SolarMagic™ Helps Balance Underperforming Array. Production Boosted by 21.7%.

Site: Northern California Bay Area High School

System Size: 440 kW
Modules: 2508 SolarWorld 175W mono
Strings: 209
Inverter: Xantrex
Monitoring: Obvius Modbus and ModHopper. (AC only)
Installation date: October 2008

Performance Evaluation

- 14 strings selected for evaluation
- 2 undamaged control strings

Findings

- System severely unbalanced. 21.3% of normalized energy left unharvested.

Corrective Action

- SolarMagic installed on 5 strings

Results

- System balanced
- 21.7% energy increase
- 51.2% lost power recaptured

Panel Damage Doesn't Mean You Have to Take a Power Hit

No matter how well an array is designed, modules are binned, or a system is installed, if cells in its solar modules are unbalanced, the array will lose power.

Cell damage can have varying impacts on an array, depending upon how badly the cells are harmed. If a cell is damaged badly enough to cause bypass diodes to engage, the entire string voltage will drop. If a cell still functions but cannot perform properly, less of the photons hitting the module will be transformed into electrical energy and string current will drop. If enough damage has occurred within a string, the entire string will drop out. Whatever the level of damage, significant mismatch is introduced into the system, unbalancing it and preventing maximum energy generation and harvest.

About the Northern California Bay Area School District Solar Initiative..

In February 2009, the largest K-12 solar and energy efficiency project in the United States was completed. The 5.5 mW project included schools in Northern California, and is expected to save more than $25M over the 25-year life of the project.

SolarMagic Power Optimizer Counters System Imbalance, Maximizes Performance

SolarMagic power optimizers are cognitive—they sense their current and voltage environment, and after performing localized Maximum Power Point Tracking (MPPT), adjust the voltage and current fed into the string to maximize system performance. With this methodology, each SolarMagic assisted module in the string can generate a different amount of power, while still positively impacting the performance of the array.

Initial Performance Evaluation

This array consists of 440 kW of capacity in 209 strings. The installation forms carports over parking spaces near the school's baseball fields. One carport was erected behind a baseball diamond and is frequently a victim of flyballs; several modules are damaged as a result. The system manager installed a net to capture the balls before they struck the array, affording their investment protection from additional harm.

This study deals only with this compromised subarray and involves fourteen strings. Two strings were included as control strings, providing the ability to normalize for weather and irradiance:

- String 6 is undamaged, and is under protective netting
- String 14 is outside the danger zone, undamaged, and not under protective netting
- Strings 3 and 10 were also undamaged.
- The remaining ten strings had been damaged by flyballs.
- All fourteen strings were instrumented, and string level data was collected over several days in August 2009.

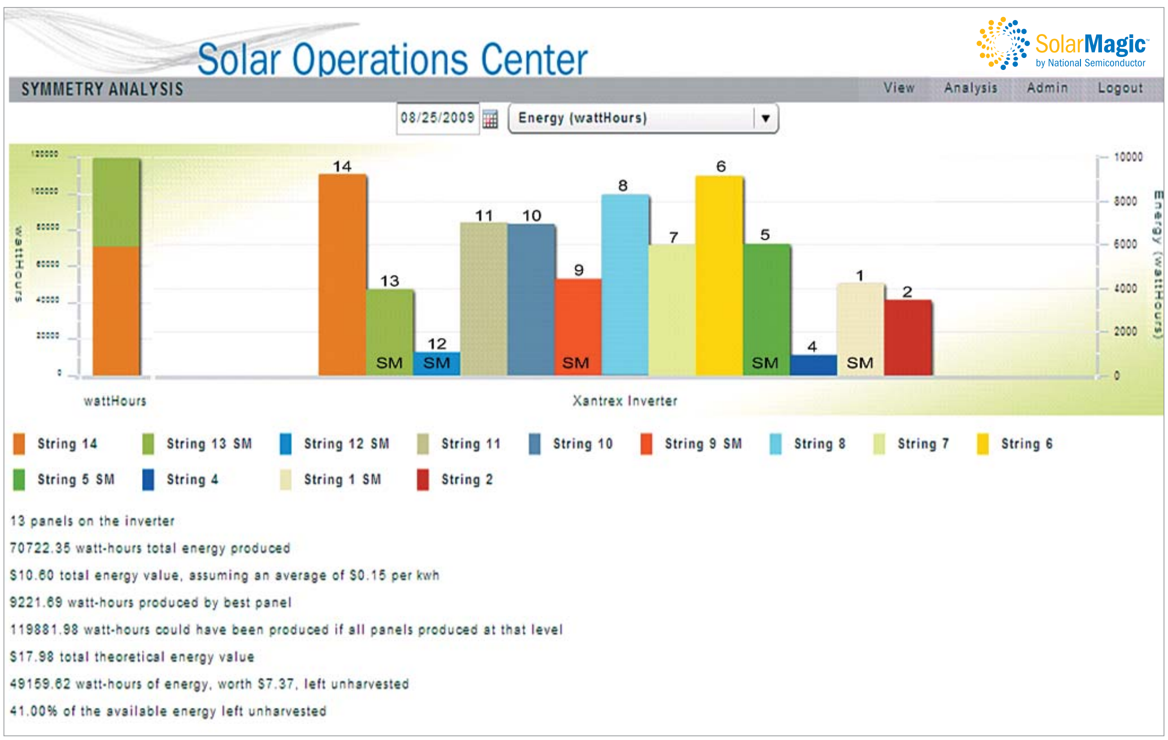

Figure 1: Solman Symmetry Analysis on August 25th 2009 shows significant underperformance, even in completely undamaged strings. Strings 1, 5, 9, 12 and 13 have at least 2 panels each damaged by baseballs. Cumulatively, these strings were underperforming by over 30% (after normalization).

