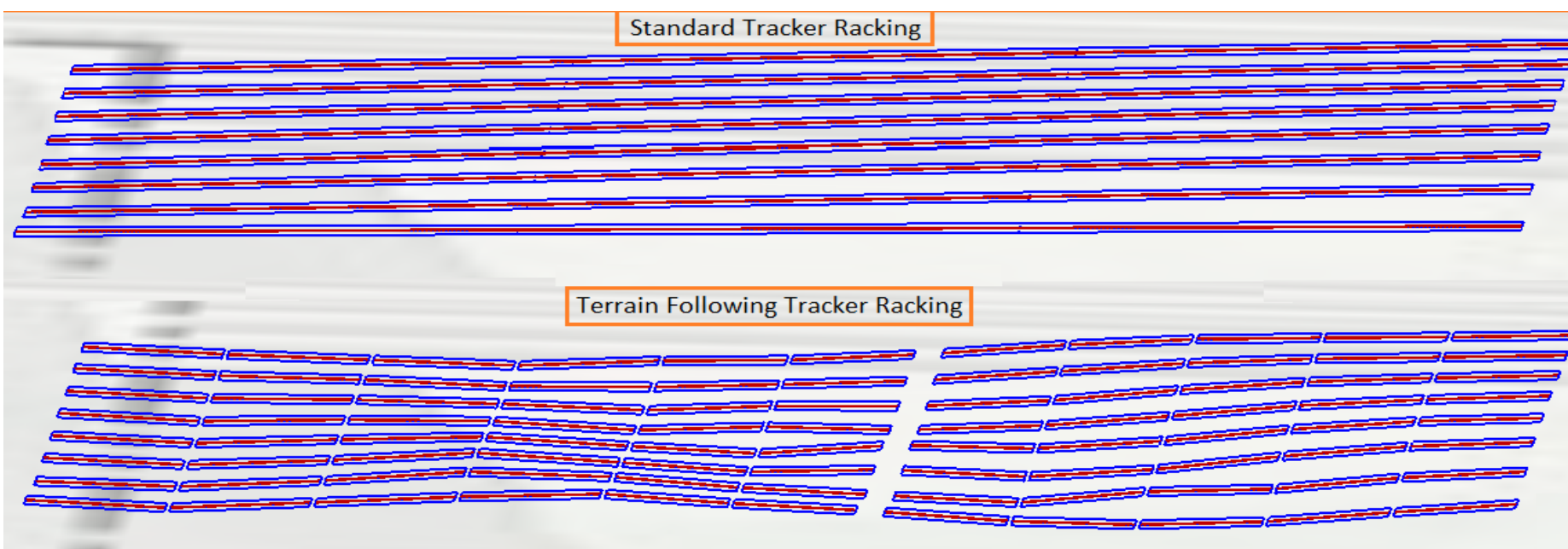


Introduction

Solar project sites are becoming more challenging with complex and undulating terrains and inadequate availability of simpler and flatter locations. Standard single-axis tracker racking allows limited option to follow slopes, requiring site grading and/or variable pile exposure adding cost, labor, and time to site development and construction. Because of this, many tracker racking manufacturers have developed terrain following tracker racking systems, which can more closely follow existing terrain, reducing the overall project cost, site preparation time and work, environmental impact, land disturbance, etc. Terrain following trackers more closely follow site elevation changes with the help of articulating joints and gaps. The trackers are broken into smaller sections to allow a better fit to the terrain and maintain precise tracking even with changes in the elevation. Typically, these tracker sections are less than one string in length.

When importing a terrain following tracker shading scene into a PVsyst model, we observe several performance modeling challenges compared to traditional single-axis tracking systems. These include vastly more shading scene objects and multiple axis tilts and slopes, which prevent accurate assignment of modules per string for the calculation of electrical effect and have a significant time impact on importing the scene and working with the scene along with increased simulation time. The figure on the right represents a sample subarray for the same project and terrain, with one variant modeled using standard trackers and the other modeled using terrain following trackers.



Framework

- For this exercise we have selected eight sample locations all around the US for a wide variation of solar irradiance data.
- We have used four sample terrains. Each sample terrain is used to first model the standard single axis tracker blocks, and this exact same sample terrain is used to model terrain following tracker blocks for an apples-to-apples comparison. This exercise was done for all four sample terrains using PVcase software and then imported into the PVsyst shade scene.
- All the PVsyst batch simulations were run with exact same system parameters, including tracking limit, module type and quantities, inverter type and quantities, and loss parameters up to the point of interconnection.
- Each sample terrain was used in all eight locations with the exact same system parameters.

