Tilt Angle

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1. Common Mounting

Roof-Mounted Systems:

- Simple and cost-effective to install
- Limited control over PV system orientation, which can reduce efficiency
- Ideal for smaller solar installations due to space limitations

Integrated Systems (BIPV):

- Uses thin-film solar technology, seamlessly integrated into building materials (e.g., roof tiles, facades)
- Inexpensive to produce but often less efficient than traditional panels
- Aesthetic appeal, as the solar elements blend into the building structure

Tracking Systems:

- Increases efficiency by adjusting panel angles to follow the sun's path, enhancing energy production
- Can improve output by 25-30% compared to fixed systems
- Expensive upfront costs and high maintenance due to moving parts
- Requires more land and space for installation

Pole-Mounted Systems:

- Panels are mounted on poles, often used for small-scale installations
- Can be adjusted for optimal tilt and orientation
- Ideal for rural or remote areas where roof or ground space is limited

Ground-Mounted Systems:

- Suitable for larger installations with ample land available
- Easy to install and maintain
- Allows for flexible orientation and tilt angle adjustment to maximize energy production

2. Tilt angle

- The tilt angle of a photovoltaic (PV) array is crucial for optimizing energy yield.
- Solar panels or PV arrays are most efficient when oriented perpendicular to the sun’s rays.
- To prevent self-shading, sufficient distance must be maintained between rows of panels.
- The spacing between rows should be at least three times the width of the panels to minimize shading and maximize energy production.

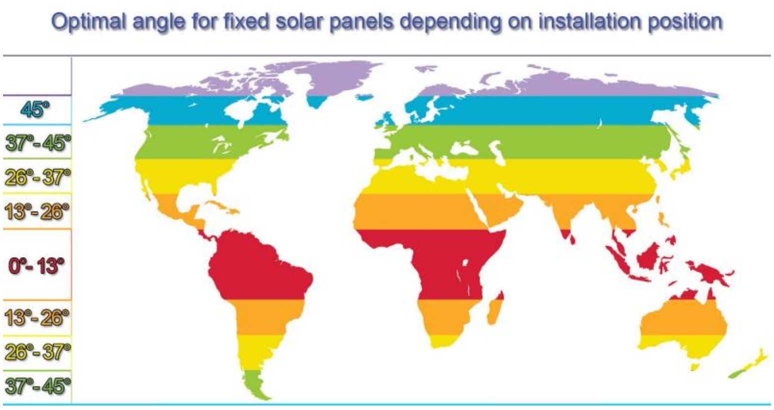

Figure 1: Map representing the Tilt Angle

Example 1:

Given the approximation method:

- For latitudes from 0 to 25 degrees, multiply the latitude by 0.87.
- For latitudes between 25 to 50 degrees, multiply the latitude by 0.87 and add 3.1 degrees.
- For latitudes over 50 degrees, the most ideal angle is approximately 45 degrees.
- *In some occasions the latitude can be used as the tilt angle in this case 3.99 degrees.*

Using the example of Loja, an Ecuadorian city with a latitude of approximately 3.99 degrees, the value for the tilt is approximately, 3.47° for a permanent solar panel:

$$Tilt\ Angle = |Latitude| * 0.87$$
$$\emptyset = |-3.99| * 0.87 \approx 3.47°$$

Equation 1: Tilt Angle calculation.

Example 2:

Given the approximation method during seasons:

- For latitudes from 0 to 25 degrees, multiply the latitude by 0.87.
- For latitudes between 25 to 50 degrees, multiply the latitude by 0.87 and add 3.1 degrees.
- For latitudes over 50 degrees, the most ideal angle is approximately 45 degrees.
- Summer with the lowest tilt angle subtracting 15 degrees
- winter with the highest tilt angle adding 15 degrees

Using the example of Loja, an Ecuadorian city with a latitude of approximately 3.99 degrees, the value for the tilt is approximately, 3.47° for a permanent solar panel, this value can be used for autumn and spring:

$$Tilt\ Angle = (|Latitude| * 0.87) \pm 15$$
$$Summer\ Tilt\ Angle = (|-3.99| * 0.87) - 15 = -11.53$$
$$Winter\ Tilt\ Angle = (|-3.99| * 0.87) + 15 = 18.47$$

Equation 2: Tilt angle for each season.

Figure 2: Tilt angle used in Loja and its Latitude.

The values obtained may differ slightly due to approximation methods. However, if we use a tilt angle of 5.7 degrees, the tilt angle for both summer and winter will align closely with the recommended values. Even without modifications, the calculated values remain reasonably accurate and are unlikely to be significantly incorrect.