof Obstruction (Enter Distance and Height)	5	7	
4 SW (Azimuth >213.75 to 236.25)	Neighboring Structure (Enter Distance and Height)	50	60	
5				
6				

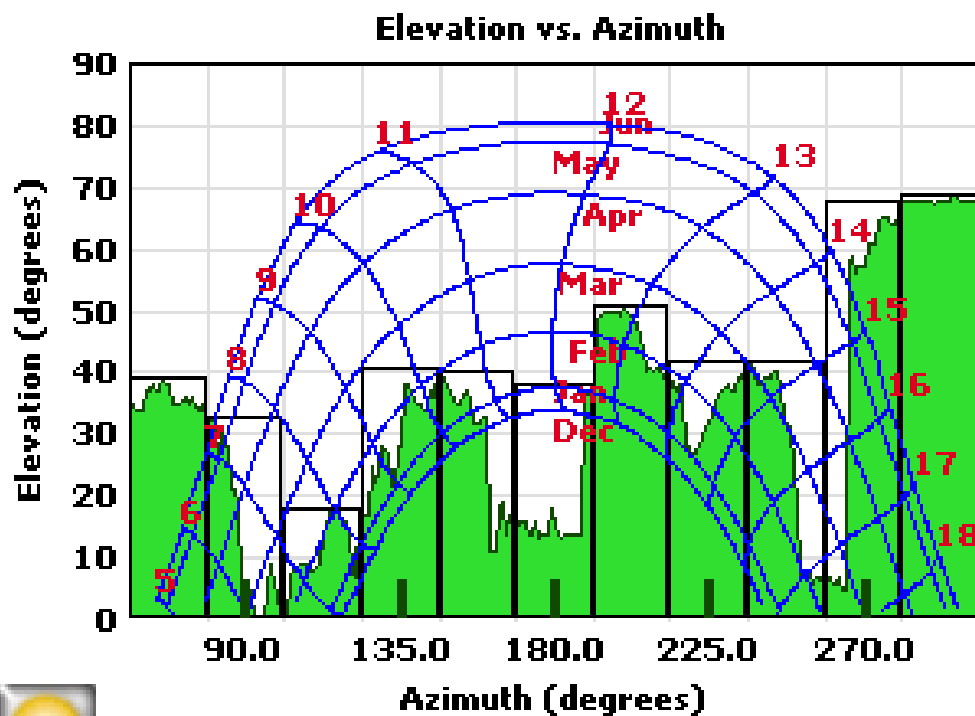


Simulation

SHADING TABLE						
Orientation	Obstruction Type	Altitude Angle to Shading Obstruction	Distance To Height Ratio	Minimum Distance To Small Tree	Minimum Distance To Medium Tree	Minimum Distance To Large Tree
CF-1R-PV ENE (55-79)	N/A	Min Shading	2	16	46	76
E (79-101)	Large Tree (existing - not mature)	32 degrees	1.58	N/A	N/A	N/A
ESE (101-124)	On Roof Obstruction (Enter Distance and Height)	36 degrees	1.4	N/A	N/A	N/A
SE (124-146)	N/A	Min Shading	2	16	46	76
SSE (146-169)	N/A	Min Shading	2	16	46	76
S (169-191)	N/A	Min Shading	2	16	46	76
SSW (191-214)	N/A	Min Shading	2	16	46	76
SW (214-236)	Neighboring Structure (Enter Distance and Height)	32 degrees	1.58	N/A	N/A	N/A
WSW (236-259)	N/A	Min Shading	2	16	46	76
W (259-281)	N/A	Min Shading	2	16	46	76
WNW (281-305)	N/A	Min Shading	2	16	46	76

SunEye "Obstruction Elevation" View (New in version 2.8)

- Obstruction Elevation Angle vs. Azimuth
- Max (or average) elevation in azimuth windows
- NSHP example



Horizon View Properties Cancel OK

Display Azim Range

Azimuth center: 180.0°

Azimuth window: 22.5°

Number of windows: 11

Maximum
 Average

Elevation Table OK

Azimuth Center	Average Elevation	Azimuth Center	Average Elevation
67.5°	15°	202.5°	32°
90.0°	12°	225.0°	49°
112.5°	29°	247.5°	46°
135.0°	36°	270.0°	37°
157.5°	50°	292.5°	35°
180.0°	43°		



