

SunCube™ minimum DC kWh output Limited Warranty (18 November 2009)

Estimating the monthly and yearly Dc kWh output from a SunCube™ Energy Farm or any solar PV farm has always been like predicting the weather. A very good probability that it will not be what is observed. However those who invest in solar do expect some certainty in the expected minimum monthly and yearly generation of power. Thanks to NASA and their 22 year database of worldwide solar availability and their ability to show the lowest observed monthly solar availability over the 22 years of the database, we can move forward to developing a method which will show the expected minimum, average and maximum monthly and yearly solar availability to the limit of the extent of the 22 years of the NASA database.

GGE believes this is the first time any CPV or PV manufacturer has offered a minimum DC kWh output Limited Warranty on the predicted minimum monthly and /or annual DC kWhs generation of their product.

1. Solar data sets to be utilized:

To bring some level of predictability to the estimation of annual DC kWh output from SunCube™ based Energy Farms, GGE has decided to employ 2 sets of data measurements.

- 1) On sun measurement of the SunCube's™ DC efficiency in converting DNI solar energy into DC kWhs.
- 2) NASA's 22 year x 12 averaged monthly measurement global data base of DNI solar availability across the globe with a resolution of 1 deg of latitude x 1 deg of longitude. This information is publicly available on the NASA web site <http://eosweb.larc.nasa.gov/sse/> by following the "Metrology and Solar Energy" link.

2. Determination of Average monthly and yearly SunCube™ DC kWh outputs:

By knowing the SunCube's™ DC efficiency in converting DNI solar energy into DC kWhs and knowing the 22 year averaged monthly and yearly DNI solar availability in kWh/m²/day for a SunCube™ Energy Farm site, it is possible to predict the average DC kWh production per month and per year as:

Monthly SunCube™ DC kWhs = NASA 22 year averaged DNI (in kWh/m²/day) for the selected month * days per month * SunCube™ DC efficiency.

Yearly SunCube™ DC kWhs = NASA 22 year averaged DNI (in kWh/m²/day) per year * days per year * SunCube™ DC efficiency.



Below we have shown an actual page from the NASA solar availability web site for Adelaide, South Australia, Australia, as an example, and have further taken the NASA data thus provided and calculated the predicted, from the NASA data, monthly and yearly minimums, averages and maximums for a single SunCube™.

Please note this data is in DC kWhs and does not take into consideration DC wiring losses, inverter DC to AC losses nor the AC output transformer losses if required to step up the inverter voltage to a medium voltage level. To a large degree these are beyond the control of GGE and thus outside GGE's minimum kWh Limited Warranty.

Additionally local site horizon to horizon solar energy blocking land slopes, hills, trees, building and industrial processes which may reduce local atmospheric transmission of solar energy and / or contribute to increased cloud cover are not taken into consideration as these require an onsite inspection and analysis before the generation minimums can be set.

Figure 1, Example of NASA DNI solar availability based on Adelaide, South Australia.

[SSE Homepage](#) [Questions?](#) [Find A Different Location](#) [Accuracy](#) [Methodology](#) [Parameters \(Units & Definition\)](#)


NASA Surface meteorology and Solar Energy - Available Tables


Latitude **-36** / Longitude **138** was chosen.

Geometry Information

Northern boundary	-35	Elevation: 60 meters
Center		averaged from the
Latitude -35.5	Eastern boundary	USGS GTOPO30
Longitude 138.5	139	digital elevation model
Southern boundary	-36	

Parameters for Sizing and Pointing of Solar Panels and for Solar Thermal Applications:

Monthly Averaged Direct Normal Radiation (kWh/m ² /day)													
Lat -36 Lon 138	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
22-year Average	7.68	7.16	6.06	5.13	4.50	4.16	4.60	4.90	5.43	6.25	6.82	6.98	5.80

Minimum And Maximum Difference From Monthly Averaged Direct Normal Radiation (%)													
Lat -36 Lon 138	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Minimum	-6	-6	-6	-14	-17	-14	-6	-7	-7	-14	-6	-28	
Maximum	9	16	22	7	12	9	12	15	15	9	16	8	

Figure 2, Example of site minimum DC kWhs calculations based on the NASA measured minimums.

SunCube™ warranted minimum DC kWhs generation worked example

Monthly Averaged Direct Normal Radiation (kWh/m ² /day)														
Lat -36 Lon 138	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	SunCube™ Yearly kWhs
22-year Average	7.68	7.16	6.06	5.13	4.5	4.16	4.6	4.9	5.43	6.25	6.82	6.98	5.8	
Average SunCube™ DC kWhs	74	63	58	48	43	39	44	47	50	60	63	67	55	657

