SOLAR PHOTOVOLTAIC TECHNOLOGY AND BANGLADESH

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ABSTRACT

The geography and topography of Bangladesh has created many rural and remote areas. The progress of rural electrification in Bangladesh faces specific problems because of the scarcity of power generation. The major electricity grid and a number of isolated local grids cannot economically reach many rural areas. A photovoltaic system is one suitable solution because of its flexibility, low environmental impact and freedom from fuel requirements. Therefore photovoltaic technology is a most feasible option to provide an alternative source of energy in areas where conventional grid electrification is a major issue. Various photovoltaic systems ranging from solar home systems, photovoltaic-pumping systems for drinking water, TV repeaters, public health centers, institutions and offices systems have been installed in Bangladesh. More recently PV system are also effectively used in income generating enterprises such as grocery shops, tailoring shops, clinics, restaurants, rice mills, cellular phone services, barber shops, buzzers, and micro utilities which sale electricity to customers in the neighborhood. And Solar PV also introduced in the electrification of cyclone shelter in the coastal areas.

INTRODUCTION

The increasing energy demand and the radiation of the limited availability of fossil energy prompted us to find out alternative energy sources. The utilization of natural energy which is clean, non-pollution and non-exhaustible is considered as an excellent alternative. Among these alternative energy sources, solar energy is the most promising.

The sun provides virtually all the energy for natural and an artificial process. Solar radiation is the electromagnetic radiation emitted from the sun produced by the complex and chemical reaction on the sun's surface. Solar radiation arrives at the earth surface with a minimum power of one kilowatt per square meter (1 kW/m ^{2}). The energy coming from the sun can be used for power generation using solar or photovoltaic cell. Edmund Becquerel first discovered the photovoltaic in 1839; this effect was first observed in all solid-state system in 1876 by willough by smith using selenium.

TECHNOLOGIES

Crystalline Silicon (c-Si):

Crystalline silicon (c-Si) is the leading commercial material for photovoltaic cells, and is used in several forms: single-crystalline or monocrystalline silicon, multicrystalline or polycrystalline silicon, ribbon and sheet silicon and thin-layer silicon.

Common techniques for the production of crystalline silicon include the Czochralski (CZ) method, float-zone (FZ) method, and other methods such as casting and die or wire pulling. The removal of impurities and defects in the silicon is of critical importance, and is addressed with techniques such as surface passivation (reacting the surface with hydrogen) and gettering (a chemical heat treatment that causes impurities to diffuse out of the silicon). Also at issue as the industry grows is the availability and purity of the solar-grade silicon feedstock. Although crystalline silicon solar cells have been in existence since 1954, new innovations continue to be developed, including the emitter wrap-through (EWT) cell and the self-aligned selective-emitter (SASE) cell.

Thin Films:

Thin film photovoltaic cells use layers of semiconductor materials only a few micrometers thick, attached to an inexpensive backing such as glass, flexible plastic, or stainless steel. Semiconductor materials for use in thin films include amorphous silicon (a-Si), copper indium diselenide (CIS), and cadmium telluride (CdTe). Amorphous silicon has no crystal structure and is gradually degraded by exposure to light through the Staebler-Wronski Effect. Hydrogen passivation can reduce this effect. Because the quantity of semiconductor material required for thin films is far smaller than for traditional PV cells, the cost of thin film manufacturing is far less than for crystalline silicon solar cells.

Group III-V Technologies:

These photovoltaic technologies, based on Group III and V elements in the Periodic Table, show very high conversion efficiencies under either normal sunlight or sunlight that is concentrated (see "Concentrating Collectors" below). Single-crystal cells of this type are usually made of gallium arsenide (GaAs). Gallium arsenide can be alloyed with elements such as indium, phosphorus, and aluminum to create semiconductors that respond to different energies of sunlight.

High-Efficiency Multijunction Devices:

Multijunction devices stack individual solar cells on top of each other to maximize the capture and conversion of solar energy. The top layer (or junction) captures the highest-energy light and passes the rest on to be absorbed by the lower layers. Much of the work in this area uses gallium arsenide and its alloys, as well as using amorphous silicon, copper indium diselenide, and gallium indium phosphide. Although two-junction cells have been built, most research is focusing on three-junction (thyristor) and four-junction devices, using materials such as germanium (Ge) to capture the lowest-energy light in the lowest layer.

Fabricating Solar Cells and Modules:

A variety of technical issues are involved in the fabrication of solar cells. The semiconductor material is often doped with impurities such as boron or phosphorus to tweak the frequencies of light that it responds to. Other treatments include surface passivation of the material and application of antireflection coatings. The encapsulation of the complete PV module in a protective shell is another important step in the fabrication process.

Advanced Solar Cells:

A variety of advanced approaches to solar cells are under investigation. Dye-sensitized solar cells use a dye-impregnated layer of titanium dioxide to generate a voltage, rather than the semi conducting materials used in most solar cells. Because titanium dioxide is relatively inexpensive, they offer the potential to significantly cut the cost of solar cells. Other advanced approaches include polymer (or plastic) solar cells (which may include large carbon molecules called fullerenes) and photo electrochemical cells, which produce hydrogen directly from water in the presence of sunlight.

