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Review Article

Impact of renewable energy resources in Health clinics of rural areas

Virendra Kumar Maurya[1], *Dharmndra Pal[2], Simmi Prajapati[3], Rashmi Raghav[4], Nikita Gupta[5], Avnish Burman[6].

[1]Department of Electrical Engineering, Shekhawati Engineering College Dundlod, Jhunjhunu, Rajasthan.

[2]Department of Physics, BBD National Institute of Technology & Management, BBD University Campus, Lucknow India.

[3]Department of Electrical Engineering, Institute of Engineering & Technology, Lucknow

[4]Department of Electrical Engineering, Integral University, Lucknow

[5]Department of Electrical Engineering, I.E.C. College of Engineering & Technology, Greater Noida

[6]Hindustan Aeronautical Limited, Lucknow.

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Abstract: This paper presents the technical and analytical challenges that must be addressed to enable high penetration levels of distributed renewable energy technologies. This paper shows the health clinic electrification with an emphasis on the use of Renewable Energy. Rural health clinics in developing countries are the last link in a fragile lifeline of support. This lifeline of infrastructure has technical, financial, managerial, and educational dimensions. The main aim of this paper is to design a health clinic using hybrid power systems combining wind turbines, solar photovoltaic systems, storage devices and fuel cells.

Keywords: Photovoltaic System, Wind turbine Generators, Rural health clinics.

INTRODUCTION

Renewable energy from sun and wind is an abundant and ubiquitous resource. Although capable of providing plentiful and reliable electricity, these resources are largely untapped. Reliable electricity produced on site has proven capable of delivering high quality electricity for vaccine refrigeration, lighting, communication, medical appliances, clean water supplies, and sanitation. It can also improve management, logistics, and distribution of information, education, and communication [1].For hospitals, renewable energy means an initial investment with potential savings later on. This makes both environmental and economic good sense, especially when financing mechanisms are structured to support this shift. [2] In locations where it is difficult to keep trained medical staff in the field, reliable electricity can provide highly valued life-style amenities such as light, music, and broadcast communications. There are successful examples of electrified health clinics that generate operating income to assist financial self support.

Off-Grid with Storage: Off-grid PV systems include electricity and other generation sources to form a hybrid system [5]. In a system of this type, correctly sizing the energy storage capacity is a critical factor in ensuring a low loss-of-load probability [6]. An off-grid solar kit usually incorporates a power generation system as well as an energy storage system. A solar array is configured in 'strings' to produce a voltage closely matched to the inverter in use. The power coming from your photovoltaic panels or other renewable energy source is managed by a charge controller through a process known as „maximum power point tracking. This controller ensures that your photovoltaic array is operating at its highest efficient DC voltage - and in remote locations the extra charge gained may be critical in winter months. The charge controller passes the generated electricity on to the inverter. Our best inverters are a multi-function device that manages the charging of your batteries from the PV or wind generator, automatically controls a backup diesel generator when necessary to keep your batteries in good charge, as well as converting your battery DC voltage to an AC supply ready to run all your lighting and appliances[4].

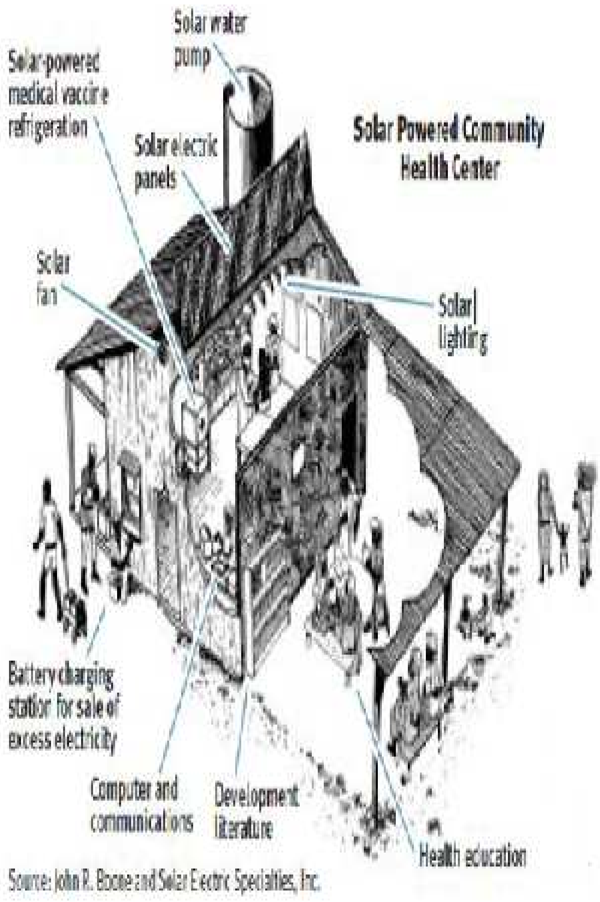

Fig.1: General layout.

