Chapter

# Techno Economic Feasibility Analysis of Solar PV System in Jammu: A Case Study

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## Abstract

Renewable sources of energy and related technologies are essential to the generation of energy worldwide. The photovoltaic (PV) is one of the renewable power technologies that support household electricity use. No prior research has studied the sustainability of the off-grid energy generation system in Jammu, India despite the potential of solar photovoltaics and significant amounts of global sun radiation in an area. The present work shown in the chapter is to calculate the residential load of the Patyari Kaltan situated in district Samba of Jammu by energy auditing. The NASA Surface Meteorology is used for the solar resource informationof selected village. The primary sources of electricity generation are fossil fuels. Recently, the energy demand and availability deficit has worsened due to the huge population and fossil fuels cannot fulfill huge energy requirement. Meanwhile they have negative impacts on the environment as well. Therefore, renewable energy offers suitable energy way out to the residents living in remote areas and in the areas near to Borders. In this paper the main aim is to examine the feasibility of solar-battery hybrid energy system to fulfill electrical demand of a residential area in a rural region in Jammu. The research shows that the cost of construction of the project can be repaid or recovered within 1 year 6 months. To accomplish the target, 214 solar panels of 325 watt are estimated to satisfy the demand 100 percent at all times. The findings of this modeling reveal that the off-grid PV system is both technical and economically viable for power generation; they may serve as a model for the successful development of the system for practical use. Furthermore, the model can promote assistance mechanisms for players in the renewable industry to introduce a PV system in residential buildings.

**Keywords:** Fossil fuels, Solar PV system, Remote regions, Economic feasibility, Off grid

## 1. Introduction

Solar energy is the primary driving force behind natural activities on the Earth's surface. The energy expenditure on the surface of the ground which depends on the landscape is a core factor in geological, environmental and risk modeling models. The contribution of radiation is also related to the biodiversity of plants and biomass production. The Sun is an ample, infinite supply of energy available all over the world which is only minimally used [1–3]. From around beginning of the century, solar-radiation technology developments became highly political when potential solutions to fossil fuel-based traditional energy systems became recognized. Solar energy systems are widely agreed to mitigate global challenges including climate change, insecurity in the developed world and lack of stability of energy supply in most of the world's economies. As for other emerging creative developments, there is a need to make significant improvements to the way in which energy is produced, distributed and used, such as a poor understanding of technological choices, higher initial investment costs and a more conservative social environment. Country assistance policies (up to 10-20 years) should be established in order to address these obstacles, identifying suitable legal and financial instruments.

The spatial and temporal solar energy affecting the earth's surface has a seasonal dynamics (due to astronomical factors) which is modulated by stochastic weather variability. It influences solar energy systems' efficiency, reliability and economy. Photovoltaics is a fast growing technology, with a better understanding of the primary solar power resource. Enhanced expertise will lead greatly to better location and economic evaluation of new plants, to efficiency management and to energy projection. Improved understanding for solar energy systems incorporation into current energy and economic processes is also essential. The spatial dependence of renewable energy production and its distribution raise issues that often involve precise location-dependent answers in the policy process [4–6].

Much like the fossil-fuel-based energy sector relies on exploration of the energy markets and the proven reserves for discovery and economic benefit, renewable energy relies upon assessing the energy production strategy and marketing resources [7–9]. The basic resources and fuel available are solar radiation for solar-based clean energy technology such as solar thermal and photovoltaic systems. Measured data was used to determine the solar resource for this technology, where accessible. Fortunately, the uneven distribution of calculated solar data in space, and in particular over time, contributes to the use of modeled solar light as the basis for various technological and economic decisions. There are major uncertainties in the measured and modeled solar radiation. Most solar radiation models are assisted by measured data, often unknown to the uncertainty or precision of these measured data [10–13].

The energy emitted by sun and terrestrial fraction of the energy flux is marked by the Solar Constant. The solar constant is defined mainly as the measurement per unit time of solar energy flux density perpendicular to the direction of the light. Satellites outside of the earth's atmosphere are the most reliably measured. The solar constant is measured at 1367 $W/m^2$ at present [8, 9, 14]. This percentage ranges by 3 percent since the earth's orbit is elliptical and the length of the year is different from the Sun. There is also a little variance in the solar constant due to variations in Sun's light. This importance encompasses all forms of radiation, a large portion of which is lost as the light travels into the atmosphere.

