Using solar electricity to power school computers at Gnanmata Sadan Schools, Talasari District, India

Case study and assessment of the feasibility to scale out

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1 About this document

This document captures the experiences from deploying a solar energy system to power computers at a school that is a part of Gnanmata Sadan, an Educational Trust of the Bombay Province of the Jesuits.

This document references the project completion report prepared by the vendor of the solution that contains the details of the project.

2 Introduction

The Gnanmata Sadan is an Educational Trust of the Bombay Province of the Jesuit, which is set up to administer the Talasari Mission. The Trust, in collaboration with various congregations of Sisters and the Diocese of Vasai, runs the following institutions:

- 11 Primary schools (Medium of instruction: Marathi language)
- 4 Secondary schools (Medium of instruction: Marathi language)
- 1 Junior College (Medium of instruction: Marathi language) and
- 2 classes where the medium of instruction is English language

These schools serve the Adivasis[1] of the region, in particular the Warli tribe. The Jesuits have been working with them for the last 75 years, assisting in their upliftment through education. The children of the village are also offered education in English, to prepare them for opportunities in a global environment.

See appendix for more details

3 Gnanmata Sadan's challenges

The Gnanmata Sadan schools are faced with daily electricity outages (power cuts) and a continuous problem of fluctuation of voltage from the power grid. These outages take place during peak school hours and last for a minimum 6 hours at a stretch.

This has resulted in the school children not having or having very limited access to computers. Besides, several computers at the schools have been permanently damaged due to severe fluctuation of voltage of grid power.

Electricity from solar panels has been explored as an ideal source of alternative electricity during power outages. The solar electric system also augments and replaces expensive grid power. The stable voltage of the solar electric system also helps avoid permanent damage of computers.

4 The Solar power project

The project was conceived through a collaborative effort between InSite International AS, Norway, Gnanmata Sadan and the St Stanislaus Ex-Students Association.

The management of the Gnanmata school complex decided that an alternative source of stable electricity was required to contribute to the development of the school. It was decided to execute this effort as a project. The project involved setting up a pilot installation at the Talasari Centre of Gnanmata Sadan which has about 900 students. The scope of the project was to power 8-10 school computers using solar power (photovoltaic cells).

[1] Adivasis meaning "original citizens" are the "first nation" people of India

The project was executed entirely by Rajasthan Electronics & Instruments Ltd (REIL)[2] on behalf of the sponsor InSite International AS. The St Stanislaus Ex-students Association, which also supports the development of the school acted in the capacity of facilitator and project liaison to link InSite International and management of the school. Activities involved follow-up of activities including the preparation of this report.

The project sought to address the following goals

1. *provide continuous electricity during peak school hours*
2. *augment and/or replace expensive grid power*
3. *reduce permanent damage to computers due to voltage fluctuations while using grid power*
4. *establish the basis for a self sustaining ecosystem based on solar power.*

The project was initiated on 01.02.2008 and work on the site commenced on 15.03.2008. The work was installed, tested and commissioned on 01.04.2008.

5 Opportunities - Leveraging experience

On April 17th 2008 Mr. Tommy Fernandes of InSite International AS along with a few members of the St. Stanislaus Ex-students Association visited the Talasari Centre at Gnanmata Sadan. The purpose of the visit was to

- inspect the solar electric system that had been commissioned at the Talasari centre and to see it functioning and used in the computer laboratory of the school.
- understand the potential of developing a sustainable activity in corporation with REIL.
- explore the idea of Gnanmata Sadan becoming a rural solar-power service provider.
- explore the possibility that Gnanmata Sadan will own and deploy a volume of repetitive solar projects for its other educational institutions based on experience of the first project.

The SSESA is working with a recently started English language school of Gnanmata Sadan and covering costs for part of the running costs of this school. In its second year of existence, the English language school has a class each of Grade V and VI comprising a total of 30 children. . The St Stanislaus Ex-students Association supports the school in two ways (i) financial donations, to cover the operating costs of the school and recently (ii) driving long-term projects that can catalyze local business opportunities.