SB1 Expectations for Rebate Programs

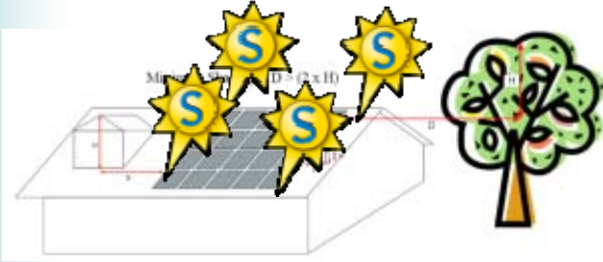
- Overall goals:
 - High Quality Solar Energy Systems with maximum performance to promote highest production per taxpayer/ratepayer dollar
 - Optimal System Performance During Peak Demand Periods
 - Energy Efficiency Measures Wherever Solar is Installed
- Impact on shading:
 - Three approved methods
 - More conservative approach
 - May increase shade impact on rebates



New SB1 shade reporting methods

3 possibilities for July '09 requirement – which of 3 is TBD

- 11 sectors (22.5 degree Azimuth Window): Maximum elevation angle for each sector, from any point on the array



Azimuth Window Center (North=0; East=90)	Maximum Elevation (0-90) MAXIMUM	Maximum Elevation (0-90) SKY01	Maximum Elevation (0-90) SKY02	Maximum Elevation (0-90) SKY03	Maximum Elevation (0-90) SKY04
67.5	24	24	22	22	20
90	24	17	19	21	24
112.5	35	22	26	29	35
135	39	30	32	25	39
157.5	62	62	50	43	22
180	55	40	43	45	55
202.5	55	40	36	55	52
225	55	25	53	55	28
247.5	51	20	25	28	51
270	52	48	52	33	52
292.5	42	37	42	33	37

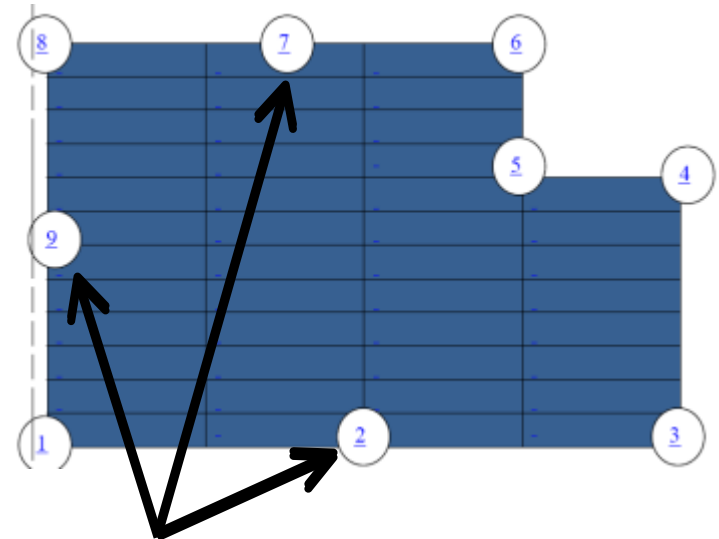
- 360 degrees (1 degree sectors): Maximum elevation angle for each sector, from any point on the array

New SB1 shade reporting methods (cont.)

3. Monthly Solar Availability: Twenty values (Average major corners)

- Shade Impact Factor – Default 2, doubles shade impact/"cost"
 - Equipment Vendors can try for lower values.

