

Shaded fraction and backtracking in single-axis trackers on rolling terrain

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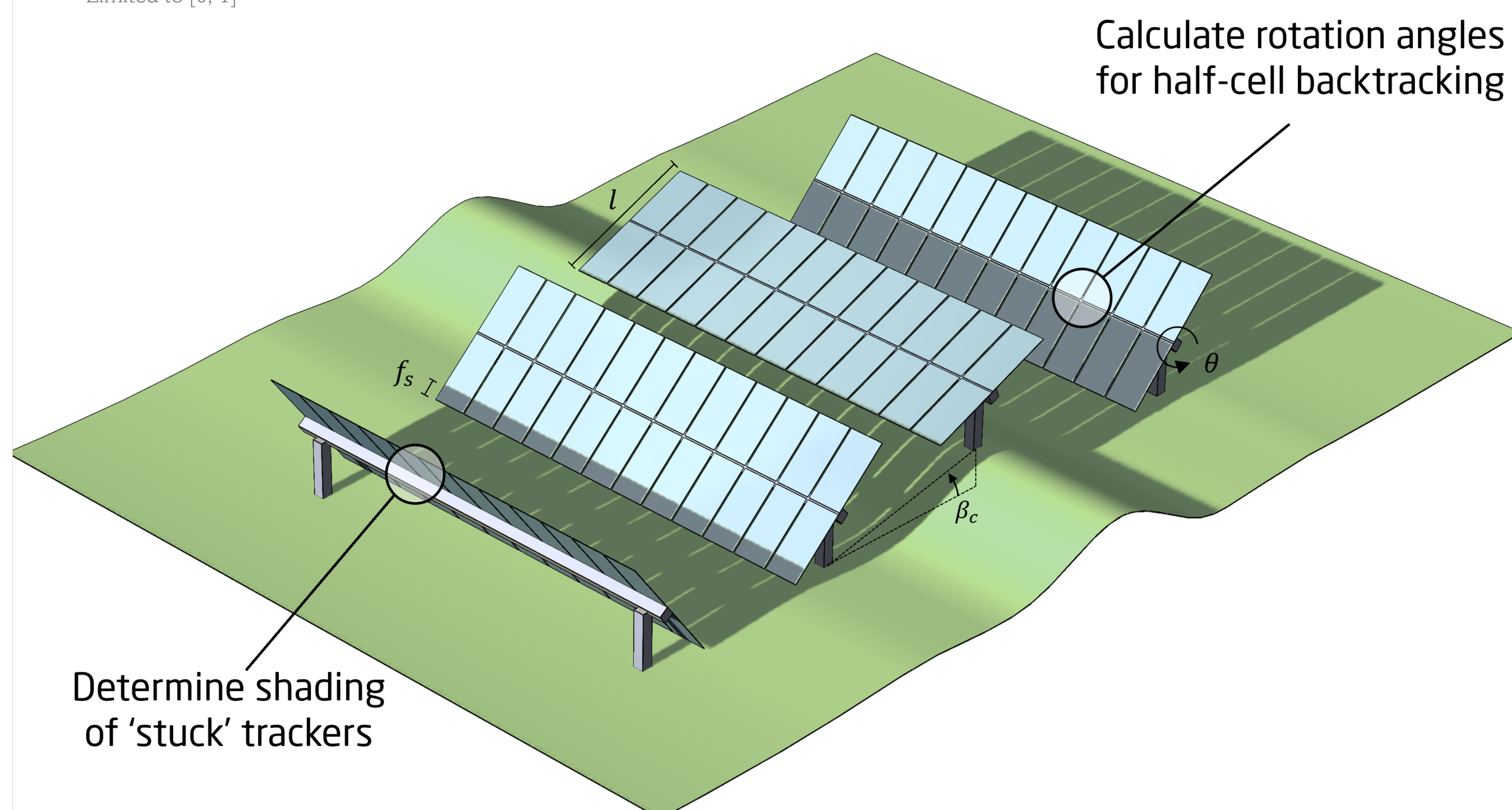
Existing 1D shading equations for collector rows have been limited to uniform sloped terrain and cannot accommodate differences in panel tilts. This work presents a new closed-form equation that overcomes these limitations, thereby allowing for calculating shading for complex backtracking strategies on undulating terrain. The equation can also be inversed to calculate the tracker rotation necessary to achieve a desired shading fraction during backtracking.