The solar radiation is absorbed, dispersed, reflected or released as it travels through the atmosphere. The energy flux density is reduced in all these processes. In reality, the Solar Flow Density in sunny days is reduced by about 30% compared to alien radiation, which on a cloudy day is reduced by as much as 90% [15].

As a consequence the direct radiation that comes to the earth's surface (or an equipment mounted on the earth's surface) never reaches 83%. This direct radiation is known as beam radiation from the solar disc. Diffuse radiation is characterized as the dispersed, reflecting radiation that is transmitted out from all directions to the surface of the Earth (reflective of other bodies, molecules, particles, droplets etc.) [10]. Complete (or global) radiation is the sum of the beam and diffuse components. The **Table 1** shows the gadgets that are used for the measurement of different solar quantities.

| Particulars | Details |
|---|---|
| Village | Patyari Kaltan |
| Block | Ghagwal |
| District | Samba |
| State | Jammu and Kashmir |
| Country | India |
| Time Zone | IST (UTC + 05:30) |
| Latitude | 34.09 |
| Longitude | 74.79 |
| Total number of Houses | 35 |

**Table 1.**
*Details about the village Patyari Kaltan.*

Solar radiation data obtained by the instruments described above form the basis for developing any solar project. A case study of village Patyari Kaltan situated in district Samba of Jammu is explained in the next section using energy auditing.

This study seeks to reconcile demand and supply differences by investigating the feasibility of using an off-grid PV system to generate power to consume the household. The main objectives for this study are the significant global solar radiation levels in the region as well as the low home energy use. The purpose of this chapter is, via mathematical modeling, to assess the technoeconomic feasibility of an off grid PV system. This paper does not include the environmental and political aspects of using offset photovoltaic systems or other Photovoltaic hybrid systems. With respect to this investigation, solar radiation, PV peak power, inverter size, batteriesize and a charging controller are the relevant characteristics specified in this work. The remaining chapter is organized in the following subsections:

The Section 2 provides a concise background of the study while Section 3 presents the problem formulation. The detailed methodology adopted is explained in Section 4. The results and the discussion are contained in Section 5 while the conclusion of the paper is in Section 6.

## 2. Background

A.K.M. Sadrul Islam etc. (2012) indicated that an 8 kW PV system linked with a 15 kw gasoline generator and 25 battery counts is the most economically viable alternative (nominal power 800 Ah, nominal voltage 2 V each) [16]. Abolfazl Ghasemi et.al (2013) highlighted the potential sun rays and the lives of remote, powered, non-connected hybrid PV-diesel battery-powered communities in Iran as excellent [17]. Mohan L. Kolhe et al. described the best hybrid architecture for energy at a cost of $0.34/kWh as a 30 kW PV system, 40 kW wind, 25 kW diesel power supplies, and a bank of 222kWh batteries [18]. M. Kashif Shajzad et.al (2017) reported that the optimum solution was constructed to conduct a cost analysis of 10 kW hybrid PV panels, 8.0 kW biogas generator, 32 battery storage and 12 KW converters [19]. Simulation results for a hybrid power system of 13 kW PV modules, 14,7 kW of hydro power, 8 battery storing units, 5 kW of the diesel generator and 9 kW converters were characterized as the optimal solution with a $113201 NPC by Ali Saleh Aziz et.al (2019). [20]. Zhen-yu Zhao et.al (2019), Muhammad Ifran, discussed the cost of traditional grid power and solar PV, which are designed to assess the economic efficiency of two simulation-driven technologies. Five areas, Bhakkar, Kanewal, Multan, Bahawalnagar and Rajanpur were selected in this paper. Research has shown that Kanewal has the maximum yearly solar irradiation in this area (5.50 $KWh/m^2$, 22].