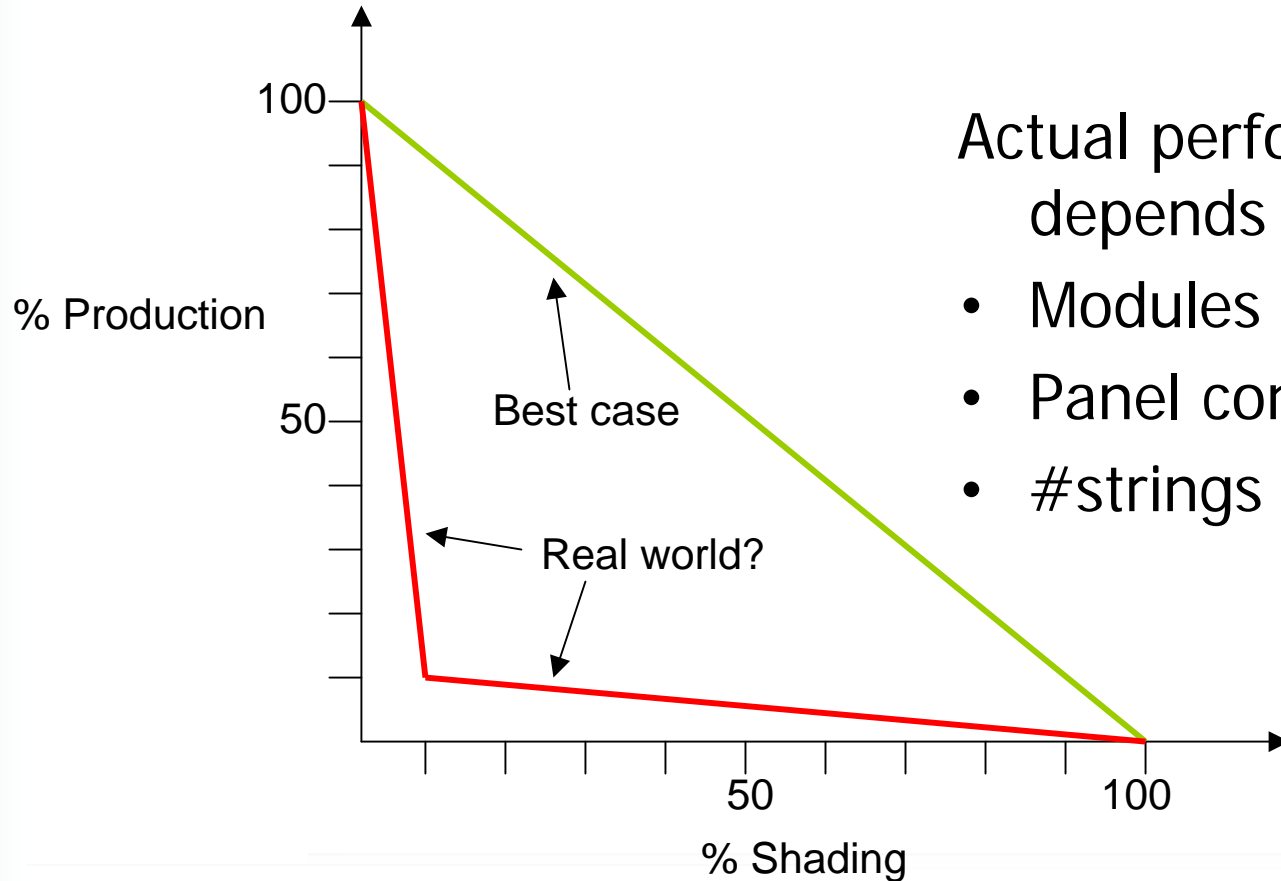
<u>Month</u>			
	<u>7 am to 7 pm</u>		
<u>1</u>	<u>0.83</u>		
<u>2</u>	<u>0.88</u>		
<u>3</u>	<u>0.94</u>		
<u>4</u>	<u>0.97</u>		
<u>5</u>	<u>0.97</u>		
	<u>7 am to 12 noon</u>	<u>12 pm to 3 pm</u>	<u>3pm to 7 pm</u>
<u>6</u>	<u>0.94</u>	<u>1.00</u>	<u>1.00</u>
<u>7</u>	<u>0.94</u>	<u>1.00</u>	<u>1.00</u>
<u>8</u>	<u>0.93</u>	<u>1.00</u>	<u>0.98</u>
<u>9</u>	<u>0.93</u>	<u>1.00</u>	<u>0.91</u>
	<u>7 am to 7 pm</u>		
<u>10</u>	<u>0.91</u>		
<u>11</u>	<u>0.84</u>		
<u>12</u>	<u>0.80</u>		



Intermediate measurements required only if distance is 40 ft or more.

