Trojan BATTERY COMPANY®

Case Study
Spice Village Resort, India

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- George Mathew, TeamSustain

Off-Grid
Spice Village Resort, India

System specifications:

Batteries: (72) Trojan deep-cycle IND29-4V* batteries
Dual-Mode Inverter-Chargers: (9) SMA Sunny Island 5048
PV String Inverters: (9) SMA Sunny Mini Central 7000HV
Solar modules: (650) 100Wp a-Si thin film PV modules
Racking: Space frame structure

Spice Village, founded in 1992, is a 56-cottage solar-powered off-grid eco-resort on the border of the Periyar Tiger Reserve in the Kerala province of Southern India. Described as "a tribute to ancient ways of life" where "hewn stone replaces shag carpets" and "birdsong takes the place of television," the resort provides comfort for modern travelers while giving them a chance to enjoy a simple "back-to-nature" experience.

Considering the recent trends and growing demand of the global traveler for eco-friendly destinations and properties, the hospitality industry is under pressure to "go green" to ensure the lowest possible environmental impact from tourism. For this reason, the management at Spice Village decided to use energy efficient measures and solar power to make Spice Village a low carbon emissions resort.

In late 2011, Spice Village hired solar company, TeamSustain, to design and install an off-grid photovoltaic (PV) system for the resort. TeamSustain is a leading green technology solutions provider based in Cochin, India. The company offers cost-effective logistics and infrastructure solutions for sustainable resource utilization to markets around the world. Until June 2012, the resort was connected to the electrical grid 100% of the time during grid availability, and it also relied on a diesel generator for backup power due to poor grid quality.

The generator ran eight hours a day to supply power to the cottages and resort buildings. Not only was it noisy, but it was time consuming and costly to maintain, and expensive to run since fuel had to be purchased and transported from far away. The previous system consisted of two generators with capacities of 125kVA and 200kVA which produced almost 62,000 kWh a year.

By analyzing a compilation of energy audit data and identifying how to reduce the electrical load without compromising the use of necessary facilities or comforts, TeamSustain was able to recommend an improvement in the resort's energy efficiency, reducing the daily consumption from 750kWh to 200kWh. As a first step, incandescent and florescent lighting was replaced with LED lighting, desktop computers were replaced with laptop computers, and electrical appliances including ceiling fans, TVs and refrigerators were upgraded to more efficient models. In addition, the eco-resort plans to revamp the laundry and the kitchen areas to include more efficient appliances to help reduce the overall load to achieve the 200 kWh daily goal. The existing diesel gensets will also be replaced by biodiesel gensets in the future to reduce carbon dioxide emissions.

Once the initial energy efficiency upgrades were made, TeamSustain designed a 65kWp battery-based PV system for Spice Village. The system was designed to support the full load of the resort during the daytime after implementing the energy efficiency measures identified in the energy audit. After all upgrades are made, the new PV system will generate enough solar electricity to meet 100% of the resort's power needs. The biodiesel genset will only be used during the rainy monsoon months for a few hours a day to compensate for the short fall of PV energy production.

The PV system consists of 650, 100Wp thin film PV modules wired in 108 strings of six modules per string for a total array size of 65kWp. They are mounted in a fixed array with a 16 degree tilt. Due to the high vegetation of the area and adhering to a mandate that no trees could be cut, TeamSustain used a space frame structure

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to raise the solar array 33 feet above the ground to avoid shading. A space frame structure is a truss-like, lightweight rigid structure designed using interlocking struts in a geometric pattern, and is ideal to span large areas with few interior support requirements. This elevated design also maximizes irradiance and utilizes the area underneath for tennis and basketball courts.

Thin-film PV modules were chosen due to the typical climatic conditions at Spice Village of overcast skies and high temperatures. The Amorphous silicon (a-Si), thin-film PV modules are expected to provide a 15% higher yield than conventional crystalline PV modules in this environment.

TeamSustain's AC-coupled micro-grid PV system features a 65 kWp PV array, nine PV string inverters totaling 67.5 kW of capacity for the PV energy contribution in AC energy, and, nine dual-mode inverter-chargers in clusters of three for a total capacity of 45kW. The AC energy coming from the PV string inverters is used by the load and/or stored through the three clusters, in three deep-cycle flooded 2V battery banks, each consisting of being 2,722 Ah @ C10 @ 1.80VPC.

For the 65 kWp PV array, a SMA PV string inverter, Sunny Mini Central 7000HV (SMC) of 7.5 kW nominal capacity, was selected because the SMC has a high 800VDC input voltage capacity, allowing the PV array to be configured with more PV modules in series than if standard PV string inverters were selected. This resulted in reducing the DC cabling size of the PV array and simplifying the PV array installation. In addition, the SMA SMC inverters feature one of the best maximum-power-point-tracking (MPPT) efficiency with its OptiTrac Tracking, allowing optimum use of the PV energy produced. An installed Sunny Webox allows detailed monitoring of the PV energy contribution.

Three SMA Clusters, each featuring three dual-mode SMA Sunny Island 5048 inverter-chargers, convert the excess of AC energy not used by the load into DC energy to charge the battery banks. When required, the DC energy stored in the batteries will be converted into AC energy to power the AC load. The SMA Sunny Island 5048 is a highly efficient, easy-to-configure dual-mode inverter-charger of 5 kW at 48V. Its intelligent battery management system helps ensure maximum battery life.

The energy produced by the thin-film PV modules is stored in 72 Trojan deep-cycle flooded IND29-4V Industrial batteries. Trojan batteries were chosen by TeamSustain due to their reputation for high quality and reliability, the fact that they were made in the USA and because the size of the Industrial batteries met the specifications of the project design. Flooded deep-cycle batteries were chosen for the project over valve-regulated lead-acid (VRLA) batteries because of their affordability and durability. Since the resort has a maintenance program in place, watering the batteries periodically with distilled water will not be an issue. Trojan's Industrial batteries have wide plates which allow for more electrolyte to be stored at the top of the plates, allowing for longer intervals between watering.

The battery bank size was designed by TeamSustain for a daily usage of maximum 50 percent depth of discharge, with each battery providing a 1,361 Amp-hour capacity at C10 at 1.80VPC. There are three 2,722 Ah at 48V battery banks in the system, totaling 8,166 Ah capacity. Each 48V battery bank, connected to one SMA Cluster, is configured as two strings in parallel, each string consisting of twelve Trojan IND29-4V batteries in series.

Trojan's deep-cycle flooded battery technology requires simple maintenance to ensure maximum battery life, which includes adding distilled water to the individual cells regularly.

Trojan's Industrial line of flooded deep-cycle batteries is designed for 1,500 cycles at 80 % depth of discharge and is specifically engineered to withstand the rigorous conditions of renewable energy applications including extreme temperatures, remote locations and the intermittent nature of solar power generation. These batteries are designed to be cycled regularly and are engineered to perform optimally under conditions where the batteries operate in a partial state of charge; a common occurrence in renewable energy applications due to the varying levels of irradiance, temperature, and available sun hours.

The anticipated payback time for the PV system is five years. Spice Village has applied for a 30% subsidy from the Indian government on capital costs as part of the Jawaharlal Nehru National Solar Mission (JNNSM) Rooftop Plant Program. This project is also eligible to earn carbon credits since there is an expected carbon reduction of 256 tons of CO_2. Overall, Spice Village expects to save nearly $45,000 per year by switching to solar energy.

* The IND29-4V battery has transitioned to the Solar Industrial SIND 04 2145 battery.

For more information contact:
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