## 3. Problem formulation

Increase in energy expenditure and worldwide dependence on fossil fuels lead to power shortages and global warming. Generally the diesel generator is used in both on-grid and off-grid systems for a reliable power source [11, 21]. This is a costly and also causes environmental toxic waste. In the country there is enormous resource of renewable energy source that is not being effectively utilized. Reliable renewable hybrid systems need to be developed by using the available renewable sources These hybrid systems can be a viable option in universities, companies, hospitals, industry and rural communities to fulfill the energy needs. The construction of such systems needs detailed study of renewable energy supplies by the location, because without this the hybrid device may be massive, which raises the device expenses [12, 22].

In order to investigate the financial and technological viability of the hybrid energy systems, the feasibility of dissimilar systems configurations and energy requirements needs need to be analyzed and analyzed.

## 4. Methodology

### 4.1 Site selection

The Jammu and Kashmir shares international boundary with Pakistan & China. The Line of Control on the area of Pakistan divides the UT which turns one part as J&K'and the other part as POK'[15, 23–26]. It also shares boundary with other state like Himachal Pradesh and Punjab [23, 24, 27]. The UT has two different parts namely 1) Jammu and 2) Kashmir. The two parts of the state differ drastically from each other on the basics of climate.

Rapid population growth and hi-tech development in recent decades have led to additional energy consumption, especially in the power sector [25]. In addition, there are numerous parts of the world in rising countries which have minimal or no way to electrical energy, particularly in rural areas [28–31]. Rural electrification is also stated to be very necessary for rural development in order to achieve economic growth, elimination of deprivation, generation of jobs and improvement of village living standards [32]. According to the 2011 Indian census, out of 1.21 billion, 0.83 billion live in rural areas and about 44 per cent of the population lack grid access [33]. Electricity generation has to be improved to solve these issues. In India, fossil fuel emissions produce a large proportion of electricity [34].

Patyari Katlan is a village located in Jammu-Kashmir Samba district which falls in India. **Table 1** shows the profile of Village adopted for study. The total residential consumption of the rural community is 1083.432 kWh/day in the summer.

**Load profile:** Load of the selected village depends on the equipments used in the houses. Load calculated by Energy audit of the village. There are 35 houses in the village and the equipments connected in the houses are tube lights, fans, coolers, TV's, refrigerators only. The equipments connected in the village are very less because the village is just 2 km away from the Pakistan border so the village is not so well developed [16].

**Energy Audit:** Energy audit is defiened as "organized monitoring and review of energy usage and energy use of site, facility, system or entity with the goal of defining and reporting on energy flows and future changes in energy quality." [17, 19–21, 35].

Energy saving is extremely relevant as the demand is rising day by day in the country, looking at the situation energy auditing is being performed. This is a method of monitoring how electricity is being used, and finding places wherever pollution can be reduced if not eradicate entirely. [27, 36]

The energy use by lighting and big appliances such as fridge, fans, etc. in 24 hours is calculated by doing survey. The wattage of each equipment is represented in **Table 2**. **Figure 1** shows the hourly variation of each equipment. The highest energy is consumed by refrigerator and lowest by lighting system. The rural community's average residential consumption is 1083,432 kWh per day in the summer, and 718,952 kWh per day in the winter months. Monthly residential consumption of the village is shown in the **Table 3**. **Figure 2** depicts the graphical representation of monthly residential consumption. The **Table 3** shows that the peak load is in the July month i.e. 33586.392kWh. And the minimum energy utilization is in the February month i.e. 20130.656kWh.

### 4.2 Meteorology data of Patyari Kaltan (Thali)

The solar resource information used for the selected village was found from the NASA Surface Meteorology. Access was made to NASA database to assess solar irradiance in the remote rural Jammu region [13]. The most important step before using a solar photovoltaic device is to define solar power potential in a given region [3–5]. The solar irradiance records for the regions selected were

| **Residential load** | | | | | | |
|---|---|---|---|---|---|---|
| **S.no** | **Equipment** | **No. of equipment** | **Wattage (w)** | **Consumed electricity per day (kwh)** | **Consumed electricity per month (kwh)** | **Consumed electricity per year (kwh)** |
| 1 | Lighting | 502 | 36 | 289.152 | 8674.56 | 104094.7 |
| 2 | Fans | 179 | 70 | 200.48 | 6014.4 | 36086.4 |
| 3 | Coolers | 41 | 250 | 164 | 4920 | 14760 |
| 4 | TV | 35 | 70 | 9.8 | 294 | 3528 |
| 5 | Refrigerator | 35 | 750 | 420 | 12600 | 151200 |

