Case Study: 13% Energy Improvement with Shade Mitigation
Utility Scale Ground Mount PV

Central Italy

Location:	Central Italy
System Size:	2.64 MW
Modules:	11,748 X GROUP XG60P, polycrystalline silicon, 225 W modules
Inverter:	Power-One PVI-CENTRAL-330-IT-TL

Summary

A side-by-side comparison of a utility-scale PV system located in central Italy showed a 13% increase in energy harvest with Tigo Energy's DC optimizers, primarily due to the mitigation of shading effects from an electrical transmission tower.

Test Conditions

The Power-One inverters used for this installation employ 55 kW modular blocks with independent maximum power point tracking inputs, so each array in this comparison had its own MPPT. Array 1C, which sees minimal shade, was used as the control for the test. For a period of 8 days the arrays were tested without optimization. The performance of each array during this time was used to establish the relationship between the two. Since the only thing that is not the same for the two arrays is shading, this part of the test determined what the baseline performance would be without optimization. Both arrays were then tested with Tigo optimizers, and data was collected for another 8 days. At the end of the testing period, numerical techniques were used to determine the performance difference that may be attributed to the optimizers.

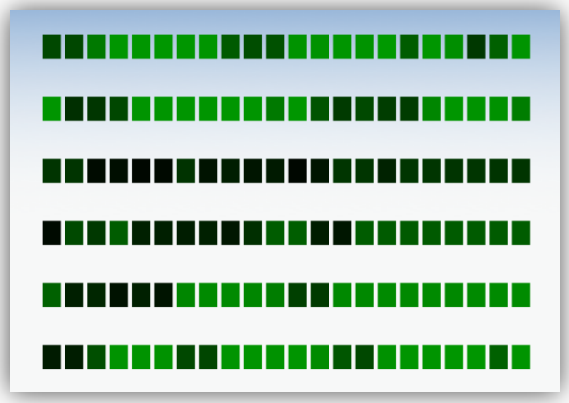

Figure 2: Array 7E, late afternoon with shade from tower.

Special Site Conditions

Shading from electrical transmission tower:

Figure 1: A satellite image of the PV array, with two portions of the array that include Tigo Energy optimizers outlined. The area marked with red, Array 7E, has significant shading due to a large electrical transmission tower. The area marked with orange, which indicates Array 1C, sees minimal shading.

	Red	Orange
Reference	7E	1C
Strings	10	12
PV modules	220	264
Rated dc power	49.5 kW	59.4 kW
Inverter rating	55 kW	55 kW
Shading	Tower, wires	Minimal

Table 1: Details about Array 7E and Array 1C. For the sake of the experiment, all data has been normalized to account for array size.

Results—13% Energy Improvement

The daily DC energy generated by the two arrays during the test is shown graphically in Figure 3. The measured value for each array was normalized by its average daily energy during the period without optimization. Normalization accounts for differences in the nameplate rating of the two arrays, and makes it easy to see any differences after the optimizers were added. The chart in Figure 3 clearly shows a consistent improvement of the energy produced by Array 7E relative to Array 1C after optimization was added.

For each array, the average daily DC energy generated was first calculated during the period without optimization, then again during the period with optimization. The ratio of the two systems reflects the relative performance of Array 7E with respect to Array 1C. By comparing these ratios, the overall benefit of optimizers can be determined. Using the numbers from Table 2, the optimizers provided a 13% boost to the partially shaded array.

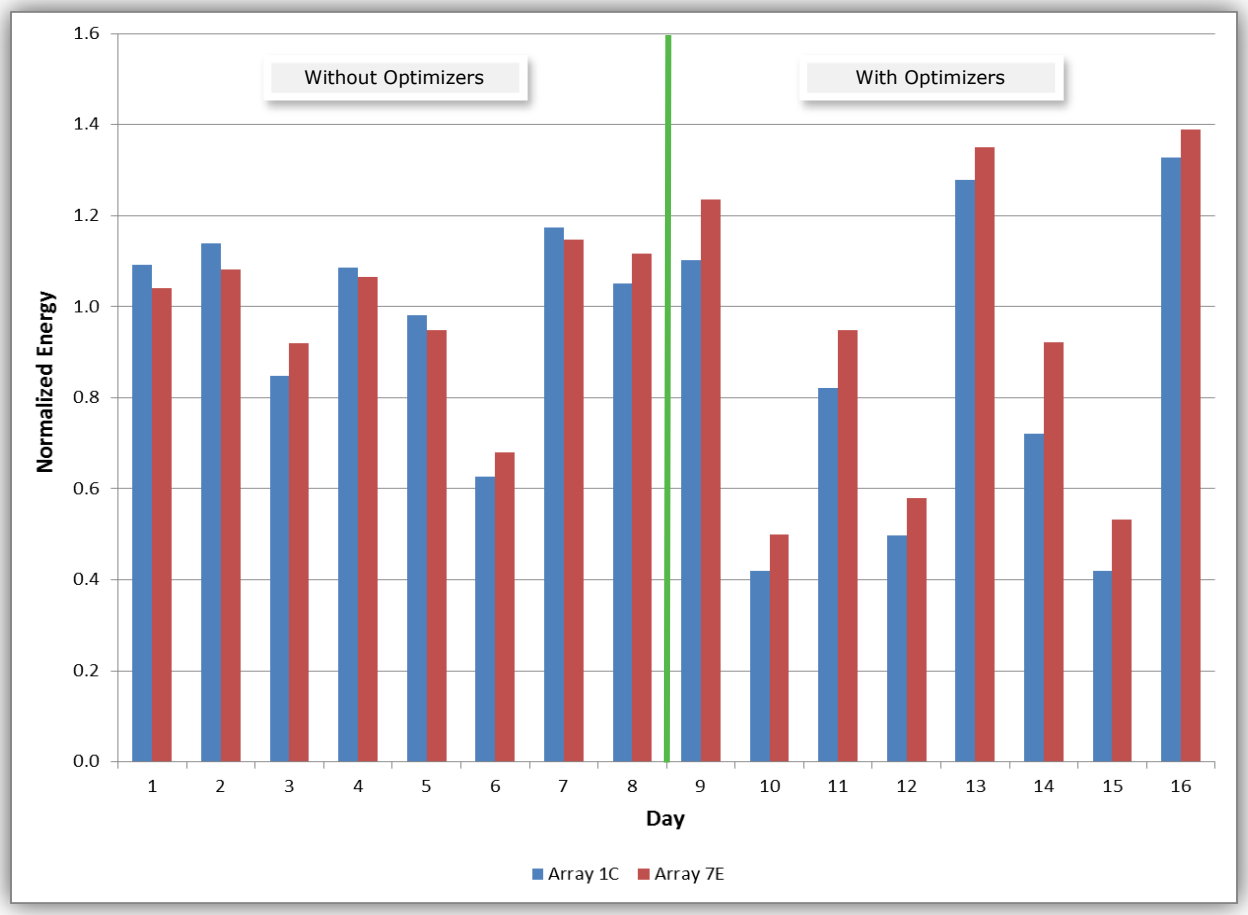

Figure 3: Daily DC energy generated by each array normalized by the average daily energy from the period without optimization.

Conditions	Array 1C	Array 7E	Gain
Without Optimization	1	0.69	—
With Optimization	1	0.78	13%

Table 2: Details for calculating the benefit of optimizers.