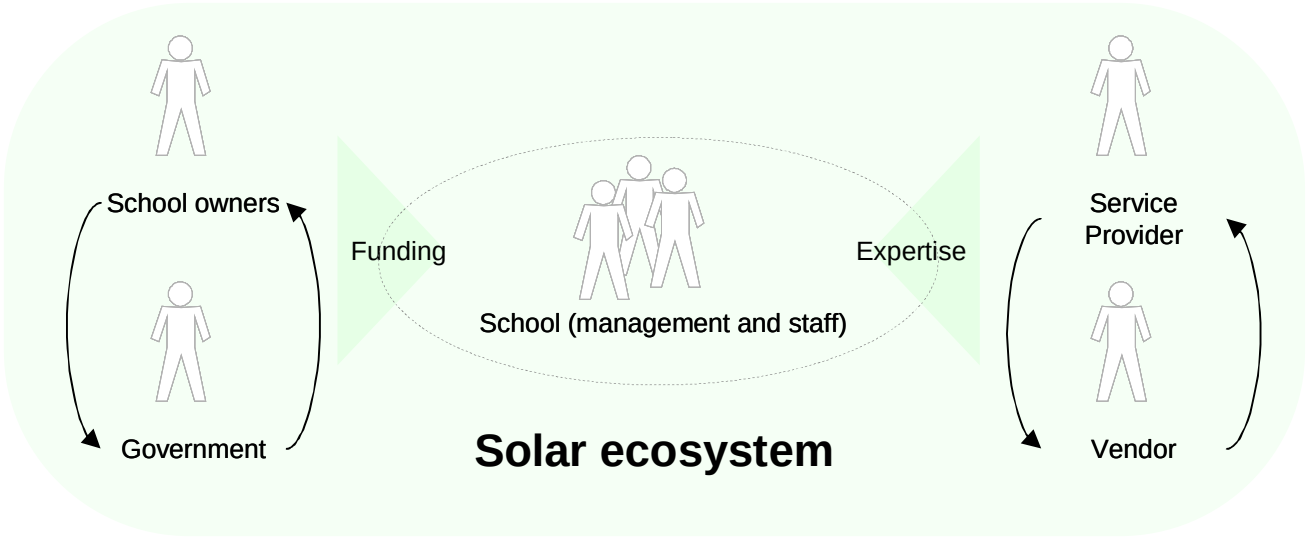
After visiting the project site and inspecting the functioning system it was felt that a self sustaining ecosystem based on solar power was feasible.

The rural sector presents interesting challenges and opportunities that can create a sustainable system for value creation in the solar sector. While there appears to be a number of areas of application for solar energy, this section focuses on school infrastructure as a focus area. Another area that can be considered is the healthcare sector (solar powered refrigerators to hold vaccines specially for visiting medical professionals)

Providing solar energy for school infrastructure can generate value in two distinct areas[3] (a) Providing a stable educational environment for the stakeholders by providing energy to new infrastructure like computer equipment (b) creating a basis for services to manage the installed base of solar units. Services should cover operations (continuous) as well as project services (turnkey deliveries or advisory).

[2] See Appendix

[3] These services are applicable for all areas of application and not unique for school infrastructure



The key stakeholders are

1. **Rural government authorities –** to provide the incentives for deploying solar energy solutions (primarily funding). The rationale being that of local value-creation which retains a workforce to serve the local community. State and federal government authorities should also be included in creating driving this initiative.
2. **School owners –** to work with government and other funding agencies to provide funding
3. **School Management and staff –** to establish good practices in the use of the solutions and to free up teaching and non-teaching staff support the implementation for solar energy solutions. To exploit the computer learning environment so as to deliver a superior teaching experience. To give feedback and prioritize enhancements in practical use of the solution.
4. **Service provider –** to work with the School management and staff to provide service support to the school in managing the solar infrastructure. Project and operations services
5. **Vendor –** to provide actual products and supporting materials and necessary technical expertise to deploy solutions

5.1 Mobilizing for roll out to other schools and facilities

The discussion with the Gnanmata Sadan administration addressed the potential to embark on repetitive projects for the other schools of Gnanmata Sadan. The following needs to be addressed – not in any particular order, however, capacity to execute and funding are key criteria.