**Table 2.**
*Residential load of the village.*

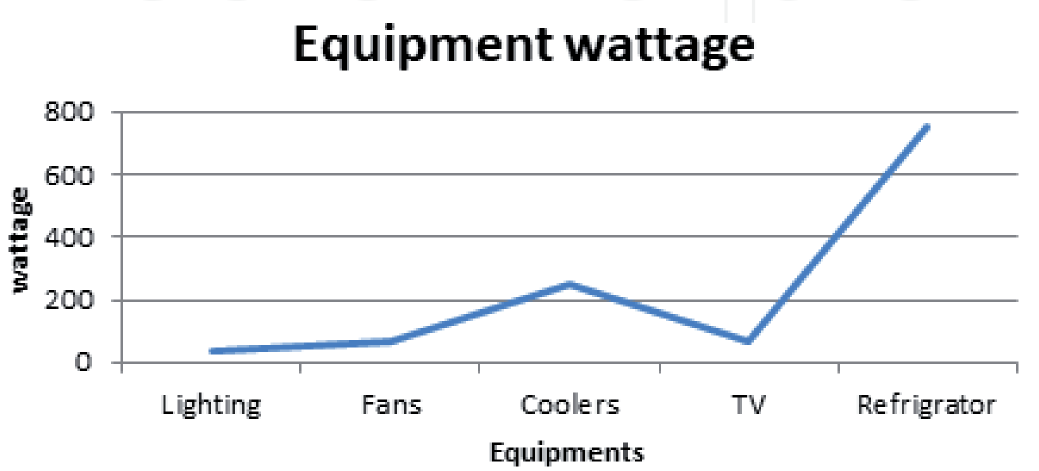


**Figure 1.**
*Wattage of equipments connected in the houses of village.*

| Months | Energy consumed per month (kwh) | Months | Energy consumed per month (kwh) |
|---|---|---|---|
| January | 22287.512 | July | 33586.392 |
| February | 20130.656 | August | 32502.96 |
| March | 22287.512 | September | 27582.96 |
| April | 27582.96 | October | 22287.512 |
| May | 28502.392 | November | 21568.56 |
| June | 32502.96 | December | 22287.512 |
| Total | | | 313109.888 |

