



PV Array row spacing ...

I need to quote on a PV system on a flat roof.
The PV modules will be on tilted frames facing true North to optimise energy production

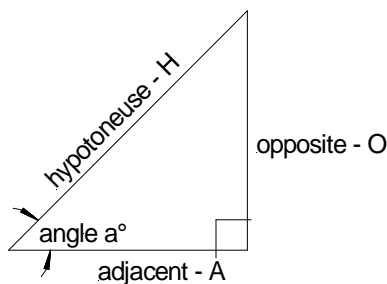
How do I calculate the distance between PV Array rows to avoid winter mid-day shading ?

Remembering back to high school math classes there was something called Trigonometry

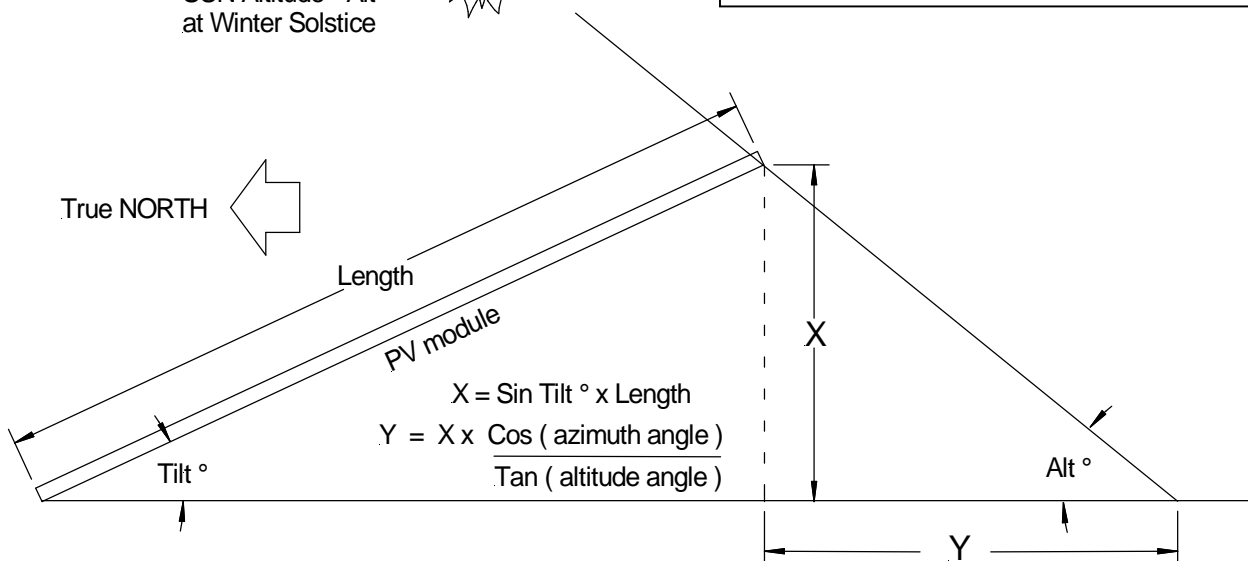
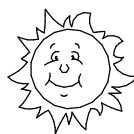
NOW YOU HAVE A USE FOR IT

for any right angle triangle ...
if you know one angle and the length of any side
you can calculate the length of the other two sides.

$$\begin{aligned} \cos a^\circ &= A / H \\ \sin a^\circ &= O / H \\ \tan a^\circ &= O / A \end{aligned}$$



SUN Altitude - Alt°
at Winter Solstice



NOTE : This calculation gives the **MINIMUM** row spacing to avoid 10:00am to 2:00pm shading at the Winter solstice (~ June 22)

refer to the diagram below

1. You know the length of the PV module
- from the manufacturers data -
and you have selected the optimum tilt angle.
e.g. 1600mm and 30°

2. You then calculate height X

$$\begin{aligned} \text{e.g. } \sin 30^\circ &= X / 1600 \dots X = \sin 30^\circ \times 1600\text{mm} \\ &= 0.5 \times 1600 = 800\text{mm} \end{aligned}$$

It is recommended that the row spacing avoids shading between 10:00am and 2:00pm at the Winter Solstice (~ June 22)
refer to Table 1 on page 2.