- prioritizing the schools in order of roll out and funding
- involve the owners of the school (Jesuit Provincial) to provide support for the project
- obtain finances for executing the project including identifying and accessing local government subsidies for solar systems in India.
- document any need for residual financing for the project
- involve local resources who can commit to providing services for deployment
- set up terms and conditions with REIL to provide training and support to grow service providers – formal training in sales and technical support should be included

It was felt that such solar applications can be further developed and deployed through support from independent entrepreneurs who could explore commercial opportunities with solar applications.

6 Appendix

6.1 Financial implications

Cost drivers for such an undertaking include labour costs and material costs. Labour costs cover installation activities, support costs and day-to-day operations and minor maintenance. Material costs include equipment including cabling and building costs to host the facilities.

6.2 Facts about Gnanmata Sadan

Gnanmata Sadan has campuses at Talasari, Uplat in Thane District, 150 km north of Mumbai, India. There are a total of 6000 girls and boys studying at the different schools. The schools are affiliated to the Maharashtra State Board of Education and follow the syllabus determined by this board. There are a total of 25 PCs spread over the various schools.

Fr. Wendell D'Cruz is the contact person for Gnanmata Sadan's involvement.

6.3 Facts about InSite International AS

InSite International as was founded by Tommy Fernandes 1st August 1997 and offers business development and mentoring services based on many years of experience and the use of an international network of business partners and service providers. InSite International focuses within the IT, solar energy related technology industries.

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6.4 Facts about REIL

Rajasthan Electronics & Instruments Ltd (REIL) is a joint venture company between the Central Government of India and Government of Rajasthan. The area of business of REIL extends to manufacturing and marketing of electronic products, services in the Agro-Dairy Sector, Solar Photovoltaic Sector, Industrial Electronics Sector and Information Technology.

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6.5 Facts about SSESA

The St. Stanislaus Ex-Students Association is a not-for-profit organization aimed at assisting alumni (ex-students and ex-staff members) to network and to support and drive activities that can help the school grow qualitatively. The mission of the association is to create an environment that encourages Stanislites to live the motto of the school (Born for Greater things – Natus Ad Moira) in all walks of life.
www.stanislites.org

DETAILED PROJECT REPORT FOR

SUPPLY, INSTALLATION & COMMISSIONING

OF SPV POWER PACK 960 Wp

AT

GNANMATA SADAN SOCIETY, TALASARI, DISTT. THANE

PREPARED BY

RAJASTHAN ELECTRONICS & INSTRUMENTS LTD., JAIPUR

1 EXECUTIVE SUMMARY – Project report

Gnanmata Sadan Society, Talasari, India is a Non-governmental organization (NGO) operating in the state of Maharashtra, India. The objective of GSS is to ensure access and quality education to the children of disadvantaged groups of society by setting up residential schools with boarding facilities at elementary level with a component of scheme to provide necessary infrastructure for these schools.

Gnanmata Sadan Society is located in remote area and the availability of the power grid is poor. The irregular power supply and that too of poor quality (in terms of voltage) pose many difficulties in terms of minimum lighting requirements and for running appliances (computers.) Off the grid power concept based on solar photovoltaic technology has emerged as one of the alternatives, best suited to address this problem. Electrification through Solar Photo Voltaic Technology can be used effectively for Gnanmata Sadan Society.

Rajasthan Electronics & Instruments Limited (REIL) which is a Public Sector Enterprise is one of the leading companies in the country which manufactures SPV module and Solar systems for a wide range of applications. REIL has so far installed large nos. of such systems all over the country. REIL has the required expertise and resources to undertake project.

2 HEALTH AND SAFETY

Solar electric: Photovoltaic / PV power systems are new to many users and maintenance personnel. Solar power systems such as the one installed have a unique set of risks and associated hazards. No attempt should be made to operate, switch, control or maintain the system without first reading the project health and safety section.

2.1 General Safety

It is in the interest of accident prevention and minimization that all personnel receive training on the contents of this manual before they perform installation, operation or maintenance on the system. Safety concern arising from the installation should be monitored and managed by the customer / installer.