Balance of System (BOS) Components:

The balance of system (BOS) components includes everything in a photovoltaic system other than the photovoltaic modules. BOS components may include mounting structures, tracking devices, batteries, power electronics (including an inverter, a charge controller, and a grid interconnection), and other devices.

CONSTRUCTION PROCEDURE

Solar cell construction is very simple. The top layer of the solar cell that the sunlight encounters is transparent. The outer most layers, which are the cover glass, is an encapsulating layer to protect the rest of the structure from the environment. Transparent adhesive holds the cover glass to the solar cell. After light passes through the cover glass and the transparent adhesives it encounters the antireflective (AR) coating.

This coating is transparent layer designed to reduce the amount of reflected sunlight. The front contact serves at the contact between the solar cell and the external electric circuit. The back contact, which can be a sheet metal since it, is hot in the way of any sunlight. Beneath the front contact and above the back contact lie the guts of solar cell. It is shown as n-type and p-type semiconductor where sunlight is absorbed and electricity is generated.

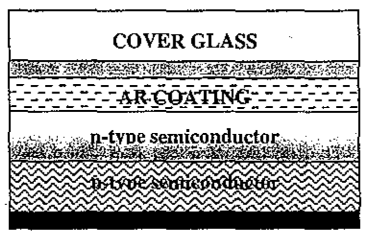

Figure1: Atypical configuration of a solar cell.

Semiconductor is a materials shoe electrical conductivities are between those of highly conduction metals and poorly conducting insulators. Most of the solar cells are composed of semiconductors which are prepared to have soled state Charest eristic and holes. The conductivity of a material such as crystalline silicon of various thin film materials is related to the energy required to promote an electron valence bond to conduction bond. Semiconductor have small bond gap due to which it from an electronic structure such that one bond of allowed states completely occupied by electrons is separated by a forbidden energy gap from the next bond of allowed state s which is virtually of electrons. Most of semiconductors have band gap energies 1- 2 eV.

The p- type and n-type semiconductor are heart of solar cell. Semiconductor materials such as a GIE and SI are referred to as tetravalent atoms because they each have four valance electrons. Adding predetermined number impurity atoms in to a geranium and silicon base forms both the n-type and p-type materials. The n-type is created by introducing impurity elements the have five valance electrons (Pentavalent) such as antimony, arsenic and phosphorus. Due to impurity atom these is and any particular co-valiant bond. This loosely bond remaining electron is relatively free to move with in the newly formed n-type material, the p-type material is formed by adding p a pure germanium or silicon crystal with impurity atoms having three valance electrons such as boron, gallium, indium, These is now an insufficient number of e3lectrons to complete the co-valiant bonds the newly formed lattice, The resulting vacancy is called a hole which will readily accept 'free' electron.

If p-type semiconductor is joined to an n-type semiconductor the interface in between is called the p-n junction on both sides of which the majority change carries being oppositely charged tend to attract each other. These charge carriers diffuse to the other side of junction, with excess electrons from the n-type region filling up the holes in the p-type region until it reaches an equilibrium state. At this point the forward and backward current is equal to each other. This form a region on both sides of the junctions depleted of charge carriers, which is the origin of the "photo-voltage" of the cell.

The basis of photovoltaic energy conversion is the absorption of photo's of appropriate energy in a properly selected semiconductor. In selection the semiconductor, it is a must consider the spectrum of the light source relative to the absorption and reflection spectra of the material. When photons strike the atoms in a semiconductor electron will absorb energy from the photons. Due to these increase in energy some electron can gain enough energy to "electrical conduction. Photo voltaic cells provide thus converted energy via the electric current through an external circuit.

APPLICATION

Concentrator Collectors:

Concentrating photovoltaic collectors use devices such as Fresnel lenses, mirrors, and mirrored dishes to concentrate sunlight onto a solar cell. Certain solar cells, such as gallium arsenide cells, can efficiently convert concentrated solar energy into electricity, allowing the use of only a small amount of semi conducting material per square foot of solar collector.

Concentrating collectors are usually mounted on a two-axis tracking system to keep the collector pointed toward the sun.

Building-Integrated Photovoltaic (BIPV):

Building-integrated photovoltaic materials are manufactured with the double purpose of producing electricity and serving as construction materials. They can replace traditional building components, including curtain walls, skylights, atrium roofs, awnings, roof tiles and shingles, and windows.

Stand-Alone Photovoltaic Systems:

Stand-alone systems produce power independently of the utility grid. In some off-the-grid locations as near as one-quarter mile from the power lines, stand-alone photovoltaic systems can be more cost-effective than extending power lines. They are especially appropriate for remote, environmentally sensitive areas, such as national parks, cabins, and remote homes. In rural areas, small stand-alone solar arrays often power farm lighting, fence chargers, and solar water pumps, which provide water for livestock. Direct-coupled systems need no electrical storage because they operate only during daylight hours, but most systems rely on battery storage so that energy produced during the day can be used at night. Some systems, called hybrid systems, combine solar power with additional power sources such as wind or diesel.