Photovoltaic: PV panels convert sunlight directly into DC electricity. PV panels, having no moving parts are highly reliable, long lived, and require little maintenance. PV panels consist of individual cells that are wired together in series and in parallel to produce the desired voltage and current. PV panels are rated in terms of peak watts (Wp) or peak kilo-watts (kWp). (1kW/m2 20°C [68°F] panel temperature.)The roughly intensity of sunlight at noon on a clear summer day should be around (1kW/m2; 20°C [68°F][1]. Thus a panel rated at50 Wp will produce 50 W when the isolation on the panel is 1 kW/m2. Because power output is roughly proportional to isolation, this same panel could be expected to produce 25 W when the isolation is 500 W/m2. Most PV panels are designed to charge 12 V battery banks. Larger off-grid systems may have DC bus voltages of 24, 48, 120 or 240 V. Connecting the appropriate number of PV panels in series enables them to charge batteries at these voltages. For non-battery charging applications, such as when the panel is directly connected to a water pump, a maximum point power tracker (MPPT) may be necessary. AMPPT will match the electrical characteristics of the load to those of the panel so that the panel can efficiently power the load.

Wind Turbines Generators: Wind turbines need somewhat more maintenance than a PV array but with moderate winds, > 4.5 meters per second (m/s), will often produce more energy than a similarly priced array of PV panels. Wind turbine energy production tends to be highly variable; therefore wind turbines are often best combined with PV panels or a generator to ensure energy production during times of low wind speeds. Wind turbines and generators become more competitive with somewhat larger loads found at the larger clinics. Summer and daytime loads favor PV. Winter loads are more suited for generators and, if winter is the windy season, wind turbines are a good choice. If the wind and solar resource are seasonally complementary then a wind-PV hybrid system may be more appropriate.

Inverters: Inverters convert DC to AC power. This capability is needed because PV panels, batteries, and most small wind turbines produce DC power. Most common electrical applications and devices require AC power. For off-grid applications the inverter must have stand-alone capability, i.e., the inverter does not need to be grid connected in order to regulate voltage and frequency. High conversion efficiency, especially at part load, is desirable. If the system includes a generator, paralleling capability allows the inverter to operate simultaneously with the generator.

CONTROLLERS, METERS AND BALANCE OF THE SYSTEM

Controllers and meters act as the brains and nervous system of an RE or hybrid system. Controllers route the energy through the system components to the load. Metering allows the user to assess system health and performance. Monitoring the current and voltage on the DC and AC buses lets the user check that the components and system are properly operating. The controller can be programmed to turn health clinic components on and off as needed without user intervention. The time-controlling method assists the system time for opening and closing the hospital components [3]. Dump load can be used to shed excess energy produced by the off grid power system. A dump load is essentially one or more big resistors that dissipate electricity by converting it to heat. Available dump loads are either water- or air cooled. DC source center offer easier system installation, less complex wiring, and easier system monitoring and control. The use of a source center should be considered, especially for systems in remote hospitals that lack easy access to technical assistance.

SYSTEM DEVELOPMENT

This off-grid system for health clinics uses the photovoltaic technology (PVT) and wind turbine generators concept. The system composed of photovoltaic array or photovoltaic panel, sensors, charge controller, battery and lighting loads whereas wind turbine generator consist of blades which capture the energy from the wind. The shaft connects the blades and the generator. The yaw bearing allows a wind turbine to rotate to accommodate changing wind direction as shown in **Figure-1**.

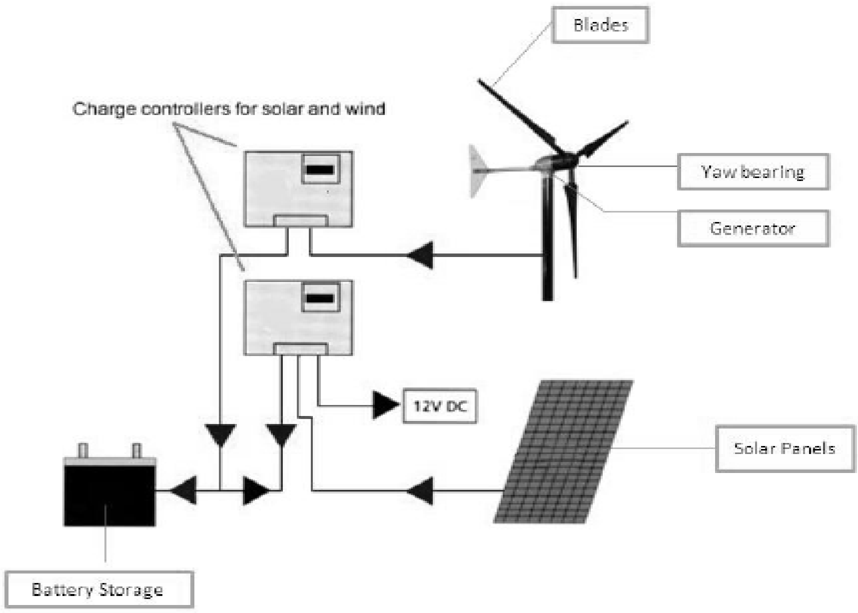

Fig. 2: Solar Charge Controllers.