**Table 3.**
*Energy consumed per month.*

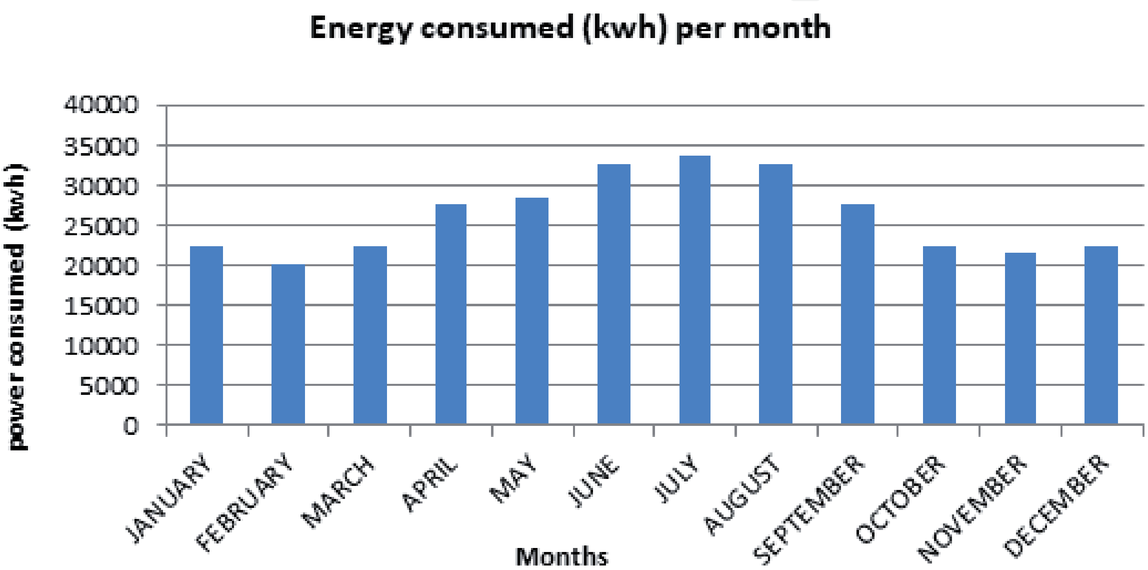


**Figure 2.**
*Power consumed per month in village Patyari Kaltan (thali) in KWh.*

provided in **Table 4**. **Figure 3** shows the daily Radiation and clearness in Patyari Katlan (Thali). Outcome of the investigation show that Patyari Kaltan received the average annual solar irradiation is 4.134 kWh / m$^2$ [3].

## 4.3 Design calculation

### *4.3.1 Energy balance considerations*

To choose the appropriate size for the day and night time loads for the solar panel or battery storage. We describe a state of energy balance when full power from the solar system ($E_{SA}$) is enough to charge the battery ($E_b$) and the energy needed to charge electricity including system losses ($E_L$) as shown in **Figure 1**, i.e. without any power source from the backup.

$$E_{SA} = E_b + E_L \tag{1}$$

Assuming that the night time load is solely provided by the storage batteries with an overall efficiency factor K1 as shown in Equation (2):

$$EB = EN / K_1 \text{ where } K1 = \eta D.FU.\eta R.\eta L.\eta B \tag{2}$$

| Monthly average | | | |
|---|---|---|---|
| **Month** | **Insolation clearness index** | **Horizontal surface clear sky insolation incident (kWh/ $m^2$/day)** | **Horizontal surface all sky insolation occurrence (kWh/$m^2$/day)** |
| January | 0.424 | 0.929 | 2.213 |
| February | 0.479 | 0.561 | 3.135 |
| March | 0.447 | 1.065 | 3.788 |
| April | 0.490 | 0.964 | 4.885 |
| May | 0.468 | 0.829 | 5.199 |
| June | 0.478 | 0.568 | 5.501 |
| July | 0.510 | 0.000 | 5.754 |
| August | 0.525 | 0.475 | 5.435 |
| September | 0.639 | 1.777 | 5.707 |
| October | 0.550 | 1.506 | 3.892 |
| November | 0.310 | 0.532 | 1.744 |
| December | 0.494 | 1.868 | 2.361 |
| Average | 0.485 | 0.923 | 4.134 |