Why a Shade Impact Factor?

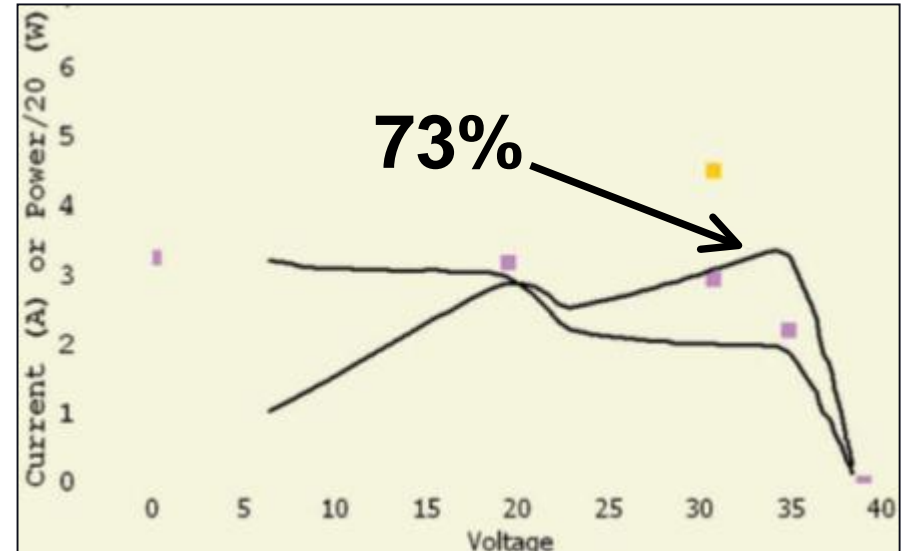
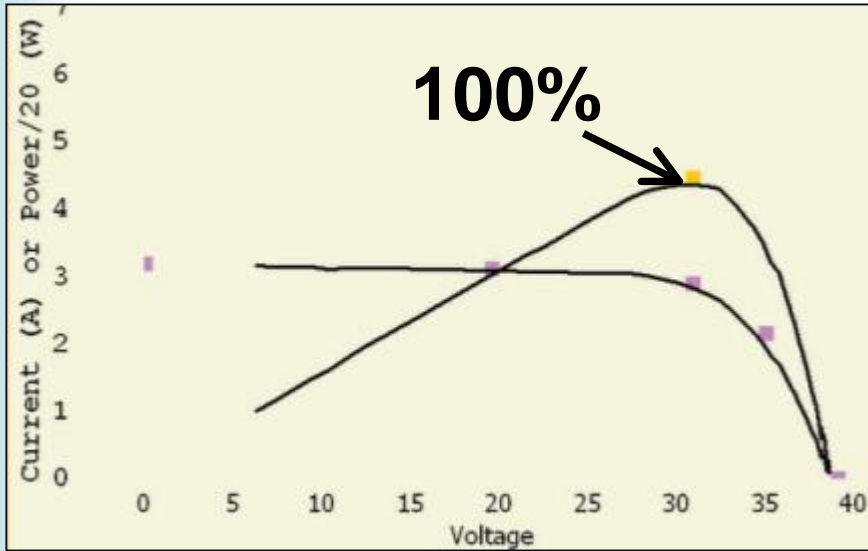
A little shading goes a long way



Actual performance depends on:

- Modules bypass diodes
- Panel configuration
- #strings affected

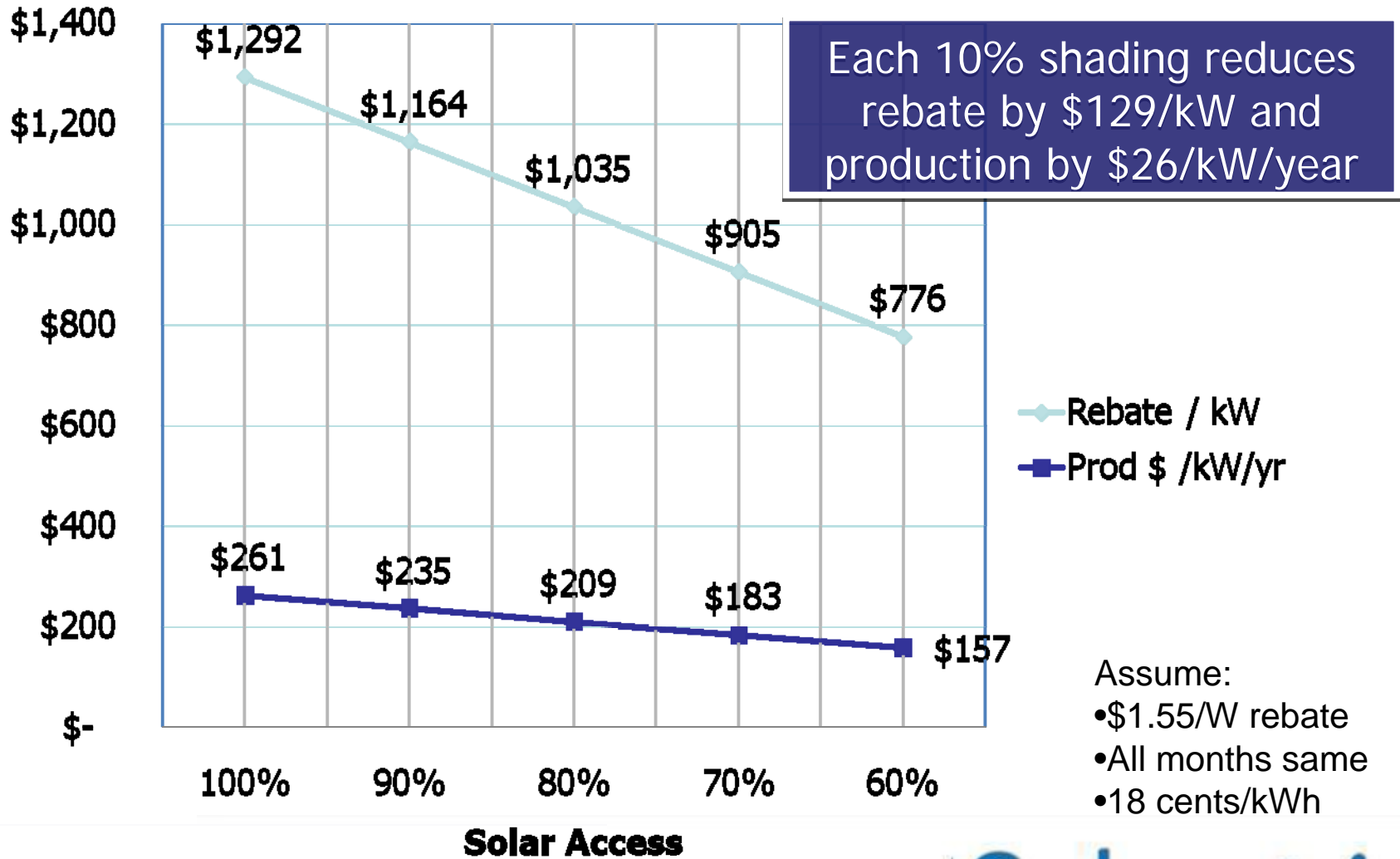
Why "Shade Impact Factor"