Features

- Handle varying/undulating terrain
- Account for torque tube offset
- Arbitrary tracking axis azimuth
- Allows for differing panel tilts
- Applicable to backtracking

$$\text{shaded fraction} = \frac{1}{2} \left(1 + \left| \frac{\cos(\theta_1 - \theta_s)}{\cos(\theta_2 - \theta_s)} \right| \right) + \text{sgn}(\theta_s) \frac{z_0}{\ell} \left(\frac{\sin(\theta_2 - \theta_s) - \sin(\theta_1 - \theta_s)}{|\cos(\theta_2 - \theta_s)|} \right) - \frac{p}{\ell} \left(\frac{\cos(\theta_s - \beta_c)}{|\cos(\theta_2 - \theta_s)| \cos \beta_c} \right)$$

Limited to [0, 1]



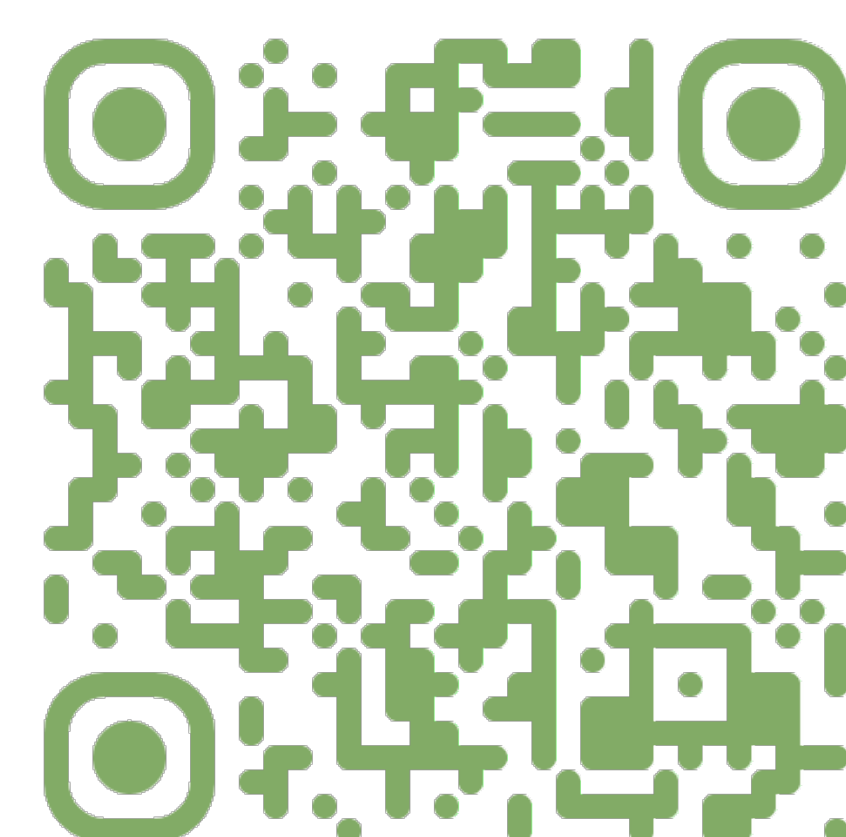
Implementation

Implementations of the algorithms are provided in Python and will be available in the next release of pvlib.

Validation

The shaded fraction equation has been validated against ray tracing simulations using the open-source software bifacial_radiance. Test cases are provided for facilitate implementation.

Scan me!



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