**Table 4.**
*The average of monthly daily isolation incident on horizontal surface in Patyari Kaltan (thali) [3, 4].*

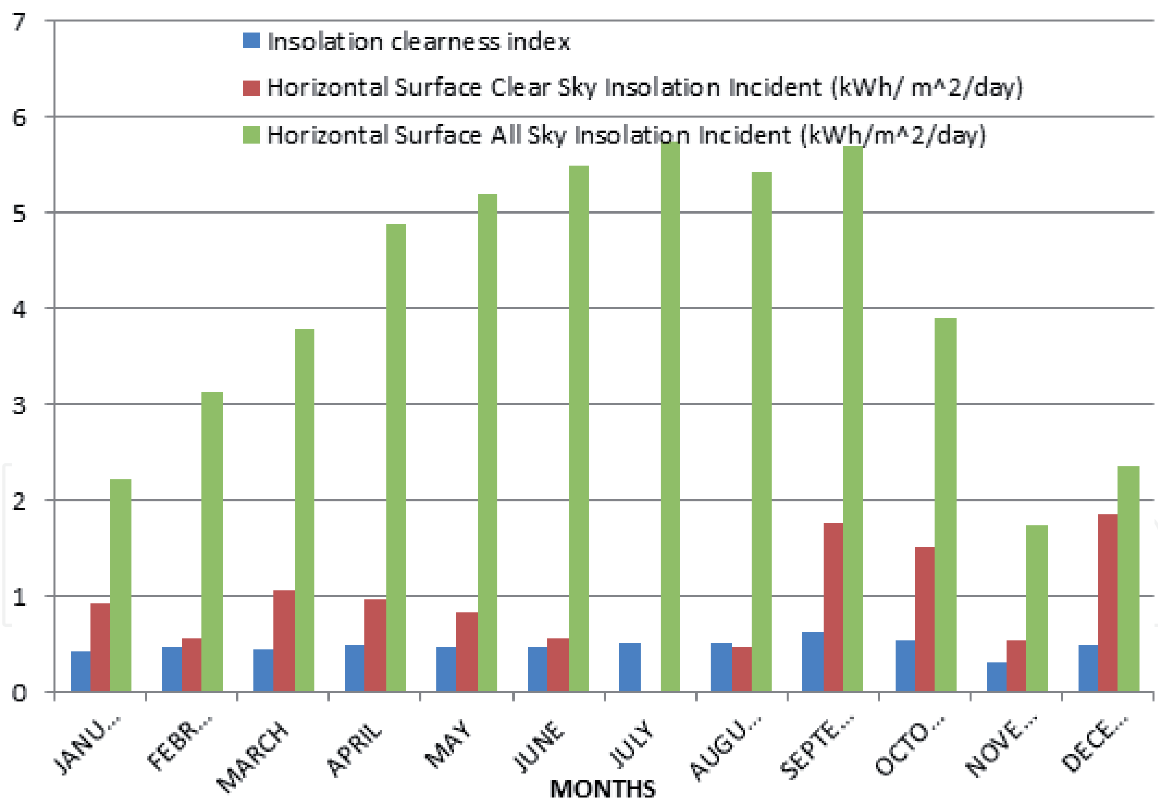


**Figure 3.**
*Daily radiation and clearness in Patyari Katlan (thali) [3–5].*

ηD being the solar array diode efficiency, FU the solar array utilization factor, ηR the regulator efficiency, ηL the line loss factor and ηB the battery WHr efficiency.

### *4.3.2 Balance of system components*

As described above, the Power System consists of a variety of balances, apart from solar panes, of device components such as (a) mounting frames of the array module, frame support and foundations; (b) circuits, load and electricity management devices, wire interconnections, etc., etc.

There are also extra expenses for the test and inspection module, system sizing, and packaging repair installation and checkout, etc. For the construction of the PEPS, account must be taken of the amount of all these costs lumped as BOS cost. The complexity of the difference between the cost of the storage batteries and the battery power in Ahr is a significant factor in the extremely nonlinear performance of energy generation costs / peak W.

### 4.4 Design requirements

The module is made of solid wire or solid ribbons by attaching one cell on another. The ties may be rigid or fluid to control motion within the series, which can be caused by thermal expansions and other forces. All links should ensure the lowest resistance possible and the least possible distortion of PV output. The designer is also trying to make this relation shorter and to reduce the cross sections against increased resistance. The output from an array is connected to a manager called a bus.

#### *4.4.1 Placing of cells*

It is essential to place cells in the array and in the cell form. As the distance between the cells increases, the overall performance of the panel determined by the voltage per unit area falls. Big cells do not always improve the performance of packaging (i.e. the need for a maximum cell to panel area ratio). In building a module with desirable electric properties, cell size is an essential element. Strom from a cell varies according to the cell size, with constant voltage. Many small cells should be plugged into series for large voltage. Round cells that were halved and put in a panel in an offset pattern are used to move more of them in a unit area. This increases the cell's packaging density. Square or hexagonal cells may also be expanded. Cells are put as near or as close as possible and cannot contact so energy is cut short. There must be additional space between the cells for thermal expansion.

##### *4.4.1.1 Array support*

More is needed to create the electrical resource needs Specific solar cells can be just as delicate groups of them. The retrofitting and disassembly should be able to be held in every module. Array must be capable of resisting moderate loads, mechanical and temperature shifts pressures. The translucent cover for a module is part of the support. The cover is primarily used to shield the PV module from situations including oxygen, moisture, dust and rain.

