Technical Whitepaper

SolarConnect™ Energy management solution for Base Stations

A Solar Powered Cellular Base Station

Many people in emerging markets like India live in rural areas with limited access to the electricity grid. This presents a significant barrier to expanding network coverage in these areas as mobile phone base stations rely on a secure supply of power. Even in areas connected to the grid, the power supply can be unstable and expensive. Use of diesel generators to power base stations require regular maintenance and are expensive to run. Fortunately solar power is available in almost every location no matter how remote. By utilizing solar power to run the base stations will not only allow operators to reduce their operation costs to a bare minimum but also allow deeper penetration of mobile networks.

Solar powered base station is a new concept in India. There is not much of technical knowhow present to execute such a system nor is there enough awareness amongst the cellular operators. This report presents the technical feasibility of such a system. It presents real data obtained from an operational site and elaborates on how such a system could allow better energy management of a tower site, reduce emissions and move towards sustainable energy.

Site specifications

The target site is a two base station (BTS) system both operating at -48V DC. Both BTS belong to Airtel. The shelter had a 600Ah Exide VRLA battery which was upgraded to 1200Ah HBL VRLA. The site has two 2 ton air conditioners from Spacemaker.

The energy requirement of the site varies throughout the year with air conditioner loading varying. The DC load requirement is more or less constant. Each BTS consumes an average power of 1350W while the main distribution panel consumes 180W. The energy requirement of the air conditioner is much difficult to predict. Each 2 Ton AC while operational consumes 2400W of power at 0.8 power factor which drops to 150W while in standby. The duty ratio of each AC is somewhere around 0.42 when the max ambient temperature is around 40 C and set temperature is 29 C. This comes out to be approximately 1unit of energy consumption/hour/AC. The duty ratio will drop drastically in winters. The diesel generator present at the site is rated at 15KVA. Table 1 summarizes the load requirements.

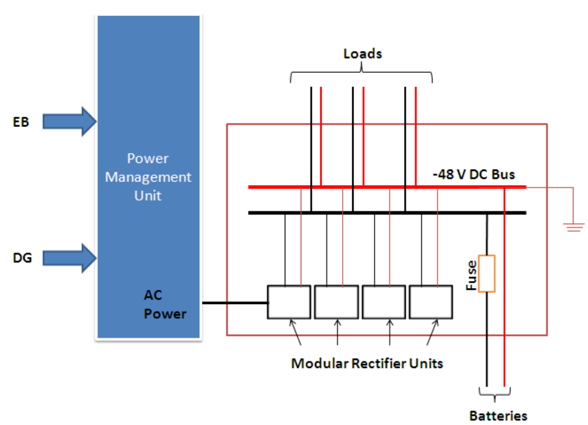
	Payload	Power Requirement	Energy Consumption
BTS	-48V DC	1350W	32.4KWh/day
MDP	-48V DC	180W	4.32KWh/day
AC	230V AC	3000VA	24KWh/day

Table1.

At the current site the total DC energy requirement comes out to be around 44.5KWh/day while consumption by air conditioners is 48KWh/day. So the total energy need is 92.5KWh/day.

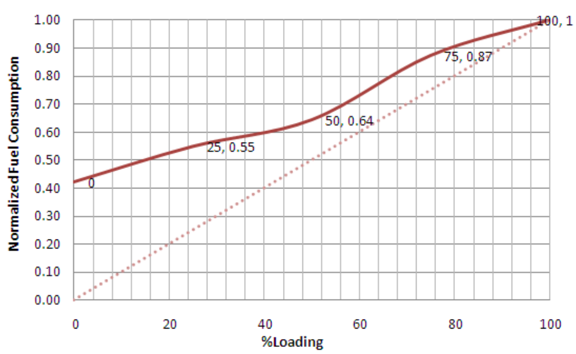
Existing setup at site

The power from electricity board (EB) and diesel set goes to a power management unit. This feeds power to a DC power supply unit with integrated distribution and meter-control alarm unit (MCA). The specific model used in the site is an Emerson 701 model. From now on we will refer to the unit as SMPS. The SMPS has rectifier modules that convert AC power to -48V DC that charges the batteries as well as powers the loads. The power management unit controls power to the SMPS. EB is normally powering the SMPS. When EB fails, the power management unit switches on the DG set once a pre set voltage is reached or the room temperature rises above some pre set value. This switching logic is flawed and could result is inefficient use of energy sources.



Sources of inefficiency

In a remote tower site where energy is at premium it is of utmost importance that the system operates at the highest possible efficiency. There are several sources of inefficiency. The prime source of inefficiency is under-utilization of the generator. As can be seen in the graph below the efficiency of a generator drops pretty fast with low loading. To utilize the generator properly it must be ensured that the batteries are discharged and offer enough loading. This may not happen in many a situation because the generator triggers both based on battery voltage and room temperature. Therefore in a hot day the generator may run for extended periods of time just to maintain the temperature while the batteries are almost charged.



Store and use strategy

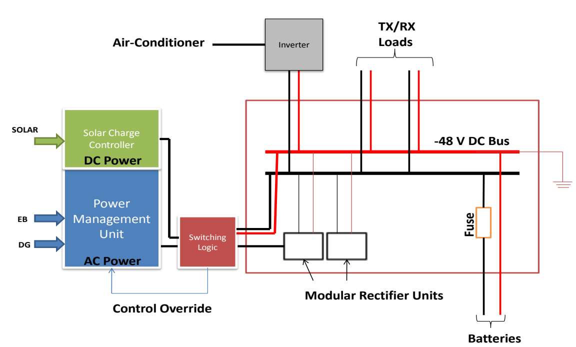
An optimal switching system ensures that there is enough loads so as to load the generator properly. Deep discharge AGM-VRLA batteries such as the one in the project have typical energy (Wh) efficiency as high as 92%. So by loading the DG set fully by switching it on only when the battery is discharged, storing the energy and then utilizing it slowly over a larger period of time will result in savings. An optimal switching logic that adheres to the following energy priority can achieve that.