Minimum And Maximum Difference From Monthly Averaged Direct Normal Radiation (%)														
Lat -36 Lon 138	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	SunCube™ Yearly kWhs
Minimum %	-6%	-6%	-6%	-14%	-17%	-14%	-6%	-7%	-7%	-14%	-6%	-28%	-11%	
Minimum Solar kWhs	7.22	6.73	5.70	4.41	3.74	3.58	4.32	4.56	5.05	5.38	6.41	5.03	5.18	
Days per month	31	28	31	30	31	30	31	31	30	31	30	31		
Minimum SunCube™ DC kWhs	69	59	55	41	36	33	42	44	47	52	60	48	49	585
Maximum %	9%	16%	22%	70%	12%	9%	12%	15%	15%	90%	16%	8%	25%	
Maximum Solar kWhs	8.4	8.3	7.4	8.7	5.0	4.5	5.2	5.6	6.2	11.9	7.9	7.5	7.2	
Maximum SunCube™ kWhs	80	73	71	81	48	42	50	54	58	114	74	72	68	886

SunCube™ on sun efficiency	31%	
Min yearly DC kWhs	585	If a SunCube™ solar farm fails to deliver the minimum monthly DC kWhs, as above in RED , for 3 months in a row or fails to deliver the minimum yearly DC kWhs as shown above in RED , GGE will supply additional SunCubes™ to ensure the above minimums are achieved.
Average yearly DC kWhs	657	
Max yearly DC kWhs	886	
This warranty is very site specific and the above example is given to show how GGE uses the NASA solar data to obtain the warranted SunCube™ minimum outputs.		
To obtain the site specific SunCube™ warranted minimum DC kWhs, please contact GGE or a GGE licensed dealer.		

3. Limited Power Warranty

GGE warrants that every SunCube™ shipped to the Customer will, at the specified site and according to the site's NASA DNI solar availability data, as determined by GGE and as reduced by GGE for horizon clutter limiting horizon to horizon DNI solar energy availability, exhibit the above minimum yearly DC kWhs outputs with allowance for a 20% reduction in SunCube™ module efficiency as may happen over time.

If, for 20 years from the date of delivery of the SunCube™ to the Customer, any SunCube™ exhibits for 3 consecutive months in a row, DC kWh generation that is below the minimum predicted by the site's NASA data and also exhibits for a full year, yearly DC kWhs generation that is below the minimum predicted, allowing for a 20% reduction in SunCube™ module efficiency reduction as may happen over time, provided that such loss in power is determined by GGE (at its sole and absolute discretion) to be NOT due to climate change or other local atmospheric and or building or such changes related to cloud changes or reduced DNI solar availability at the site, GGE will replace such loss in power by either:

1. providing to the Customer additional SunCube/s™ to make up such loss in power

2. providing monetary compensation equivalent to the cost of additional SunCubes™ required to make up such loss in power
3. repairing or replacing the defective SunCube™

at the sole and exclusive option of GGE.

4. Exclusions and limitations

Warranty claims must be filed within the applicable Warranty period and may only be made by, or on the behalf of, the original Customer.

The Limited Warranties do not apply to any of the following:

1. SunCubes™, which in GGE's absolute judgment have been subjected to: misuse, abuse, neglect or accident; alteration, improper installation, application or removal (including but not limited to installation, application or removal by any party other than a GGE licensee; non-observance of GGE's installation procedures, users and / or maintenance instructions; repair or modifications by someone other than an approved service technician of GGE; power failure surges, lightning, flood, fire, accidental breakage or other events outside GGE's control.
2. Cosmetic defects stemming from normal wear and tear of the SunCubes™ materials.
3. SunCube™ lens damage as the result of improper cleaning, contact with any falling object or wind driven particle or wind driven object or chemical.
4. SunCubes™ installed in locations, which in GGE's absolute judgment may be subject to direct contact with salt water or salt water rich air.

The Limited Warranties do not cover any transportation costs for return of the SunCubes™, or for reshipment of any repaired or replaced SunCubes™, or cost associated with installation, removal or reinstallation of the SunCubes™.

Warranty claims will not apply if the type or serial number of the SunCube™ is altered, removed or made illegible.

5. Limitation of Warranty Scope

Subject to the limitations under applicable law, the limited warranties set forth herein are expressly in lieu of and exclude all other express or implied warranties, including but not limited to warranties of merchantability and of fitness for a particular purpose, use, or application and all other obligations or liabilities on the part of GGE, unless such other warranties, obligations or liabilities are expressly agreed to in writing, signed and approved by GGE

GGE shall have no responsibility or liability whatsoever for damage or injury to persons or property or for other loss or injury resulting from any cause whatsoever arising out of or related to the SunCube™, including without limitation, any defects in the SunCube™, or from installation.

Under no circumstances shall GGE be liable for incidental, consequential or special damages, howsoever caused. Loss of use, loss of profits, loss of production, loss of revenues are therefore specifically but without limitation excluded.

GGE's aggregate liability, if any, in damages or otherwise, shall not exceed the purchase price paid to GGE by the Customer, for the SunCube™ or service furnished, as the case may be which gave rise to the warranty claim.

6. Obtaining Warranty Performance

If you feel you have a justified claim covered by this Limited Warranty, immediately notify GGE. In addition, please enclose evidence of the date of delivery of the SunCube™.

The return of any SunCubes™ will not be accepted unless prior written authorization has been given by GGE.

E&OE. Errors and Omissions Excepted