Grid-connected Photovoltaic Systems:

Grid-connected photovoltaic systems, also called grid interface systems, supply surplus power back through the grid to the utility, and take from the utility grid when the home system's power supply is low. These systems remove the need for battery storage, although arranging for the grid interconnection can be difficult. In some cases, utilities allow net metering, which allows the owner to sell excess power back to the utility.

Space Applications:

Solar arrays work well for generating power in space and power virtually all satellites. Most satellites and spacecraft are equipped with crystalline silicon or high-efficiency Group III-IV cells, but recently satellites have begun using thin-film amorphous-silicon-based solar panels.

APPLICATION IN BANGLADESH

Solar cell utilization is being accepted gradually. The tropical climate of Bangladesh is an advantage to the utilization of solar cell but its slow progress in our country is due to high initial lost, low daily operation time and lower output level. Bangladesh atomic energy commission ran the first photovoltaic pilot project at Swandip Island in 1988.These gave been the substantial intervention in Bangladesh in the field of rural electrification through solar photovoltaic cell. These are solar PV project by Grameen Shakti (GS) and Narshingd: pilot project by rural electrification Board (REB). These projects attempted to provide basic needs such electric lighting and power for TV or Radio with assistance from the French Government; REB has implemented a solar PV electrification project for rural households and commercial enterpriser at a remote island in Narshingdi district. This pilot project serves about 700 households of the island community. Other application of PV. Include water

pumping and power for mosques, institutions and office. PV system are also effectively used in income generating enterprises such as grocery shops, tailoring shops, clinics, restaurants, rice mills, cellular phone services, barber shops, buzzers, and micro utilities which sell electricity to customers in the neighborhood. In addition to these LGED (local Government Engineering Department) is continuing its work on the electrification of cyclone shelter in the costal areas through solar PV installation. In the current place cyclone shelters in greater Patuakhale, Noakhali, and Cox's Bazer district have thus electrified. Several national NGO such as BRAC and PROSHIKA have used solar PV system to electricity their offices and some targets group homes in rural areas. CMES a national NGO, has trying up projects involving pilot marketing system through them in rural areas and developing its own accessories and appliances for this.

Table 1: Solar PV installation 1985-1995[2]

Description & Location	Sponsoring organization	Year	Wattage (W)	Purpose
Solar pumping, Saver	BAFC	1985	14000	Pumping
Solar pumping, Shiola	BAFC	1989	2332	Irrigation in tea garden
Solar lighting, Tangail	BAFC	1988	480	Charging light
Solar system, Sawandip	BAFC	1988	1880	Freeze, Lights
Solar system, Sawandip	BAFC	1989	329	Freeze
Solar system, Moheskhali	BAFC	1993	1000	TV, Lights, Freeze
Badarkali,Cyclone center	LGED	1995	745	Light, Bacon light, Loud speaker
Kazikamda,Galachipa Cyclone center	LGED	1995	300	Light, Bacon light, Loud speaker
Char Mantaz,Cyclone center, Galachipa	LGED	1995	300	Light, Bacon light, Loud speaker
Char Agasti, Cyclone center, Galachipa	LGED	1995	300	Light, Bacon light, Loud speaker

Table 2: Solar PV installation 1996-1997, for private consumer [2]

Description of System	Organization	No. of consumer	System wattage (W)	Total wattage (W)
Lanterns	REB	200	6	1200
2 Lights, a socket for TV	REB	380	Charged at charging station	Charged at charging station
3 Lights, 1 Fan, a socket	REB	120	-	Charged at charging station
3 Lights, 1 Fan, a socket	REB	100	46	4600
3 Lights, 1 Fan, a socket	REB	140	92	12880
Battery charging station, Karimpur	REB	-	-	14720
Battery charging station, Natun Bazer	REB	-	-	7360
Battery charging station, Alipur	REB	-	-	7360
Lights, 1 Fan, socket, TV	GS	409	30-35	21743

Table 2: Solar PV installation 1996-1997, for private consumer [6]

Sl No.	Solar System	Capacity(Watt)	Location
1	Solar household system	19650	Kuakata in PatuaKhali,Noakhali,Cox' Bazzer,Kutubdia,Chitagong(Specially Cyclone Center),Khagrachari
2	Solar household system	1800	Solar Voltage in Baliadangi,Takurgaon
3	Solar Battery Charging Station	150	Kazikanda,Patuakhali
4	Solar Pumping System	300	Prantik Lake,bandurban
5	Solar Market Electrification(AC)	1500	Gangutia Growth Center,Jenaidah
6	Community Center Electrification	530	Milon Karbaripara,Dighinala,Tangail, Khagrachari $ Sadar Thana
7	Cluster Voltage Electrification	1725	Ashrayan Project,Nalitabari,Sherpur
Total in Watt		25655	

CONCLUSION

Thus the most beneficial solar photovoltaic PV) system are gaining acceptance as a technology for electricity generation in remote and rural areas. But these no manufactures of PV panels in Bangladesh in the country by private companies. The government encourages promotion of PV industry. Also the solar PV system is established. However, more commitment and effective policies will strengthen PV promotion and load to full commercialization of this technology.

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