3. the minimum spacing (Y) between rows can now be determined ...

$$\text{Row spacing } Y = X \times \frac{\cos(\text{azimuth angle})}{\tan(\text{altitude angle})}$$

- e.g. The PV array is located in SYDNEY - Latitude 34°S
Azimuth = 31° and Altitude = 26°

$$\begin{aligned} Y &= X \times \cos 31^\circ / \tan 26^\circ = 800\text{mm} \times 1.757 \\ &= 1406 \text{ mm} \end{aligned}$$



LAT. ° S	Azimuth ° E	Altitude °	$\frac{\text{Cos (azimuth angle)}}{\text{Tan (altitude angle)}}$	Location examples ...	LAT. ° S
11	40	45	0.766	THURSDAY ISLAND	10.6
12	40	44	0.793	DARWIN	12.5
13	39	43	0.833		
14	38	42	0.860	KATHERINE	14.5
15	38	42	0.875	COOKTOWN	15.5
16	37	41	0.919	KUNUNURRA	15.8
17	37	40	0.952	PORT DOUGLAS / CAIRNS	16.5 / 16.9
18	36	39	0.999	BROOME / HALLS CREEK	17.9 / 18.2
19	36	38	1.017	TOWNSVILLE	19.3
20	35	38	1.048	TENNANT CREEK / PORT HEDLAND	19.6 / 20.4
21	35	37	1.087	MT ISA / MACKAY	20.7 / 21.1
22	35	36	1.127	EXMOUTH / WINTON	21.9 / 22.4
23	34	35	1.184	LONGREACH / ROCKHAMPTON	23.4 / 23.4
24	34	34	1.229	ALICE SPRINGS / GLADSTONE	23.8 / 23.9
25	33	33	1.267	BUNDABERG	24.9
26	33	33	1.291	CHARLEVILLE / ROMA	26.4 / 26.4
27	33	32	1.342	BRISBANE	27.4
28	32	31	1.411	OODNADATTA / TOOWOOMBA	27.6
29	32	30	1.469	GERALDTON / LISMORE	28.8 / 28.8
30	32	29	1.530	GLEN INNES / COFFS HARBOUR	29.7 / 30.3
31	31	28	1.579	FORREST / KALGOORLIE	30.8 / 30.8
32	31	28	1.612	EUCLA / PERTH	31.7 / 31.9
33	31	27	1.682	CEDUNA / WILLIAMTOWN	32.1 / 32.8
34	31	26	1.757	SYDNEY / MILDURA	33.9 / 34.2
35	30	25	1.857	ADELAIDE / ALBANY CANBERRA / WAGGA WAGGA	35.0 / 35.0 35.3 / 35.3
36	30	24	1.945	ALBURY / ECHUCA	36.1 / 36.1
37	30	23	2.040	HORSHAM VIC / SEYMOUR VIC	36.7 / 37.0
38	30	22	2.091	MT GAMBIER / MELBOURNE LAVERTON / SALE	37.7 / 37.8 37.9 / 38.1
39				--- BASS STRAIT ---	
40	29	21	2.278	KING / FLINDERS ISLANDS	39.9 / 40.1
41	29	20	2.403	SMITHTON / DEVONPORT	40.8 / 41.2
42	29	19	2.540	LAUNCESTON / QUEENSTOWN	41.6 / 42.1
43	29	18	2.692	HOBART / GEEVESTON	42.8 / 43.2



... multiply by height X to obtain the minimum row spacing

Table 1 - Solar Azimuth and Altitude at 10:00 am on the Winter solstice (~ June 22)