Light and Energy Impacts for Short-Term Modified Tracking of Agrivoltaic Arrays

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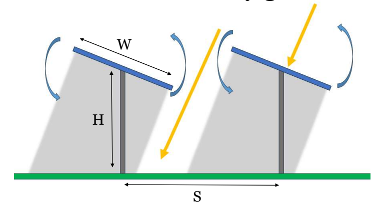
Introduction

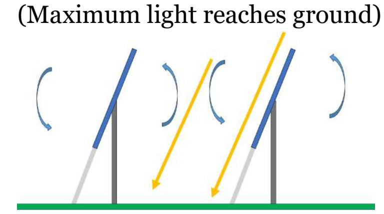
- Sunlight is vital to crop growth, especially during early plant development
- Modifying the tracking algorithm in a "plant-friendly" way to allow more light through can improve seed germination and plant establishment
- We aimed to find out through simulation how much irradiance can be gained and whether the electrical output loss is tolerable
- We simulated irradiance and electrical outcomes for different tracking movements to assess if modified tracking is useful

Crops are grown underneath and adjacent to tracking solar arrays. Module tracking movement can be altered for a time period to improve seed germination and early plant establishment.

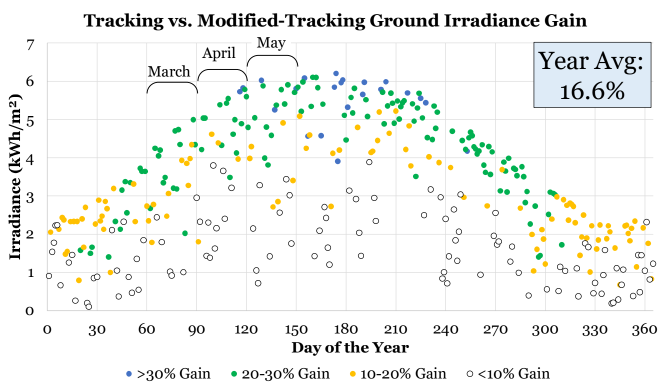
Tracking
(Maximum electricity generated)

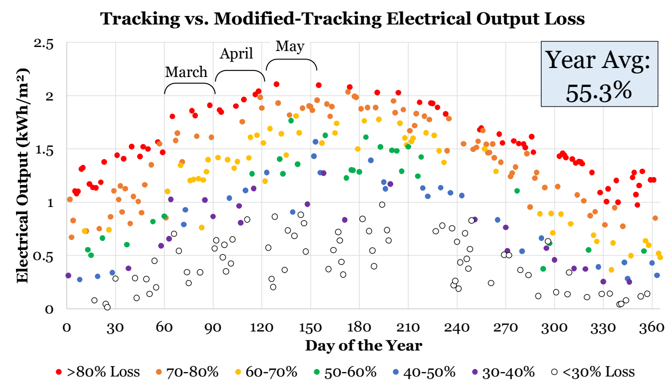


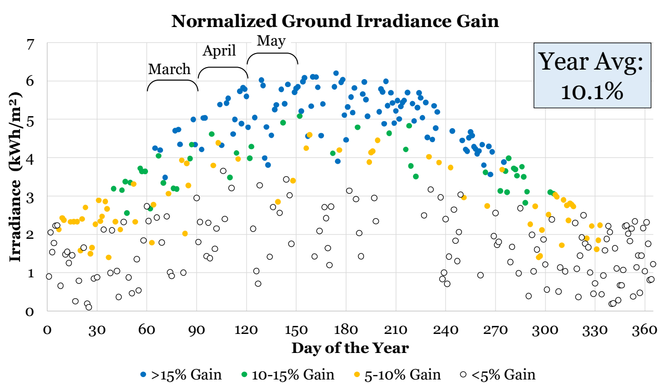
Modified Tracking
(Maximum light reaches ground)

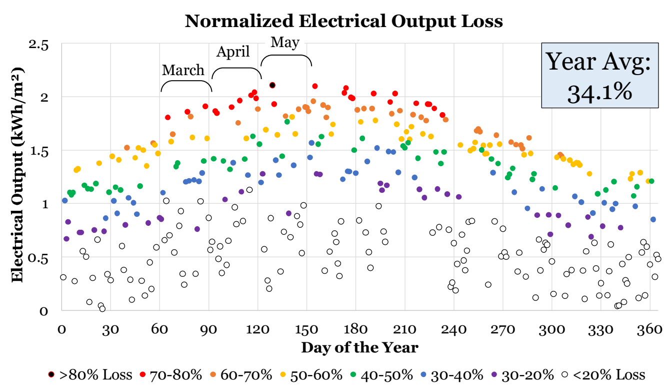


All calculations performed in Python using module dimensions of W = 2 m, H = 2 m, and S = 6 m, based on TMY data for New Jersey, USA.
Data points are plotted for irradiance or output of tracking modules, and color-coded for the percentage of loss or gain attributed to modified tracking.









- Data were normalized based on day of the year with maximum irradiance and maximum electrical output
- Low irradiance gain correlated with low output loss (cloud cover, mainly diffuse light)
- For March, April, and May, normalized irradiance gains were 9.9%, 13.0%, and 14.5%, respectively
- For March, April, and May, normalized output losses were 34.5%, 37.4%, and 35.5%, respectively
- Irradiance is non-uniform, so gain would be more impactful in plant areas that are normally more shaded

Conclusions and Future Work

- Output losses are relatively static during months when light is critical for germination and early plant development
- The timing of planting will impact the economic feasibility and the necessity of using modified tracking
- Work is ongoing to explore these findings on experimental arrays to confirm data and observe plant growth rates

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For updates on our agrivoltaics work, please visit us at the Rutgers Agrivoltaic Program website using this QR code:

For many agrivoltaic arrays, and modern solar arrays in general, the panels we use track the sun throughout the day. They are motorized to automatically move to point themselves as close as possible to the location of the sun in the sky. This is great for electrical production, as we maximize the sunlight on the panels. Simultaneously the shadows move laterally on the ground, which is good for the crop conditions, as we spread out the shade to avoid dark spots on the ground. We quantified the electrical and shading amounts for a different tracking algorithm aimed at maximizing how much sunlight reaches the ground, and what effect that would have on our electrical output. This would be useful during times when we want to make sure seeds are warm enough to start sprouting, or during the early growth stages to get established in the soil, or to dry out finished crops like hay or soybeans.

Our simulation calculated the ground-level sunlight exposure and electrical output based on the tracking arrays we use and the sunlight conditions here in New Jersey. When we normalized the results based on a bright day with strong sunlight, we found that the average for the sunlight reaching the ground under a modified tracking array rose by about 10% when compared to the usual tracking arrays. The average electrical output decreased by about 34%. While you wouldn’t want to point the panels away from the sun like this year-round, the increase in sunlight reaching the ground could be beneficial for some crop needs. The Rutgers Agrivoltaics Program continues our work to give you as much information as possible in order to make the best choices rooted in data typical for New Jersey.