During the daytime the controller preserves the electricity energy gathered by the solar panel and wind turbines, and then stores the energy in the 12 Volt lead acid batteries. Whereby, in the evening the charge controller uses the battery energy to power the light bulb and clinical equipment [3]. The system block diagram is illustrated in Figure1. Sun ray delivers rays of photons or also known as solar energy which hit the photovoltaic panel. This solar panel converts the sunlight ray into electricity. This conversion happens when the sunlight strikes the silicon plates of the solar panel, freeing charged electrons and bumping them into energy field [7]. The electrons are able to move in one direction and this can give the electrons somewhere to go [8]. Energy is stored in the battery during daytime and consumed at night. This energy stored is monitored and used by various appliances of the health clinic. Electricity produced by wind turbine is more valuable during winter season when intensity of solar radiation is less to generate good amount of power.

HEALTH CLINICS APPLICATIONS

Vaccine Refrigeration and Ice Pack Freezing: Immunization programs depend upon reliable refrigeration to preserve vaccines to prevent or eradicate dangerous diseases including Polio, Diptheria, Tetanus, Pertussis, Tuberculosis, Measles, Yellow Fever, and Hepatitis-B. Solar and wind energy generated on site can power compression-type refrigerators and icepack freezers. Temperature control is far more accurate than with kerosene-fueled absorption refrigeration. Many Cold Chain programs use renewable energy to power efficient compression refrigerators at remote locations where the supply of kerosene and propane is unreliable or costly. Because most often a PV system powers these refrigerators they are often referred to as “PV refrigerators” even though they can be powered from any electrical source. Efficient compression- type refrigerators can be powered by 12 or 24 V (volt) storage batteries which are recharged on site by photovoltaic panels or a small wind turbine. The main advantage is greater temperature control and elimination of the need for a fuel supply.

Lightening: When using a renewable energy system, energy efficiency is key to reliability and affordability. Compact fluorescent lights give four times the light per watt consumed, as compared to incandescent bulbs. With an expected service life of 10,000 hours, they last ten times longer than incandescent bulbs.

Communication: Radio and radiotelephone communications will greatly improve health care services at rural health clinics. Emergency medical treatment is greatly facilitated with reliable communications to other health clinics and facilities in the region. Health clinic communications require very little electrical energy. Stand-by power consumption may be as little as 2 watts (W). Power consumption for transmitting and receiving are higher, on the order of 30-100 W, but generally are for very little time. Many rural health clinics have reliable two-way regional communication via VHF radio with electricity provided by a single 30-W PV module.

Medical Appliances: Small medical appliances that operate on 120-volt (V) AC electricity may be operated if an inverter is incorporated into the system. Health clinics can make use of a microscope, a nebulizer, a centrifuge, dental equipment, and other medical appliances.

Sterilization: Sterilization requires rather high temperatures, approximately 120°C (250°F). It is generally more appropriate to sterilize with thermal energy rather than photovoltaic system. These temperatures can be produced by solar thermal collector systems at a lower cost, especially in areas with good solar isolation.

Water Treatment: These are the sophisticated means of water treatment that generate higher volumes of potable water and are effective for a wider variety of types of contamination. These processes require electricity that can be produced on site with solar and wind power. They include ozone treatment, reverse osmosis, photochemical, also known as ultraviolet or UV, disinfection and carbon filters. Some processes utilize a combination of these treatments. There are also several technologies that provide for on-site production of disinfectants such as sodium hypochlorite from a water and salt solution.

HOSPITALS USING THIS PROGRAM

Fig. 3: Mindelheim Hospital – Bavaria, Germany.

INDIA: Jamshedji Jijibhoy (JJ) Hospital, Mumbai: The Sir J.J. Hospital is among the oldest and largest hospitals in South-East Asia. It has 1352 beds and spreads over 65 acres in the centre of Mumbai. In 2001, following the Indian prime ministers call for all states to implement energy conservation plans; hospital authorities launched an awareness campaign to reduce energy use throughout the hospital campus. The campaign included slogans, posters and other tools. Modest energy conservation measures were also implemented campus-wide, including systematically turning off office equipment, using natural light during daylight hours in hospital corridors, and plugging leaks in the air conditioning. The project resulted in a total energy savings of 812 000 kWh from 2002 to 2004, and a cost saving of US$ 90 000. The Sir J.J. staff is now considering adopting additional conservation measures, including solar water heating and energy-efficient lighting [9].

USA: York Hospital, York, Maine: Almost a decade ago, York Hospital officials took steps to slash the facility's fossil fuel consumption by buying renewable energy from the state of Maine. Since then, 90% of the hospital's energy purchases have come from alternative energy sources, including wind power, hydro power and biofuels from wood-fired boilers. As a result, the hospital reduced its carbon emissions by 24% between 2000 and 2006, a decline of about 300 tonne a year despite an overall increase in energy utilization. Hospital officials estimate that the shift to alternative energy fuel sources has saved the hospital over US$ 100 000 a year10, 11.

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***Correspondence Author:** Dr. Dharmendra Pal**;** Assistant Professor, Department of Physics, BBD National Institute of Technology & Management, BBD University, Campus, Lucknow, India.