

# Final Project Report

on

the

Wind solar stand alone hybrid energy system  
for rural application,

in

Mt. Abu Rajasthan, India

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## 1. Responsibilities

The body responsible for the project is the World Renewal Spiritual Trust ( WRST ) .

Managing Trustee Ramesh Shah  
World Renewal Spiritual Trust  
121, Mahatma Gandhi Road  
1st Floor, Above Bank of Baroda  
Fort, Bombay - 400 023  
Ph: 0091 22 262 58 25/26  
Fax : 0091 22 262 39 19

in conjunction with the

International Centre for Solar Application  
Managing Director Gordon Thompson  
Level 8, 220 St. George's Terrace  
Perth, WA -6000, Australia  
Ph: 0061 89 321 7600  
Fax: 0061 89 321 7497  
email: CASE@wantree. com.au

and the

Curtain Centre for Renewable Energy Systems  
Technology  
Prof. Chem Nayar  
Curtain University  
Perth WA- 6000, Australia

## 2. Summary

Renewable energy technologies offer a sustainable solution for bringing power and its educational, economic development, health and quality of life benefits to remote villages without electricity supply, or to those who currently have an unacceptable level of service. Photovoltaics, small wind turbines, and micro-hydro systems have gained increasing recognition as reliable, cost effective alternatives to grid extension and diesel generator sets for village electrify applications. Electricity grid extension is generally uneconomical, while diesel generator sets are expensive to operate and maintain and do not provide long term environmentally and economically sustainable solutions for remote applications.

Hybrid energy systems rely on two or more sources of energy for electrical generation and are configured so that the loads can be served directly or indirectly by one or more of these sources. Most hybrid electricity supply systems have a diesel alternator and a renewable energy source such as photovoltaic ( PV ) and /or wind. By providing battery storage at partial loads, smaller diesel generators and power conditioner (inverters) are able to meet short term overloads and provide 24 hour grid quality power, which in most cases is not available to industry in rural India.

The hybrid system is installed at the Academy for a better World in Mt. Abu, Rajasthan, India. The Academy attracts around 60000 visitors per year.

By its height of 1200m above sea level, Mt. Abu provides almost continuously clear skies. The wind speed and the solar radiation are among the best in the state of Rajasthan.

The system's element ( 10kw peak output ) include solar photovoltaic ( SPV ) panels, an Australian made wind generator, batteries and a control system.

### 3. Goals

A key objective of the project is to improve the living standards in underprivileged remote villages in Rajasthan by increasing the uptake of alternative energy technology.

By the constant stream of participants in various programs, conferences and seminars held at the Academy, this project acts as a reference point from which the social, environmental and economic benefits of such a technology are demonstrated. In collaboration with the scientist and engineer's wing of the Brahma Kumaris, several workshops on renewable energy have been held successfully and further activities in this area are planned. Contacts have been established with the Rajasthan energy development agency ( REDA), the Gujarat energy development Agency ( GEDA) and the Ministry of Non – Conventional Energy Sources ( MNES) and other NGO organisations to create a broad base of dissemination.

### 4. Project Progress

The project proposal has been formulated in 1995 between WRST, CASE and CRESTA and than forwarded to Ausaid in 1995.

After further discussion's with Ausaid the proposal was finalised and subsequently sanctioning. The procurement of equipment started immediately afterwards and in 1996 the Wind generator and the power conditioning system have been shipped to India. In 1996 the foundation work on side for the Wind generator and the civil work for battery and control room started, as well as the purchasing of tower material, cables, batteries and PV took place. In 1997 the erection of WEC and cabling started. In the middle of 1997 the system got commissioned and is running since that uninterrupted. In 1997 a Workshop with CASE, CRESTA in the Academy for a better world took place.

## 5. Technical Description

The system consist out of a 10kw power system (120V Dc), a West Wind 2.5 kW wind generator and 5 kW photovoltaic cells.

The inverter has been recently introduced to the market by Advanced Energy Systems, a Perth based company. The system is offering a complete solution to remote areas powers supplies ( RAPS ) . The controller has a very high level of feature integration.

The single phase controller is operating with a single generator system to enhance capacity to operate as a stand alone unit. With solar wind input to the battery system the unit is supplying current to some essential consumers of the Academy.

The unit can configure either as a charger or inverter and will intelligently start and stop the generator / mains to maintain battery reserve with optional integrated DC renewable control. In charging mode the system maintains the battery voltage at a user specified value and charges the battery in accordance with the manufacturer procedures. This maximises the life of the battery bank, a potentially costly investment.

The operation and control setpoints of the system are completely flexible, making the System the one of the most configurable unit available.

This guarantee that's its function can be tailored for each application, in this case for the Academy, allowing optimally customised performance.

The system offers through LED screen a full over view of the performance and status. There is a self test in build and it is possible to attach a computer or a modem for remote monitoring and control ( SCADA ) . Provided there is a telephone line, it is possible to access the system and get a full over view of the performance. Through a in build data logger special events can be stored and evaluated.