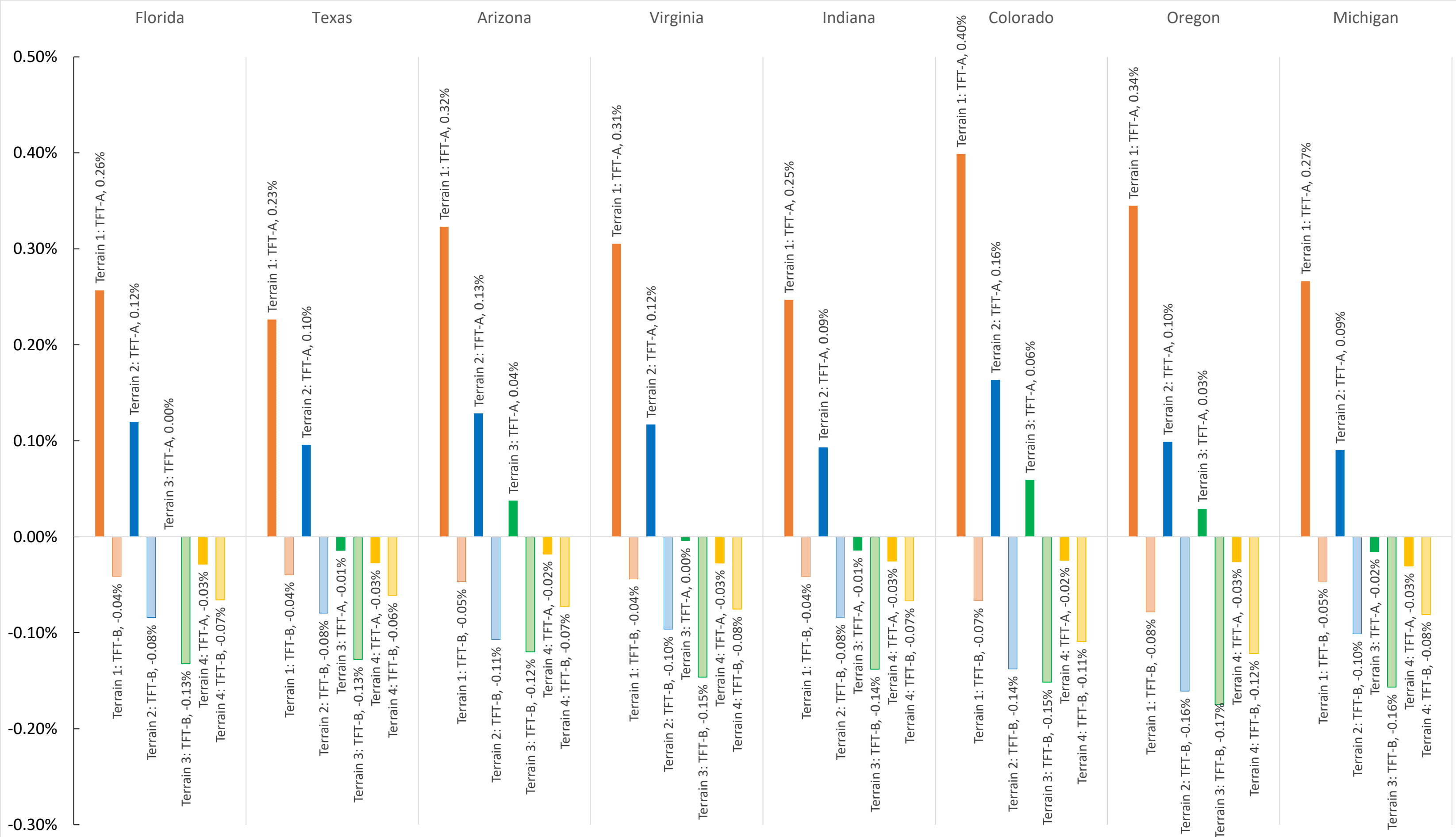
Methods

- The standard single-axis tracker scene is based on the terrain following tracker scene, which includes the gaps to achieve the same tracker length, but the tracker pieces are reassembled into a complete unit.
- Additionally, for the terrain following tracker model, we have discussed two different methods to account for the shortcomings in the electrical effect calculation. Also, note that all terrain following trackers can experience module voltage mismatch loss which has not been considered here for consistency and can vary from terrain to terrain.
 - The first method, which is simple, is to treat each of the small tracker pieces as an independent electrical string unit by setting the partition to "1" along the tracker direction.
 - The second method is based on the recommendation from PVcase, which requires some additional PVsyst model runs compared to the first method. This second method is to run the terrain following tracker scene with small tracker pieces using linear shading, which will deactivate the electrical effect loss, and then run the standard tracker scene which is based on the terrain following tracker scene reassembled into a complete unit, to compute the electrical effect loss separately. This electrical effect loss can be added to the terrain following tracker scene production value which was run using linear shading to obtain a final result.

Results

- Here we will compare results for both terrain following and standard single-axis tracker systems using the same project location and layout.
- The production difference from these two terrain following methods are compared with standard tracker and are shown in the graph below.
- The figures on the right shows the four sample terrains. The first type of graph shown on the right gives a comparison of various losses such as the Near Shadings Loss, Electrical Shadings Loss and the IAM Loss for both standard and terrain following single-axis tracker (Method A) for all the eight locations. The second type of graph shown on the right gives a difference in the Near Shadings Loss, Electrical Shadings Loss and the IAM Loss when comparing the terrain following (Method A) with the standard single-axis tracker. However, we believe each terrain is unique and the results will depend on terrain to terrain.

Production difference compared to Standard Single-Axis Tracker



Conclusion

Based on the analysis from four sample terrains and eight different locations, using terrain following tracker – Method A, the production difference when compared to standard tracker can vary from -0.03% to 0.40%. Whereas, using terrain following tracker – Method B, the production difference when compared to standard tracker can vary from -0.17% to -0.04%. With this exercise, we can conclude that for typical array configurations in these types of moderate terrain, standard tracker blocks can be used to model the production of terrain following trackers with limited error. This approach can save significant time and effort, as the margin of error is small. However, for more rugged sites with larger slopes, more detailed modeling of terrain following slopes may be prudent to ensure accurate results.

Comparison of Near Shadings Loss, Electrical Shadings Loss & IAM Loss