##### *4.4.1.2 Size of array*

Solar cell size can vary from approximately 1 mm to more than 100 mm. For most standard silicone cells, the thickness range is 0.2 to 0.4 mm. For the collection of the array size we established a very basic semi empirical rule as per the Equation (3)

$$P_{ph} = \left( LH + LHd / Cr\,Bb\,x100 \right) / X \tag{3}$$

Where Pph is the full watts array. X is the estimated annual maximum equipment time a day and is the average annual watt hour a day per poor flat hour of the PV module. L is the watts load rating, and H is the working hours a day. d is the number of storage days required. Cr is the time for charging recovery and Bb is the battery watt-hour efficiency. The value of X depends explicitly on the overall insolation of the panel on the installation site. The value of X can be calculated as shown in **Figure 4**.

$$X = EXm / 12; \text{With } Xm = \eta ov\ Im / \eta m \tag{4}$$

Where ηov is the overall device performance, $I_m$ is the average sleeping surface insolation of the area, ηm is the efficiency of the module. Performance is the product of the efficiency of the module and the balance of device efficiency including efficiency of power conditioning, efficiency coefficients of temperature etc.

*4.4.1.3 Solar panels*

For terrestrial applications the majority of silicone solar cells have a round diameter of 5 cm and a diameter of 0.3-0.5 mm. The trend is to massive diameters. A 5-cm diameter cell with a surface area of approximately 20-cm has a capacity of 0.2 W with 0.45 volts during full sun and at room temperature. A variety of cells need to be mounted into a panel for higher power or higher voltage. Two cells are wired in parallel, for example, for double power at constant voltage. It can provide any amount of power at the desired voltage by joining numerous cells in parallel and series.

*4.4.1.4 Battery storage*

Electric storage battery is the easiest way to stored a smaller moderate scale. Solar cells generate a battery charging direct current. When needed the stored energy can then be supplied to the local load as electricity. A battery is an independent cell mixture. A cell is the elementary mixture of materials and electrolytes that form the essential energy storer electromechanical. A block box into which electrical energy is collected, electromechanically stored and then recuperated as electrical power can also be thought of as a battery. Primary batteries are non-rechargeable while secondary batteries are still able to be recharged. So secondary batteries also have a major interest in solar electricity. Sub-examples of secondary batteries include lead-acid, nickel-cadmium, iron-air, nickel-hydrogen, zinc-air etc.

Energy efficiency of a battery is defined as shown in Equation (5).

$$\eta_{energy} = \int I_1\ E_1\, dt / \int I_2\ E_2\, dt \tag{5}$$

where $I_1$ = battery discharging current for a period 0 to t1.

$I_2$ = battery charging current for a period 0 to t2.

$E_1$ = Battery discharging terminal voltage.

$E_2$ = Battery discharging terminal voltage.

Cycle life is the amount of times that the battery can be charged and unloaded, and this can differ considerably with discharge depths. Deep discharge tends to a short life cycle.

### 4.5 Design calculation

No. of panels required, $N_S$ = per day demand/Rating of 1 panel (w).

= 69552w/325w.

$N_S$ = 214.0.

20 ft.^2 = 1.858 $m^2$ (Area of 1 panel).
Area required = Area of 1 panel*No. of Panels.
= 1.858$m^2$*214.
= 397.612 $m^2$.

Total load per day in kwh = 1083.432 kwh.

Using 12 V, 17 Amp hour lead acid battery.

Total Capacity ($C_B$) = Total load kwh/Voltage of single battery.
=1083.432kwh/12 V.
=90.286 KAhr.

Number of lead acid batteries, $N_B$ = $C_B$ /Rating of single battery Ahr.
=90.286 KAhr / 17 Ahr.
$N_B$ = 5310.9 or 5311 (approx).

Use charge controller of 12 V, 20 Amp is used.

Rating of charge controller in Ampere's = Total load (w)/12 V.
=69552 W/12 V.
=5796 Ampere.

12 Volt, 20 Ampere Charge Controller ($N_C$) needed can be measured as:

$N_C$ = Rating of charge controller (Amp)/20 amp.
$N_C$ = 5796 Amp/20 Amp.
$N_C$ = 289.8 or 290 (approx).

Total load per day in watt = 69552 W.

Load per day in kw = 69552/1000.
=69.552 kw or 70 kw (approximately).

For 70 KW load, 70 KW of Inverter is needed.

Cost per watt = Rs 22.

Price of solar panel, C = overall load (watt) * price per watt.
C = 69552 W*Rs 22.
C = Rs 1530144.