You can always be injured working on the PV systems minor injuries like cuts, bumps, fall and sprains although, most safety suggestions are just plain common sense and the goal is to reduce the number of injuries/accidents to zero. This requires good work habit and awareness of potential hazards and a program where safety rules are frequently reviewed.
You should be trained and competent to perform the work.
“You always have an obligation to stop work that is unsafe”.
Take Two minutes To Think About Your Safety - The goal is to reduce injuries and accidents to Zero

2.2 Applicable Standards

It recommended that installation work to be executed in compliance with relevant local standards applicable for electrical wiring and installation, building codes and standards do power systems. PV systems and battery installations.

Relevant local standards are to be followed.

2.3 Structures

Erection of support structures must not be attempted in high winds
Additional care must be taken while lifting structural members and working at high levels.
Protective footwear, gloves, eyewear and headgear should be worn.

For further information on structural installation practices, refer to the local standards for safety in erecting structural frames.

2.4 Modules

NOTE: SOLAR ARRAYS CAN PRODUCE LETHAL VOLTAGES.
When performing any modification to the wiring or terminals associated with the solar modules and before any electrical connections are made to the junction boxes, the modules should be covered from the sun by opaque sheet. Use the cardboard packing boxes to shade the modules if the packing is in good conditions without holes or tears.

2.5 Battery handling

Ensure to use insulated tools and wear eye and hand protection when transporting of installing batteries.

Maintain terminal insulation covers on lead acid batteries & or battery bank, cover them before system connection, to prevent accidental high current discharge or shock.

2.6 Wiring

Poor wiring practice can contribute to electrical hazards. Electrical installation and wiring of the system shall be carried out as per local electrical wiring standards as applicable. Power supplies standards within public telecommunications networks, local electrical and safety standards to be followed as applicable.

2.7 Precautions

The solar electric power systems are to be installed by skilled personnel.
The installer should review all installation information before starting the work.
Avoid installation in wet / damp conditions due to increased slip and shock potential.
Remove watches from hands, wrists, jewellery from hands and neck.

2.8 Structural Assembly

Do not attempt construction in high winds.
Take appropriate precautions when lifting structural members and working at elevated levels.
Local regulations may require you to follow specific procedures when working at elevated levels.
Use at least two persons to install the assembled Solar Array, more if necessary.
Follow applicable codes and safe practice when lifting the batteries and enclosures.

2.9 Electrical Connections

Normal Cable colour coding: Red is positive, Black is negative.
Check for consistent polarity of equipment before interconnecting.
Use insulated tools.

2.10 Batteries

Batteries can deliver extremely high short-circuit currents (10,000) Amperes or more depends on the ratings). Implement precautionary procedures and use insulated tools while working around the batteries to reduce the risk of accidentally shorting the battery terminals.

Batteries capacity and life is reduced if operated at low voltages for long intervals.
High temperature reduces battery life keep batteries cool.
Battery must be installed in ventilated room, no naked flames in battery room.

3 TECHNICAL DETAILS

REIL has supplied and installed 960Wp SPV Power Pack for operating 8 computers in the computer facilities of Gnanmata Sadan.

3.1 SPV MODULES:

Type and Quality

The total Solar PV Array Capacity is 960 Wp.

The modules used have following specifications:

Make	REIL
Type	80W36
Peak Power Output	80 Watts
Maximum Current	4.70 A DC
Maximum Voltage	17 VDC
Dimension in mm	1200 x 550 x 33
Type of Cell used	Crystalline Silicon

3.2 MECHANICAL COMPONENTS

3.2.1 ARRAY SUPPORT STRUCTURE

Modules are mounted on a non corrosive support structure suitable for site conditions. The inclination angle of the array support structure is in accordance with the latitude of the place of installation. No provision for adjusting inclination angle is required.

There shall be mild steel frame structures (Hot dipped, Galvanized) with corrosion resistant painting for holding the PV modules to form the PV panels

Each panel frame structure is so fabricated as to be grouted using cement concrete foundation.

Each panel frame is complete with a weather proof junction box as per the relevant ISI specifications, where the module terminals are interconnected and output taken.

The panel frame structure is capable of with standing a wind load of 150 km per hour, after grouting and installation.

3.3 Power Conditioner Unit (PCU)

3.3.1 General Description

As SPV cells produce direct current electricity, it is necessary to convert this to alternating current and adjust the voltage levels before powering equipment designed for nominal mains supply and before interfacing with an electricity supply network (grid). Conversion is to be achieved using an electronic inverter and the associated control and protection devices. All these components of the system are termed as the "Power Conditioner" Unit".