The wind generator has a maximum output of 2.5 kW at a rated wind speed of 12.5 m/s and is manufactured by Westwind Turbines in Kelmscott, Western Australia. The wind turbine has 3 blades, a rotor diameter of 3.6 metres, a permanent magnet generator with 3 phases, variable volts and hertz. The weight of the turbine is around 150 kg and the turbine is mounted on a 18 meters pole. The wind turbine has a cut in wind speed of 2.5 m/s

The photovoltaic array consists out of 2.7 kW modules of TATA BP Solar of Bangalore and 3.3 kW modules of Siemens. The modules are mounted on manual tracking frames.

The mains, the wind generator and the solar array are connected to the AES power control system and are charging a battery bank of 120 V Dc and 600Ah capacity.

From the output of the AES power control system different loads in the Academy are connected. The loads are spread over a distance up to 300 meters and are as follows:

- 50 Lamps PL 10 W
- 10 computers, 4 printers
- Telephone exchange
- Water pump
- Electronic Laboratory
- Emergency light
- .

## 6. Results and Evaluation

### a. Technical.

The AES power control system has performed until now without any major problems. We had a smaller problem with the software, which did not affect the performance of the system. By a recent visit of an AES engineer the problem could be solved by reloading the software.

The output of the inverter as is sine wave, frequency, efficiency, stable voltage, overload, surge capacity and availability is concerned is excellent.

Through the microprocessor controlled hardware it is possible to configure and adapt the system to the local requirements and specifications. We could adjust the float voltage of batteries, the bulk charge voltage, the cut in voltage of the mains charger, alarm status, priority of solar wind charge against mains charge.

The system is even immune to the rough condition of the Indian Grid and can deal with power cuts spikes and other most hazardous irregularities.

The solar charge controller who features a maximum power point tracker which optimises the charging current of the solar cells has performed without any problems. The same was observed with the wind controller.

Through the individual settings of the parameters it is possible to configure the whole system in such a way, that optimisation of size and efficiency of the wind generator the solar array and the battery can be achieved. This ultimate results in a significant reduction of the overall system costs and a increased life span.

As per the performance and the features of the AES power system it definitely has to be rated among the top products in this range.

The wind generator manufactured by West Wind of Perth runs since its erection very smoothly without any problems. The output rating of the manufacturer could be confirmed by individual ampere readings at specified wind speeds.

The turbine has passed already several serious storms without damage.

The 3-blade arrangement and the 12 pole permanent generator ensure a easy starting and early power production. The mechanical stability and workmanship of the turbine is excellent.

The photovoltaic cells perform as per their specification.

Mt .Abu has al most clear skies and we have a annual solar irradiation of nearly 2000kw/sq. The wind speed at Mt. Abu is around 4 meters per year average. The grid has a very bad quality and is available 75 % of the time.

At present to maximum load at the inverter is 5kw peak. The actual load follows a curve as per the demand of the users. The peak load is in morning ( computers ) and evening (light). By a good load management for the pump etc. the load could be diverted more equal through out the day.

The daily total charge by solar is in full sunshine around 25 kwh. In night time we are presently discharging the battery bank by 15% of its rated capacity of 600Ah. This ensures us a long life span of the battery. In addition we have a good back up time for cloudy condition.

The contribution of the wind generator, is as per the wind speed in Mt. Abu more significant in the summer and monsoon time. In any case it is observed that the charging is more unregular and that under this wind regiment the wind generator can be seen only as a secondary additional charging source.

As per the microprocessor settings the charging through the grid comes into picture only if solar and wind are not sufficient. By the size of the battery bank and the present load we can manage for 5 sunshine days without additional charge through the grid.

Especially in rainy season Mt. Abu is quite cloudy and than charging through the grid or diesel generator becomes necessary.

Finally we can say that the 10 kW AES Power system in combination with solar / wind / grid or diesel has proven to be a reliable option for the electrification of remote areas.

Training and some technical expertise at the side is necessary to maintain and run the system properly.

## b. Demonstration and Distribution

The Academy attracts around 60000 visitors per year. Out of them many are getting introduced to the renewable energy systems at the Academy. We receive quite a good feedback from many and we are passing on all the information's regarding prices, manufacturer etc.

In addition we had several seminars and workshops at the

Academy on renewable energy with the participation of AES and CASE and local manufacturers like HIREL. By networking with other interested institutions and government agencies we share the experiences and results of this project. We are planning a seminar in Mai with 50 members of all nodal agencies in India. Meanwhile we have a quite well trained team in the Academy for maintenance and smaller repairs of the Hybrid system.

Presently the main problem in a broad distribution of these systems seems to be in the high investment cost. Facing the high prices for the equipment people tend to rely on conventional power, which is still heavily subsidised in India. If one has to run a computer or any other sensitive load a UPS is a must. That means a quite substantial investment. Through awareness campaigns the public should be informed about the advantages of a decentralised power generation based on renewable energy. This can redirect some of the investment presently needed to improve the quality of the grid by UPS or stabilisers towards renewable energy products.

## Appendix

Drawings

Graphs

Photos