

Off grid solar PV Programme

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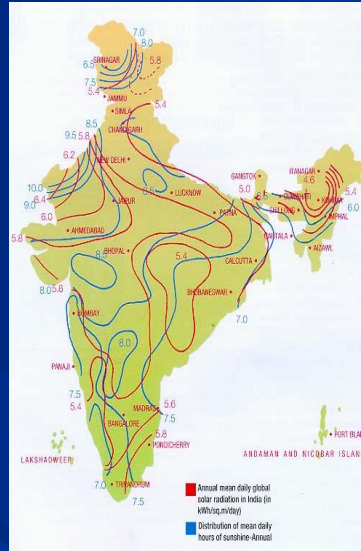
6th January, 2011
at
TERI University, Delhi

Solar Energy

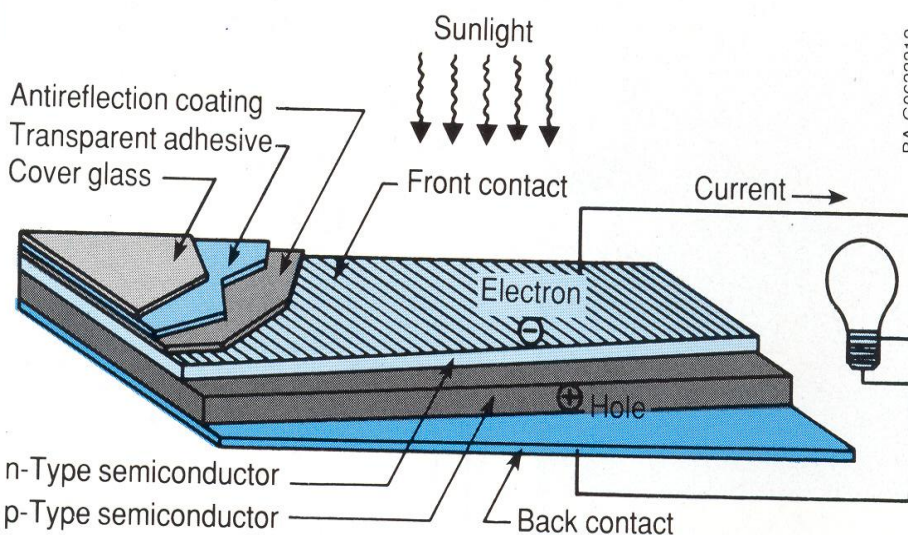
- Distance between sun and earth is about 1.495×10^{11} m or 150 million km.
- Surface temperature of sun is 5800° K.
- Solar constant 1353 W/m^2 .
- Reflection and absorption by air is 30%.
- AM1 is 1070 W/m^2
- AM 1.5 is 1000 W/m^2

Solar Resource Availability in India

- Daily solar radiation 4 - 7 kWh per sq. m.
- 250 - 300 sunny days in a year
- 600,000MW from 1% land area
- 5000 trillion kWh solar radiation incident in a year
- Radiation data collected by India Meteorological Department. Data Hand Books available. Update available on MNRE website