Price of batteries = $N_B$* Cost of one battery.
=5311 * Rs1900.
=Rs 10090900.

Price of charge controller = $N_C$ * price of one charge controller.
= 290 * Rs 798.
= Rs 231420.

Price of 70 KW inverter = overall load in KW * price per KW.
= 70* Rs 72065.
= Rs 5044550.

Total Cost = Price of solar panel + Price of charge controller + Price of Inverter + Price of battery.
=1530144 + 10090900 + 231420 + 5044550.
=Rs 16897014.

To take the cost of cabling, junction box etc. into account, 20 percent of the overall cost is applied to get the whole cost of the project.
= 20% * Rs16897014.
= 20/100 * 16897014.
=Rs 3379402.8.

Therefore the total expenditure of the project $C_t$,
$C_t$ = 16897014 + 3379402.8.
$C_t$ = Rs 20276416.8.

When we buy the electricity from the energy grid, otherwise we have to pay.
= overall demand * Price of one unit.
= 1083.432 Kwh * Rs 3.
=Rs 3250.296.

Overall cost of energy which is purchased from utility grid/year is.

$D_t$ = Rs 3250.296*365.

$D_t$ = Rs 1186358.04/year.

*4.5.1 Pay back period*

Payback period = Project costs / Annual cash inflow

$C_t - N\,D_t = 0$

Or $N = C_t/D_t$

Where $C_t$ = Rs 20276416.8

$D_t$ = Rs 1186358.04/year

thus

N = Rs 20276416.8/Rs 1186358.04

N = 17.09

Project costs for the project can be recovered in 17 or 18 months (1 year 6 months).

## 5. Results and discussion

Solar power is a huge source of electricity that can be used directly, generating other reservoirs of power: biomass, wind, hydroelectric power and wave power. While there are major differences in latitude and seasons, most Earth's area receives ample solar energy to enable low-grade heating of water and houses. Simple mirrors can focus solar energy enough at low latitudes to cook and even drive steam turbines. In certain semiconducting materials the energy of light switches electrons. This photovoltaic effect is able to produce vast amounts of electricity. However, the current low effectiveness of solar photovoltaic cells requires a great deal of energy. The only renewable way to substitute existing global electricity supplies from non-renewable sources is the immediate use of solar energy, at the cost of land areas of at least half a million $km^2$.

The Roof top solution is supported by the design methodology for installing solar panels in Patyari Kaltan (Thali). The incorporation of the panels into the roof of the building is the strategy used. This solution is given when it replaces the traditional roof and permits the filtering of natural sunlight. It serves as roof for structural and weather requirements with structural support, stability, protection from damage such as chemical or mechanical damage, fire-fighting protection, sun, wind and moisture protection, heat absorption and heat conservation, light diffusion control etc. It acts as a power generator in addition to those functionalities by fulfilling a portion of the building's electrical load specifications. Due to the highly flexible design of the solar cells and the storage cells, individual roof capacity can be used for specific loads – top PEPS for the same energy need as the previously described loads. The mean Horizontal insolation surface incident is 4.134 KWh / $m^2$ / day and the clarity index estimate has been found to be 0.485.It is closely related to the solar radiation itself, but isolation gives you a more accurate way to calculate the radiation on an energy-relevant single object, rather than just taking a sunlight measurement itself. The clearness index is a calculation of the proportion of solar radiation emitted to the Earth's surface through the atmosphere. Research shows that the payback period for the solar project of the selected village is 1 year 6 months. It shows that the cost for installing the whole project can be recovered within 18 months which means solar project can be benifical for the Patyari Kaltan village.

## 6. Conclusion

The study shows that the village has significant solar power capacity and is ideal for producing electricity. The cost of building the project can be recovered in 1 year 6 months. To calculate solar irradiance in the remote rural Jammu area, the NASA database was accessed, which reveals that solar irradiation obtained by Patyari Kaltan is 4,134 kWh / $m^2$. To meet up the demand 100% at all the time during the year, 214 solar panels of 325 watt is needed. The future work on this project is to check the feasibility and sensitivity of the PV hybrid system using HOMER software.This methodology is further extended to other parts of the country to utilize the available renewable energy resources and to meet the increasing load demand.

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