Andhra Pradesh Human Resource Development Institute, Bapatla

A

A Three day Residential Training Program on "Energy Reforms"

29th -31st, Aug – 2017

Renewable Energy(*Green Energy*) and System Technology

31st Aug- 2017

By

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Renewable Energy(*Green Energy*) and System Technology

Outlines :

1. Introduction to Renewable Sources
2. Importance of RES
3. Net-Meter policy in Renewable Energy Power Plants (Case study)

Introduction

Renewable energy is derived from natural processes that are replenished constantly, it derives directly from the sun, or from heat generated within the earth. Included electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen.

- Renewable Energy Sources broadly divided into three categories:
  - Direct solar energy
  - Indirect solar energy
  - Non-solar renewables

The majority of renewable energy sources derive that energy from solar radiation. Direct solar energy refers to solar thermal energy conversion and solar photovoltaics. Indirect solar energy includes wind power, wave power and biofuels.

Non-solar renewables are those that do not depend on solar radiation. There are two sources of non-solar renewable energy - tidal and geothermal.

cont….

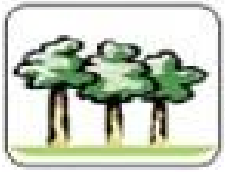
- Energy is the ability to do work. Energy sources are divided into two groups namely renewable and non renewable energy sources.
- Renewable and non renewable energy sources are used to produce secondary energy sources including electricity and hydrogen.
- Non renewable energy sources are derived from ground in the form of liquids, gases and solids. Crude oil is the only natural liquid commercial fossil fuel. Natural gas and propane are normally gases, and coal is a solid.
- Coal, petroleum, natural gas, and propane are all considered as fossil fuels because they are formed from the buried remains of plants and animals that lived millions of years ago.
- Uranium ore, a solid, is mined and converted to a fuel.
- These energy sources are considered as non renewable because they cannot be replenished in a short period of time.

Cont….

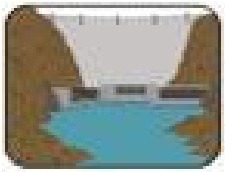
- The continuous growth of the global energy demand associated with society's increasing awareness of environmental impacts from the widespread utilization of fossil fuels has led to the exploration of renewable energy sources.
- Such as photovoltaic (PV) technology. PV systems are solar energy supply systems, which either supply power directly to an electrical equipment or feed energy into the public electricity grid.
- Generally, PVs are considered as an expensive method of producing electricity. However, in stand-alone situations, PVs are the most economic solutions to provide the required power service.

- Moreover, with the development of PV technologies, applications of PVs in grid-connected situations have grown rapidly, indicating that PVs are very attractive to produce environmentally electricity for diversified purposes.

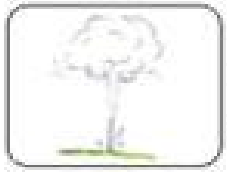
Renewable & Non Renewable Sources



BIOMASS
renewable
Heating, electricity, transportation

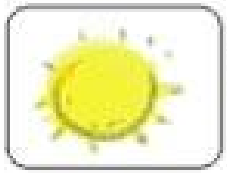


HYDROPOWER
renewable
Electricity

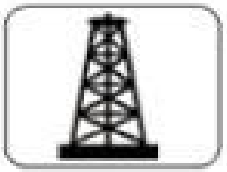


GEOTHERMAL
renewable
Heating, electricity

WIND
renewable
Electricity

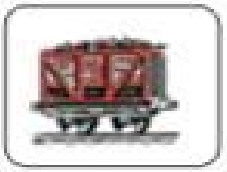


SOLAR & OTHER
renewable
Light, heating, electricity

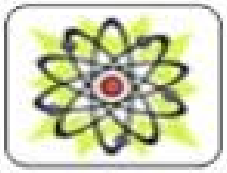


PETROLEUM
nonrenewable
Transportation, manufacturing

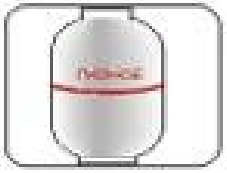
NATURAL GAS
nonrenewable
Heating, manufacturing, electricity



COAL
nonrenewable
Electricity, **manufacturing**



URANIUM
nonrenewable
Electricity



PROPANE
nonrenewable
Manufacturing, heating

Importance and sustainability of renewable energy.

- ✓ As fossil fuel resources have depleted and environmental concern has increased, renewable energy has become a very important engineering sector. It is undoubtable that in the future a large proportion of energy used by the human race will be derived from a diverse range of renewable sources.

- ✓ Renewable energy can be regarded as one of the fundamental premises for building a sustainable global society.

- ✓ A truly sustainable energy source should accordingly not only be renewable, but also apply the principles of sustainability.