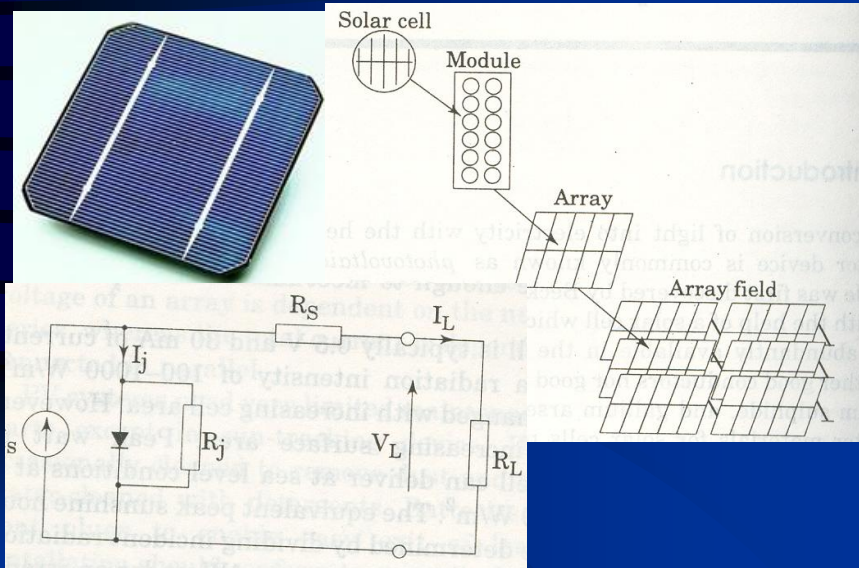


Solar Photovoltaic Systems



BA-G0633312

SOLAR CELL



Solar Cells : Technology Options

- Crystalline Silicon solar cells
 - Single, Multi, Ribbon
- Thin Film solar cells
 - Silicon, a-Si, mc-Si, CdTe, CIGS
- Concentrating PV
 - Si, GaAs
- Dye, Organic & other emerging solar cells
 - TiO_2 , ZnO, Quantum Dots, Carbon nano-tubes
- Use of nano-structures/materials in most of these technologies

Highest Solar Cell Efficiencies (World)

TECHNOLOGY	AREA sq. cm	EFF. %	GROUP
Si SINGLE CRYSTAL	4.00	25.0	UNSW
Si MULTI CRYSTAL	1.00	20.4	FhG-ISE
a-Si SINGLE JUNCTION	1.00	12.7	SANYO
a-Si TRIPLE JUNCTION	0.27	13.5	USSC
CdTe	1.00	16.8	NREL
CIGS	1.00	19.5	NREL
Si FILMS	4.01	16.7	Stuttgart Uni.
DYE	1.0	10.4	Sharp
Organic	1.0	6.0	North Carolina U.
GaAs (500 x)	0.4	40.7	SPECTROLAB
GaAs (20 x)	0.2	42.8	Delaware Univ

Highest Solar Cell Efficiencies (India)

TECHNOLOGY	AREA SQ. CM.	EFF. %	GROUP
Single crystal	64.00	19.7	CEL
Multi crystal	100.00	16.8	TATA BP
a-Si Single Junction	1.00	12.0	IACS
a-Si Multi Junction	1.00	11.5	IACS
a-Si/ μ c-Si(nc-Si)	1.00	7.0	IACS
CdTe	0.03	12.0	NPL
CIGS	0.41	13.0	IISc
Si Films	0.98	8.7	Jadavpur Uni.
Dye Sensitized	1.00	7.8	Delhi Univ.
Organic cells	0.50	3.6	IIT – Kanpur
Typical Cell Efficiency	Single crystal	14-16.5%	
	Poly Silicon	13-16%	

Crystalline Silicon Solar Cells

Largely understood and documented material and process for making silicon wafer based solar cells, with proven long life in the field

Mature technology for volume production (Plant size 100 - 800 MWp already set up)

Likely to continue leadership role for next 5 -7 years.

However, the share of crystalline silicon in global market will gradually reduce and give way to thin films and concentrator technologies

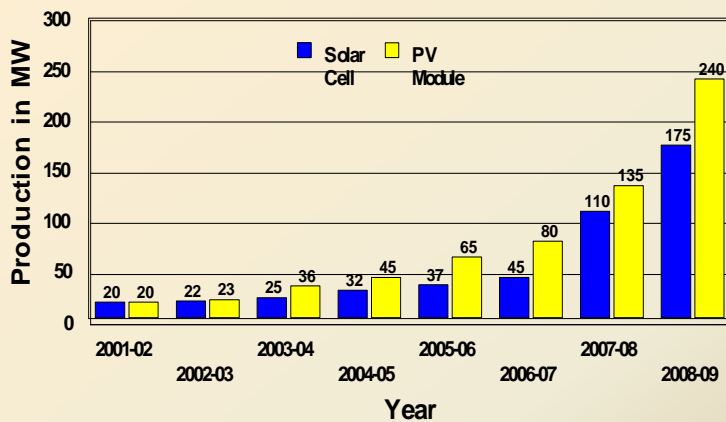
Several processes to produce solar grade silicon by low energy consumption methods under development

Thin Film Solar Cells

- Amorphous silicon (single junction, multi junction and micro-crystalline) are also in commercial production**
- Poly crystalline thin film solar cells based on CdTe, CIGS and silicon are in early stages of commercial and pilot production**
- New materials and concepts based on dyes, polymers, carbon nano tubes and quantum dots have huge potential for low cost PV but these device structures are still in early stages of development : life expectancy, reproducibility, scalability are some of the issues that need to be resolved**