Figure 1 shows a representative day during the performance evaluation phase. Strings 6 and 14, SolarMagic's control strings, were performing well, and set a baseline for the subarray. If all strings had performed at this level, the subarray would have produced 120 kWh, but the damaged strings (plus the control strings) only produced 71 kWh of energy. **Figure 1** shows this left 41% of the energy entitlement unharvested. After normalizing the data for weather, irradiance, and a blown fuse in string 4, 31% of energy potential proved to be left unharvested.

SolarMagic Corrects Imbalance

Figure 2: Baseballs cause starburst breakage patterns in the module glass and can damage underlying cells.

Of the fourteen strings evaluated in this case study, five had damage by at least two fly-balls. **Figure 2** shows 3 modules with breakage caused by baseballs. Even though other strings were also underperforming, only these strings were selected for assistance by SolarMagic power optimizers. In September 2009, strings 1, 5, 9, 12 and 13 were optimized with SolarMagic. Results are illustrated in **Figure 3**.

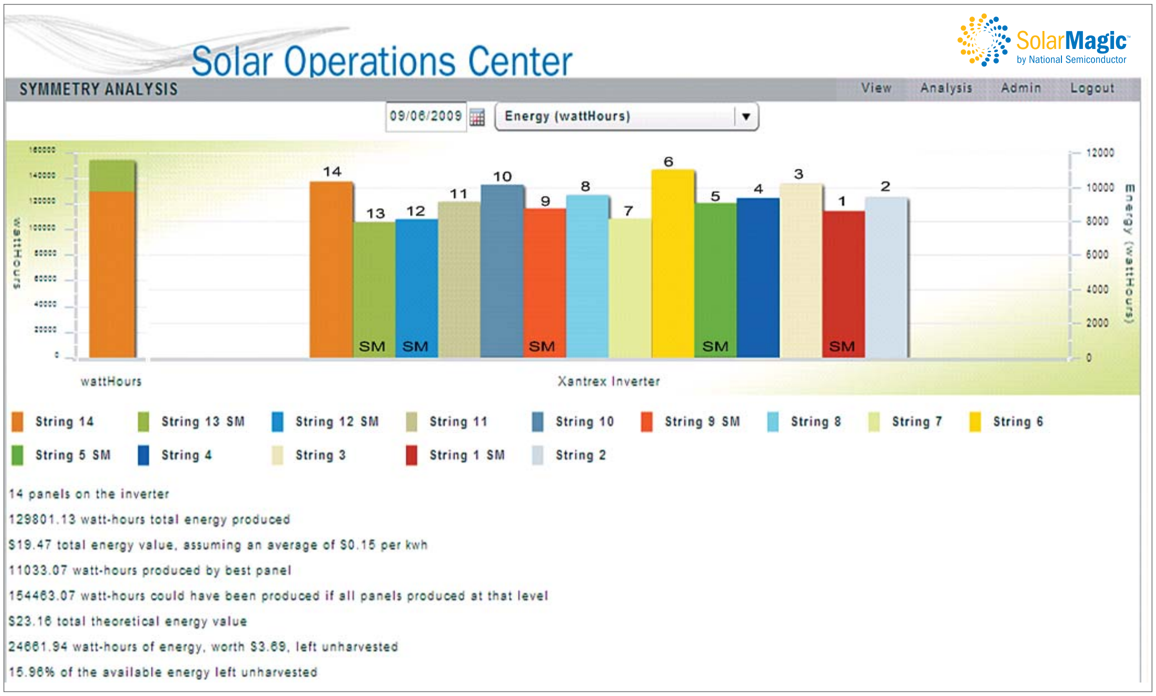

Figure 3: Solman symmetry analysis on September 6th shows significant improvement in energy harvest both from SolarMagic assisted strings, and other strings in this subarray.

Figure 3 shows significant improvement in energy harvest. Even with damaged modules in most strings, SolarMagic power optimizers balanced the system enough to reduce the power loss from 31% to under 16%. Even unassisted strings benefited when the worst performing strings were instrumented with SolarMagic power optimizers. This translates to recapturing 51.2% of previously lost energy.

Maximize Performance with SolarMagic Power Optimizers

While SolarMagic power optimizers cannot create energy that was never generated, they can maximize system performance by harvesting the energy generated by those modules, without compromising the performance of the rest of the array. By implementing SolarMagic power modules under these circumstances, the voltage mismatch between strings, and current mismatch between modules, was corrected. This enabled other strings in the same sub-array to operate in an optimal range, allowing more energy to be harvested from all strings and significantly increasing the financial benefit of the system.

SolarMagic™
by National Semiconductor