

PV Land Area Calculations

SAM's land area calculations for photovoltaic arrays make the following assumptions for each subarray (see diagrams below for reference):

- The ground under the array is flat and horizontal.
- The ground area occupied by the array is rectangular.
- Modules are arranged in parallel rows.
- Rows are rectangles with the same dimensions.
- Spacing between rows is uniform.
- The length of the “bottom” of a row is the same as the length of one side of the ground occupied by the array.
- The ground occupied by the array extends beyond the array the distance of one row space.

Given these assumptions, SAM calculates the land area A_{land} as:

$$A_{land} = A_{ground} \times F + A_{additional}$$

Where:

- A_{ground} = Area of ground occupied by the array, including space between rows.
- F = Land area multiplier from the System Design page.
- $A_{additional}$ = Additional area from the System Design page.

The ground area A_{ground} depends on the following inputs:

- L = Module length from the Module page.
- W = Module width from the Module page.
- N_{side} = Number of modules along side of row from the Shading and Layout page.
- N_{bottom} = Number of modules along bottom of row from the Shading and Layout page.
- N_{rows} = Number of rows from the Shading and Layout page.
- GCR = Ground coverage ratio from System Design page.

Array area

The array area A_{array} is the product of the area of one row and the number of rows:

$$A_{array} = L_{bottom} \times L_{side} \times N_{rows}$$

For portrait modules:

$$L_{bottom} = W \times N_{bottom}$$

$$L_{side} = L \times N_{side}$$

For landscape modules:

$$L_{bottom} = L \times N_{bottom}$$

$$L_{side} = W \times N_{side}$$

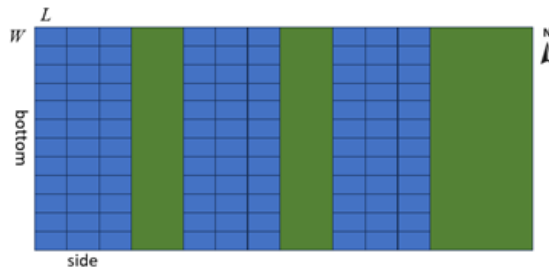
Ground area

The ground area A_{ground} is an estimate of the area occupied by rows and the space between rows:

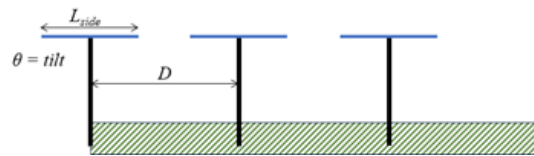
$$A_{ground} = D \times N_{rows} \times L_{bottom}$$

For an array with one-axis tracking, D is the distance between tracking axes of neighboring rows. For a fixed array, D is the distance between bottom edges of neighboring rows.

Looking down:



Looking North or South:



Looking East or West:



Figure 1: Diagram of one-axis tracking array with portrait modules for Tilt = 0° , Azimuth = 180° .

Ground Coverage Ratio (GCR) and Row Spacing

The ground coverage ratio GCR is defined as the ratio of array area to ground area.

$$GCR = \frac{A_{array}}{A_{ground}}$$

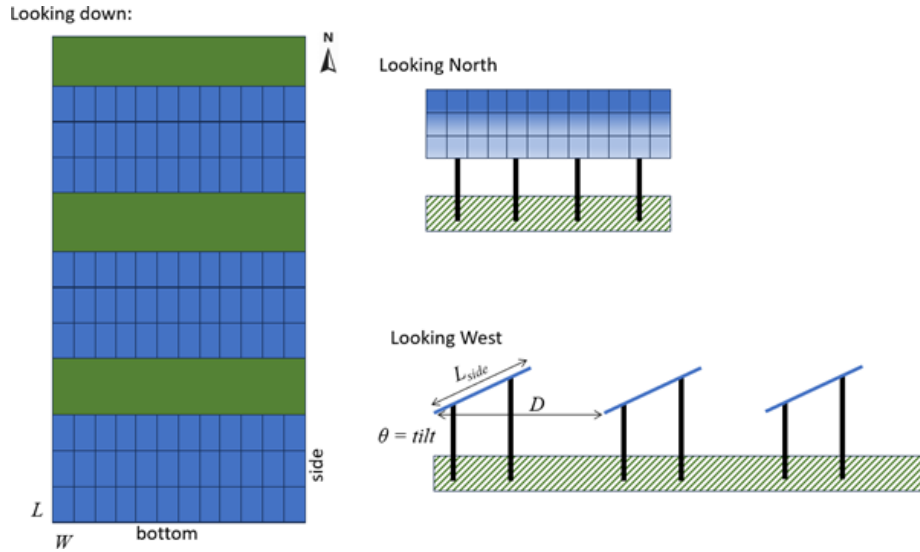


Figure 2: Diagram of a fixed array with portrait modules for Tilt = 25°, Azimuth = 180°.

The GCR is one way to represent the distance between rows in the array without knowing the dimensions of the array: As row spacing increases, the ground area increases and GCR decreases. You can use SAM to determine the GCR that minimizes self shading given a generic array, and then, given the module and row dimensions of your array, determine the row spacing that is equivalent to that GCR.

The array area A_{array} is the total area of modules in the array, *not* the module area projected onto the ground. The GCR is independent of tilt angle.

As the figures above show, the array and ground share the length of a row bottom, so the GCR can be expressed as:

$$GCR = \frac{L_{bottom} \times L_{side} \times N_{rows}}{L_{bottom} \times D \times N_{rows}}$$

Which simplifies to:

$$GCR = \frac{L_{side}}{D}$$

Because GCR is an input, SAM calculates the row spacing estimate (distance between rows) D shown on the Shading and Layout page as:

$$D = L_{side} \div GCR$$