Case Study: AC, Mini-Grid, KalkeriSangeetVidyalaya, Dharwad, Karnataka
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School Mini-Grid (Kalkeri, Karnataka)

SELCO installed a custom mini-grid system to electrify a school in Kalkeri in the outskirts of Dharwad district in Karnataka. This project was in partnership with Kalkeri Sangeet Vidyalaya ('KSV'), an existing customer of SELCO's DC lighting systems. KSV was the winner of the 2014 Zayed prize in Asia, and wanted to utilise the grant received as part of a larger goal of making the school energy self reliant. In this mission, KSV and SELCO came together to design and implement a cusom mini-grid that will support the larger energy needs of the school. Also, as part of the larger project with KSV, SELCO helped implement a solar water pump solution, solar water heaters and a biogas plant.

Identification

Kalakeri Sangeet Vidyalaya ('KSV') is an existing customer of SELCO's DC light systems

Problem Statement

To design and install a solar mini-grid system that will cover the energy needs of the 10 classrooms, a library, 2 labs, 8 hostels, meeting halls and office spaces in the school, in order to enable energy self reliance. Apart from basic lighting needs the mini-grid would have to support projectors and laptops in the classroom, labs and offices. The classes contain a 2 light system with a projector including provisions for powering music instruments like tambura, metronome, etc.,. The lab unit would contain between 2-4 LED lights and an average of 2 fans. Each hostel unit will support 4 LED bulbs and provisions for plug points

Project nuances

With pre-existing DC systems installed in the classrooms, SELCO had the option to install standalone systems for individual units or go for a mini-grid as a centralized system within the school.
A solar AC mini-grid is ideal because the individual rooms are shaded due to foliage and also to cater to the diverse load needs of individual units and to avoid energy islanding.

The electric grid is not reliable in and around the area of the school with more than 10 hours of power cut every day. Additionally, when the grid is available there is huge fluctuation in the voltage, which can damage the devices. Although, the school is supplied with a three-phase connection, only two phases are actually available rendering the three-phase water pump system redundant.

KSV provides education performing arts and academics to children from socially and economically disadvantaged backgrounds. In addition, food, accommodation and healthcare is also provided to the students for free. After winning the grant funding, Adam Woodward-Director at KSV approached SELCO with a proposal to install individual solar systems to provide reliable clean energy for the classrooms, hostels, library, office spaces and meeting halls. Most of the energy reliant activities in the classroom was identified to be during the day time when the student learn and use music instruments, and tutors access the projectors as learning aide for teaching. Similarly, the meeting halls and the office spaces had peak lighting and energy needs during the daytime when the school proceedings were underway. The energy consumption pattern in the hostel is intensive during the evenings and the nights when the students retire to their respective hostels. Added to this, is the challenge of having to support multiple AC based load devices that will be mounted in these individual units/rooms. It was evident that, any system design whether individual / standalone systems or mini-grid has to factor in these inputs, given the energy consumption and load pattern within the school.

After two rounds of energy audit (first walkthrough and second detailed audit) from the SELCO team, a custom 20kVA mini-grid solution with 14kWp solar panels was agreed to be more efficient than installing a number of individual units. Because of tree shade on the rooms, installing individual solar panels over each room would not be practical. Further, because the mini-grid distributes electricity across all the rooms from a single generation source, it is able to balance the varying loads across rooms and efficiently distribute the power. This allows the solar photovoltaic array to be smaller compared to a collection of individual systems. Also varied loads including teaching aides need not be custom-made, in order to be operated on DC at different voltage level.

System Design

14kWp Solar PV panels with one hundred and twenty 300Ah batteries and a custom designed control system at 240V_{AC} distribution.
The mini-grid will power twenty 5 W LED, seventy-four 10 W LED, seven 7.2W outdoor lights seventeen 20W LED and ten projectors across the classrooms, hostels, labs, office spaces and meeting halls, water filtration system and wet grinder in the kitchen

Impact

More than 200 people including students and staff benefit from the electrification of the school.
Savings: School should ideally save 80% of money currently spent on electricity bills and become energy self-reliant
Reliability & Learning: Reliable energy in the classroom and hostels. Students are learning the benefits of renewable energy

Key aspects:

- Design Challenge: Avoiding energy islands,in terms of having individual power generating units for each room, was a key consideration while opting for a mini-grid over standalone DC systems in the school. This will enable the school to utilize the surplus energy thus generated, elsewhere within the campus
- Mounting Challenges– The solar modules and panel had to be mounted at a suitable location within the school given, the canopy/green cover that spreads through much of the school. It was decided that a module mounting structure ('MMS') will be erected which can support the panels at a location where there is no shadow due to foliage. The school does not have a lot of space and is expanding. The tall MMS allows for space under the panel for outdoor seating as well as a store room/battery room
- Alternate Current Distribution–SELCO designed a custom control system to support the AC transmission network. Although, low voltage direct current (individual system) reduces line losses and is efficient for powering lights it was decided that the AC transmission would be ideal for varying loads
- Increase Efficiency–A mini-grid here is relatively more efficient than a standalone system for individual rooms as the power is generated from a single source and distributed across the school. The efficiency is due to optimal number of panels used due to mounting it at shadow free area rather than overrating the panels for individual systems mounted under shadow to compensate for the loss.
- Substituting Grid Energy: The excess unutilized power generated from the mini-grid will be routed to the parts of school which still rely on unstable grid, thus substituting grid power for a larger part of the school

Learnings:

- Building branch knowledge –This project is by far the largest single system by capacity installed by SELCO, and is a joint effort of the projects (SELCO Solar), tech team (SELCO Foundation) and operations team (SELCO Solar) within SELCO. It was conceived by the projects and tech team, and executed in coordination with the operations team. It was crucial to get the local branch personnel involved throughout the execution of the project. This will help build the knowledge base of the branch and more importantly will aid in future servicing and maintenance of the system

INNOVATION

Custom 14kW AC distribution system

Surplus energy from the mini-grid will be used to substitute grid-reliant sections of the school

Solar Photovoltaic Array-14kWp

Series of 300 Ah Batteries (120nos)

20kVA Invertor, control panel and data logger system, Battery array in the background

Classroom