World PV Industry : Status

- During 2009 the world production of solar cell is estimated to be about 5.8 GWp
- More than 88% production is based on crystalline silicon
- World production of poly silicon material in 2008 is estimated to be about 55,000 MT
- It is estimated that in 2010 the world production capacity of poly silicon may be around 72,000 T.
- R&D and pilot production of solar grade silicon, based on alternative methods progressing



GROWTH IN INDIAN PV PRODUCTION

Tipping Point



PV Applications

Calculators, Watches, Mobile phones, Torches, Key Chains, Satellites, Lanterns, Home lights, Television, Street lights, Studs, Blinkers, Traffic signal, Community lights, Water pumping, Stand alone power plants, Grid connected power plants, Building integrated photovoltaic systems, Rural Telecom Network, Boats, Cars, Aero plane, Microwave Repeater Stations, Community & DRS TV Sets, Low Power TV Transmitters, Railway Signalling/ unmanned Level Crossings, Off Shore Oil Platforms, Cathodic Protection of Oil/ Gas Pipelines, Diesel/ Petrol Dispensing Stations, Obstruction Warning Lights at Airports, Battery Charging by Defence & Para Military Forces, etc.

Solar Lighting Systems

- Solar Lanterns- 3 & 10 Wp
- Solar Home Systems for average daily use of 2 - 4 hrs depending upon combination of loads
Several models covered - 18 -74 Wp PV
Module capacity
- Solar Street Light for nightlong operation;
automatic switching On & Off. - 74 W PV
Module, CFL of 11 W
- Stand- alone Power Plants - 1-250 kWp PV
capacity



Solar lanterns

Solar home lighting system



Solar Powered TV in a village



Solar street lighting systems installed on new Naina Devi Road, Anandpur Sahib, Punjab.

Solar Street Light in a Village in Bastar

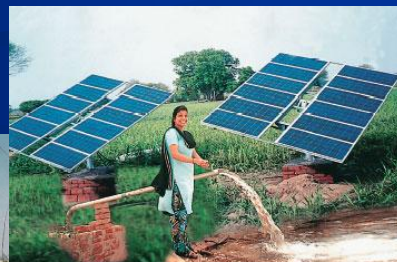


3.11

PV blinker



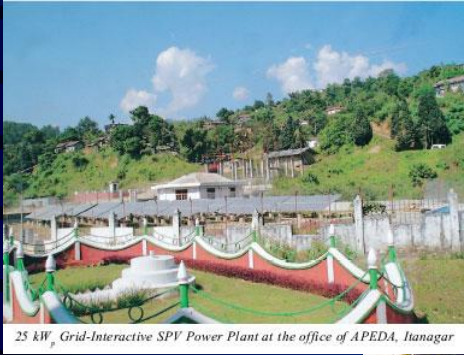
Pump in an Agricultural Field in Punjab



An SPV Water Pumping System installed at Murad Nagar, Ghaziabad, Uttar Pradesh

Pump for drinking water supply in a forest colony Chhattisgarh





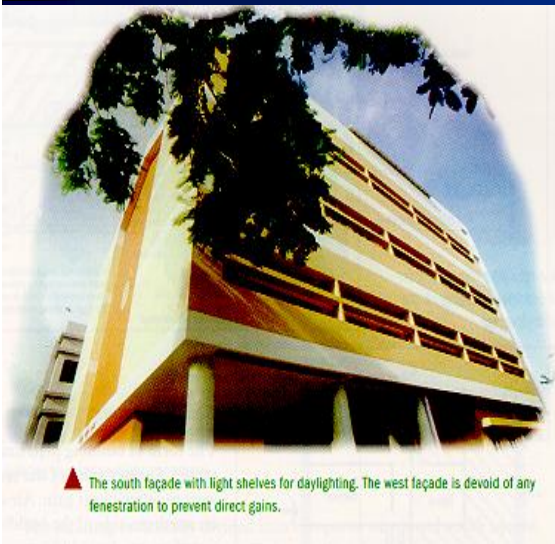
25 kW Grid-Interactive SPV Power Plant at the office of APEDA, Itanagar

26 kWp PV Power Plant at Sagar Island



WBREDA Building, Calcutta

An Energy Efficient Building with 25 kW PV power plant



▲ The south façade with light shelves for daylighting. The west façade is devoid of any fenestration to prevent direct gains.