3.3.2 Electrical

INVERTER	
Max. No. of Series panels	4 nos.
Nominal Battery voltage	48 volts
AC out put voltage	230 volt, 50 Hz + 5%
Maximum out put capacity	2 KVA
Peak out put capacity	Up to 150% of maximum current for 15 seconds
Out put wave shape	Quasi Sine wave
Efficiency at 30 degree centigrade	Up to a maximum of 85%
Battery Charging Through Grid option	Available
SOLAR CHARGE REGULATOR	
Maximum capacity	2 kW

3.4 Battery Bank

A battery bank of 48 Volt, 200 Ah capacity is provided with the power pack.

Specifications:

Type	Tubular Lead Acid type
Make	Exide - Invared
Capacity	48V, 200 AH at C/10 rate (8 nos. 12V, 100 AH connected in series parallel combination)
Self Discharge	less than 4% per month
Ampere hour eff.	96%
Watt hour eff .	81%
Max. depth of discharge	80%

3.4.1 Junction Box

The junction box is provided in PV array field for termination of connections from various arrays.
Features: Made of FRP/Metal for dust, water and vermin proof.

3.4.2 Cables

All cables are:

- Multistrand , annealed high conductivity copper/aluminium conductor
- Overall PVC insulation for UV protection
- Armoured cables for under ground laying
- All cables shall conform to BIS standards (IS 694) and (IS 1554)

4 SYSTEM COSTING

Supply, Installation and commissioning of **Euro 5980.00**
960 Wp SPV Power Pack at Gnanmata Sadan Society
Price : FOR Destination
Payment : 100% advance

5 INSTALLATION PROCEDURE

The location for the installation of the Solar Array was selected ensuring that the modules face due south direction and will not be shaded at any time of the day. Legs for the structure were grouted in ground with cement concrete foundation.

We placed the modules on the mounting structure and tight the modules with nut-bolts.
Four modules were connected in series and 3 such series were connected in parallel.

We made the cable connection between the modules, junction box, battery bank and PCU as per block diagram. We secured the cables to the structure using cable ties to prevent chafing.

5.1 Commissioning Checks

These checks were carried out only in conditions of bright sunshine.
We measured the voltage present at the end of the incoming cables of the array junction box.
Verify that this voltage is in the range of 78-84 Volts (in bright sun).
We measure the current being generated by the array and record the reading. Under bright sunny conditions each 4 module solar array should generate more than 4 Amp.
We checked that module junction boxes have lids securely fitted.
We checked tightness of terminals & cable glands at Junction box.
We check the correct polarity of cables
We checked all structure fasteners are tight.

We ensured all nuts and bolts are tightened and corrosion free.

Note: It took 2 days for installation and commissioning of the SPV system. Two persons from REIL did the installation work.

5.2 Maintenance of the system

Following points shall be considered for maintenance of Solar System.

5.2.1 SPV Array

The modules of PV array shall be cleaned to remove dust and bird droppings etc. so that power output of modules is not reduced. The modules shall be cleaned once in a day on a routine.
The connections at junction boxes shall be checked for any loose connection to avoid any sparking resulting in fire. The cabling shall be checked for any loose/damage. The wires shall be tied with tie wraps to avoid any damage. Inspect modules for damage, ensuring that the front and rear surface are not damaged. Replaced as necessary.

5.2.2 Battery Bank

Topping up of the battery bank to be done once in a month.
Clean battery terminals once in a month.
Connections at battery terminals are to be checked for any loose connection.
Apply petroleum jelly to battery terminals once in 6 months.

Note:

- If battery is maintained as per above schedule it will last for 5 years.
- In case any faults occur during the guarantee period, REIL will repair the system and make the system operational.

6 Images after completion of installation

6.1 VIEW OF THE COMPUTER LAB

6.2 BATTERY BANK AND PCU

6.3 PV MODULES MOUNTED ON SUITABLE STRUCTURES

6.4 Block diagram for Solar PV-pack

960 Wp SOLAR PV POWER PACK FOR OPERATING COMPUTERS