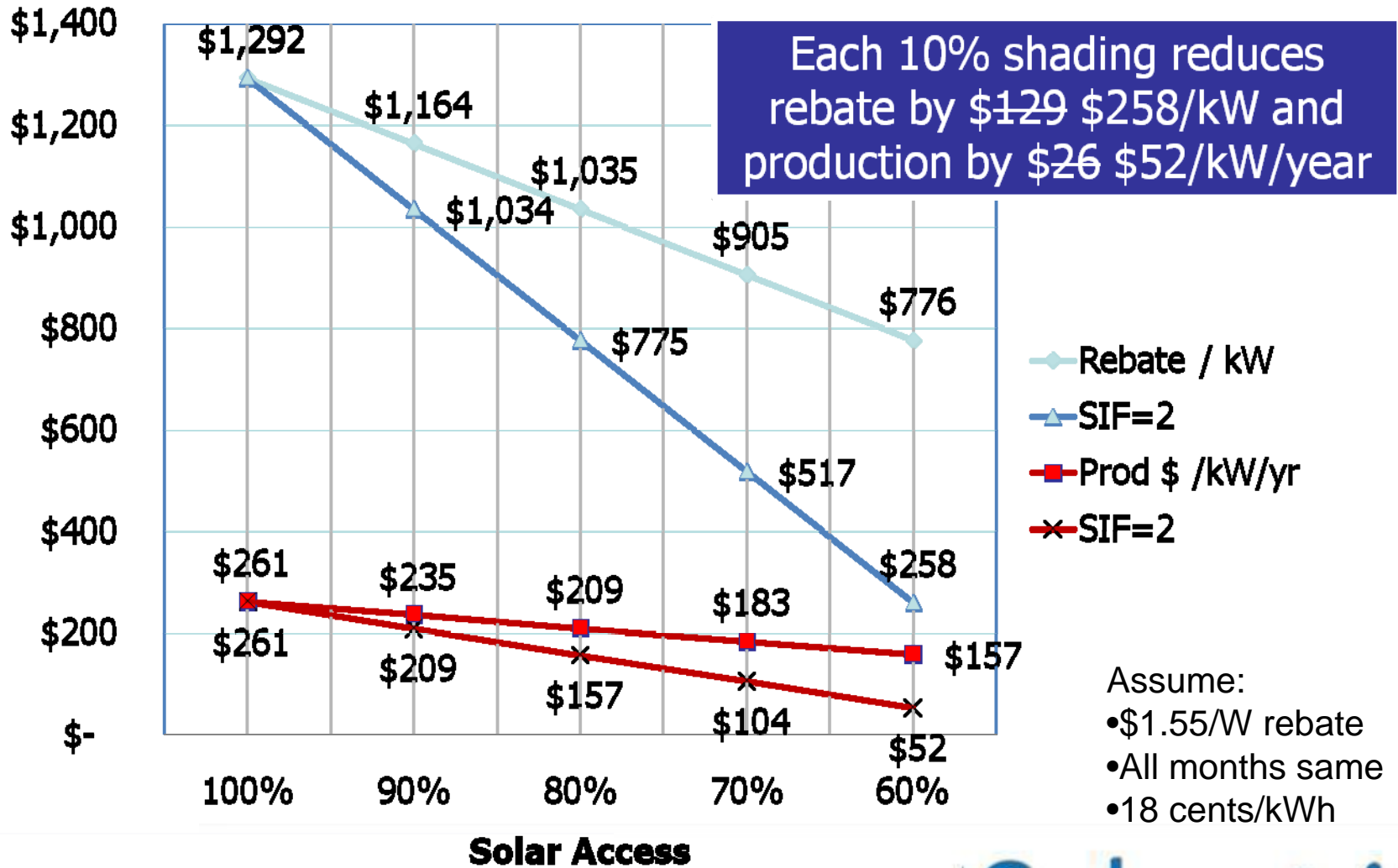
Business Card covering half of one cell



CSI "Cost-of-shading" BEFORE SB-1



CSI "Cost-of-shading" AFTER SB-1 with SIF = 2



Shade/Calculator Summary

CSI

"Major Corners Method"

CSI Incentive Calculator



Shade Tool

Rebate Calculator

AC
kWh/year
Rebate \$\$

"11 sector method"

"360 degree method"

"Solar availability method"

SB-1

"Closest Point Method"

CEC PV Calculator

NSHP



Resources

- www.gosolarcalifornia.com
- CSI Handbook
- NSHP Handbook
- CEC PV Calculator (NSHP)
- CSI Incentive Calculator
- GUIDELINES FOR CALIFORNIA'S SOLAR ELECTRIC INCENTIVE PROGRAMS PURSUANT TO SENATE BILL 1"
<http://www.energy.ca.gov/2008publications/CEC-300-2008-007/CEC-300-2008-007-CMF.PDF>
- www.calhers.org
- www.solmetric.com



Dec-Jan issue:
"Solar Site Evaluation"
www.solarprofessional.com



Questions?



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