▲ The roof of the solar chimney is of low e-glass. A 25-kW peak solar photovoltaic system has been installed on the roof



Building Integrated 4 kW Solar Photovoltaic Power Plant at IIT Kanpur

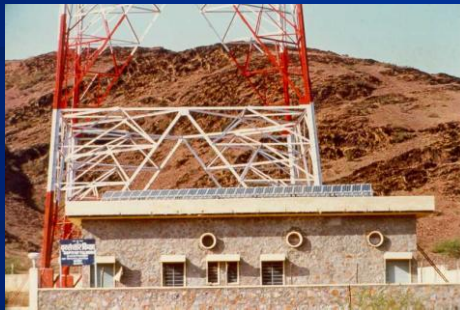
Grid Interactive SPV Power Plant

Voltage support at the tail-end sections of rural grids, Peak shaving (DSM in urban centre), Diesel savers in islands and isolated locations and Captive power projects in industry



100 kW PV Power Plant at an Island in Lakshadweep

Power plant for microwave repeater system



Off-shore platform



Solar power plant (8.4 kW_p) at a hospital at Darhal, District Rajouri, Jammu & Kashmir



Satellite earth station in Jammu and Kashmir



Solar Car

SPV Systems – Achievement (31.12.2010)

Solar Lanterns	813,380 nos.
Solar Home Systems	619,428 nos.
Street Lighting Systems	121,227 nos.
Pumps	7,334 nos.
Power Plants Stand Alone	2925.60 kWp
Grid-connectd Power plants	11.09 MWp

SOLAR MISSION (first Phase)

Power Generation	1100 MW
Roof top systems	100 MW
Off-Grid Systems	200 MW
Capacity Building	
R & D in different aspects with industry, universities, research organisations, etc.	

Objectives of Off-grid Solar Applications Programme 2010-11

- To promote off-grid applications of solar energy (both SPV and Solar Thermal) for meeting the targets set in the Jawaharlal Nehru National Solar Mission for Phase-I.
- To create awareness and demonstrate effective and innovative use of Solar systems for individual/ community/ institutional/ industrial applications.
- To encourage innovation in addressing market needs and promoting sustainable business models.
- To provide support to channel partners and potential beneficiaries, within the framework of boundary conditions and in a flexible demand driven mode.
- To create a paradigm shift needed for commoditization of off-grid decentralized solar applications.
- To support consultancy services, seminars, symposia, capacity building, awareness campaigns, human resource development, etc.
- To encourage replacement of kerosene& diesel, wherever possible.

Channel Partners

- Renewable Energy Service Providing Companies (RESCOs)
- Financial Institutions including microfinance institutions acting as Aggregators
- Financial Integrators
- System Integrators
- Programme Administrators

Bouquet of Incentive Instruments

- RE Voucher/Stamp
- Capital Subsidy (Credit Linked and non credit linked)
- Interest Subsidy
- Viability Gap Funding
- Green Energy Bonds

BOUNDARY CONDITIONS FOR SUPPORT TO OFF-GRID SOLAR PV APPLICATIONS

1.	Individuals		
A.	All applications except 1B	1 kWp	Capital Subsidy & Interest Subsidy
B.	Pumps for irrigation and community drinking water	5 kWp	
2.	Non- Commercial entities		
A.	All applications except 2B	100 kWp per site	Capital Subsidy & Interest Subsidy
B.	Mini-grids for rural electrification	250 kWp per site	
3.	Industrial/Commercial entities		
A.	All applications except 3B	100 kWp per site	Capital Subsidy Or Interest Subsidy
B.	Min-grid for rural electrification	250 kWp per site	

Contd....

Scale of Capital Subsidy: 30% or			
Based on benchmarking annually.	Rs. 90/Wp	With battery storage	
	Rs. 70/Wp	Without battery storage	
Scale of Interest Subsidy:			
	Soft loan @ 5% p.a.	On the amount of project cost	
		Less promoter's contribution	
		Less capital subsidy amount	

To meet unmet community demand for electricity or in unelectrified rural areas, standalone rural SPV power plants with battery storage in a micro grid mode/ local distribution network, would be provided Rs.150/Wp of capital subsidy AND soft loan at 5%.

Thank You

Web-site: www.mnre.nic.in