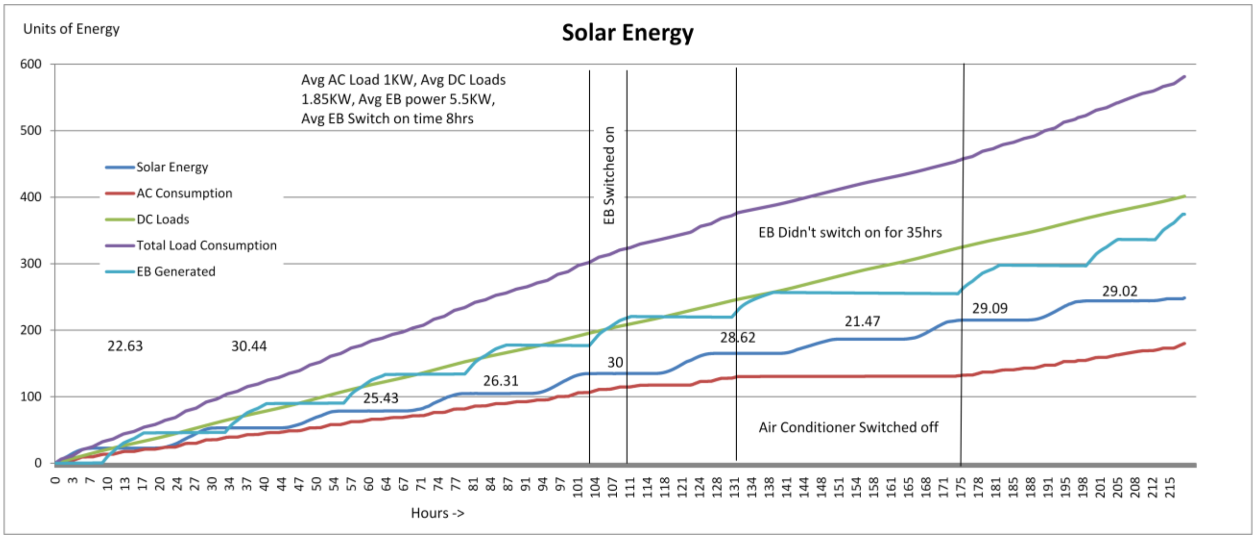
Priority	Energy Source
1	Solar/Wind
2	Battery
3	Grid power
4	Diesel Generator

To utilize such strategy larger than normal battery size is required and air conditioning has to be powered by battery. Fortunately solar applications require such battery banks as solar power is available only for a limited period of time. Utilizing an inverter the air-conditioner can be made fully or partially powered by battery.

Setup with SolarConnect™

Minor changes are made to the electrical schema of the existing system. The battery bank was upgraded, solar power was fed into the SMPS and control signal from switching logic was interfaced to the power management unit (PMU) that controls the switching of DG. Furthermore one of the two ACs was powered by the battery via an inverter. Grid power (EB) is available 24X7 in the site. The figure below shows a simplified schema.





Total Solar power being fed into the system was 6.025KWp. A data-logger (Yokogawa Datum XL900) continuously measured all electrical parameters including voltages, currents at regular interval of 30 seconds. The graph above shows energy generated/consumed by the different units. The data logging started on 6th April 2010; 11 A.M. and continued for 220hrs.

Observations

As can be seen in the graph the air conditioner was switched off from 130th hour to 175th. This is to demonstrate the importance of proper switching. Neglecting that time in the analysis the following can be observed – Average total DC loads including AC: 2.85KW. Average rate of consumption by each air conditioner: 1KW. Average charging rate from grid/DG: 5.5KW the averaged energy balance of the system is shown below –

Total Load Consumption	Solar Generation	From Grid/DG
68.4KWh	28.41KWh	40KWh
	%age of total load supported	
	41.5%	58.5%
	Hours of operation	
	16	8
	% of time supported	
	66.7%	33.3%

It is interesting to note that although solar is supporting only 41.5% of load it is on for 66.7% of time. This figure is a bit misleading because during this time both solar power as well as battery power is supporting the loads. The power supplied by battery is mix of solar and grid/DG power. By letting the battery support the loads the run time of DG is reduced, drastically cutting operational as well as maintenance costs. Also note when the AC was switched off the energy generation by solar also dropped.

This happened because of reduced loads there was not enough loads to properly capture the power generated by solar. So it is of utmost importance that the switching logic keeps the battery appropriately discharged in the morning time so that it along with the loads can properly absorb the solar power.

Financials

SolarConnect™ is available both as a capex as well as an opex model. In the capex model the consumer pays upfront for the whole system. The system pays it off over a period of time after which it is almost free except for very minimal cost involved in cleaning of the modules and remote monitoring. In the opex model the consumer pays monthly EMIs to operate the solar system. This EMI is for a period of ten years. The monthly EMI paid to operate the site could be considerably less compared to operational cost involved before solarizing the site. The detailed analysis of both the models can be found in a different document. The sales and marketing department can help chose the best way to finance the system.

Site Details

Interested clients can setup a site visit to understand the system in operation. The sales and marketing team can help in this regard.

Site Photos

The first picture shows the solar charge controller, SMPS and PMU. The second picture gives a bird's eye view of the site.

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