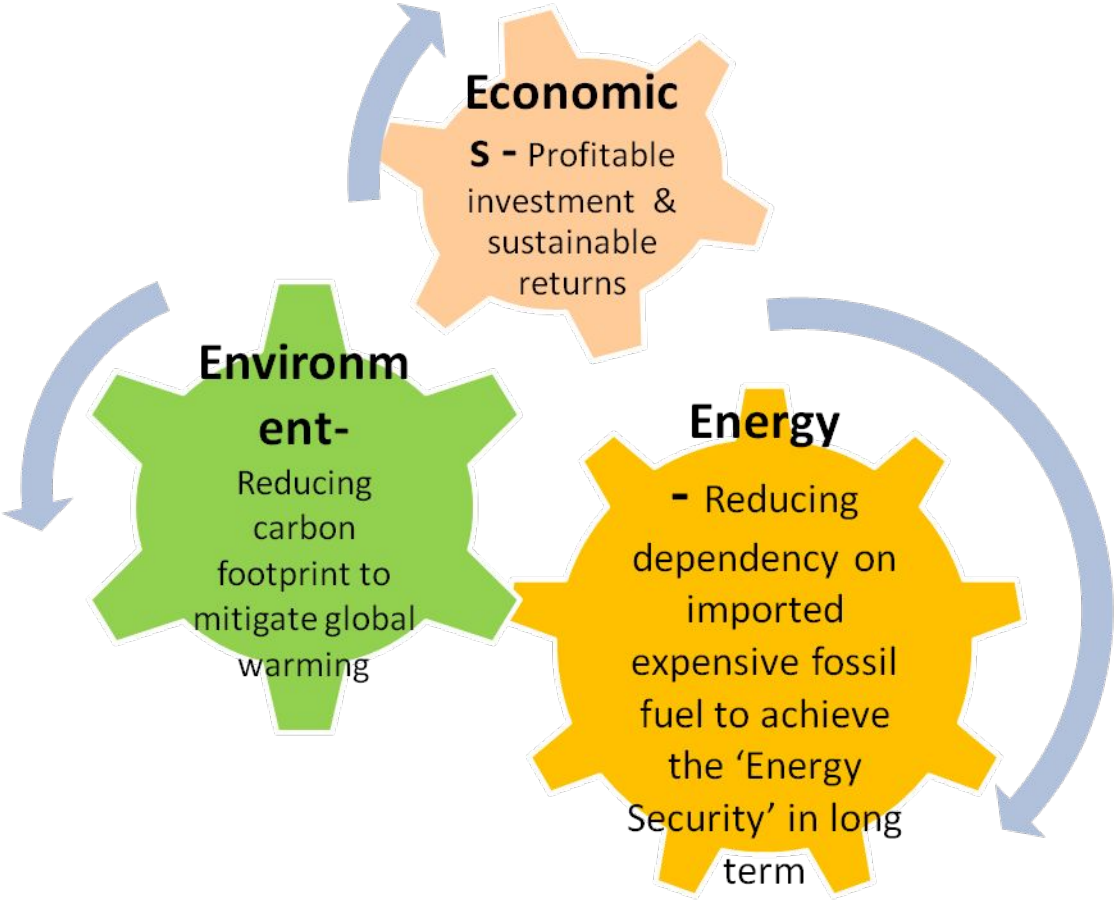
- ✓ That is, to look at the energy production and use in light of endured maintenance of our biosphere, the biodiversity and the social stability of the human culture.

Why we Prefer the RES

- ✓ As we know that electrical energy is generated at generating stations, transmitted, distributed and utilized in the form of AC. In order to meet the load demand and for consumer satisfactory point of view with optimal per unit cost. Now a days the conventional energy source are decaying day to day but we need to generate and meet the load demand then definitely we must depends on other sources like “Renewable Sources”.
- ✓ Among the RES, solar power is best and optimal and convenient to all users. Even costly but it have more applications.
- ✓ Photovoltaic systems are one of the direct solar energy systems. Whereas, photovoltaic systems collect light from the sun and convert it to electricity. PV systems are clean whereas it reduces greenhouse gases, and it is nonpolluting.
- ✓ Photovoltaic power is an established technology and has recently experienced rapid growth over the last ten years

- Power electronic conversion is the key to improve the efficiency of PV panels and the system stability in grid-connected PV systems.
- One task of power electronic conversion is to continuously adapt the system such that it can draw the maximum power from the PV panels regardless of weather or load conditions.
- Since the PV panels have nonlinear voltage–current characteristics, and the insolation and ambient temperature are unpredictable, the maximum power point tracking (MPPT) controller tends to be a nonlinear and time-varying system.

Benefits of Renewable Energy



Wind Energy:

- Wind is the natural movement of air across the land or sea. Wind is caused by uneven heating and cooling of the earth's surface and by the earth's rotation. Land and water areas absorb and release different amount of heat received from the sun. As warm air rises, cooler air rushes in to take its place, causing local winds. The rotation of the earth changes the direction of the flow of air.

Basic technology-

Wind electric generator converts kinetic energy available in wind to electrical energy by using rotor, gearbox and generator.

Photovoltaic (PV) System

Photovoltaic :

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.

Types of Solar Power Generation

1. Photo light (Photovoltaic)

2. Photo heat/Solar thermal.

Solar Cell :

A solar cell, or PV cell is an electrical device that converts the energy of sun light directly into electricity by the photovoltaic effect, device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels.

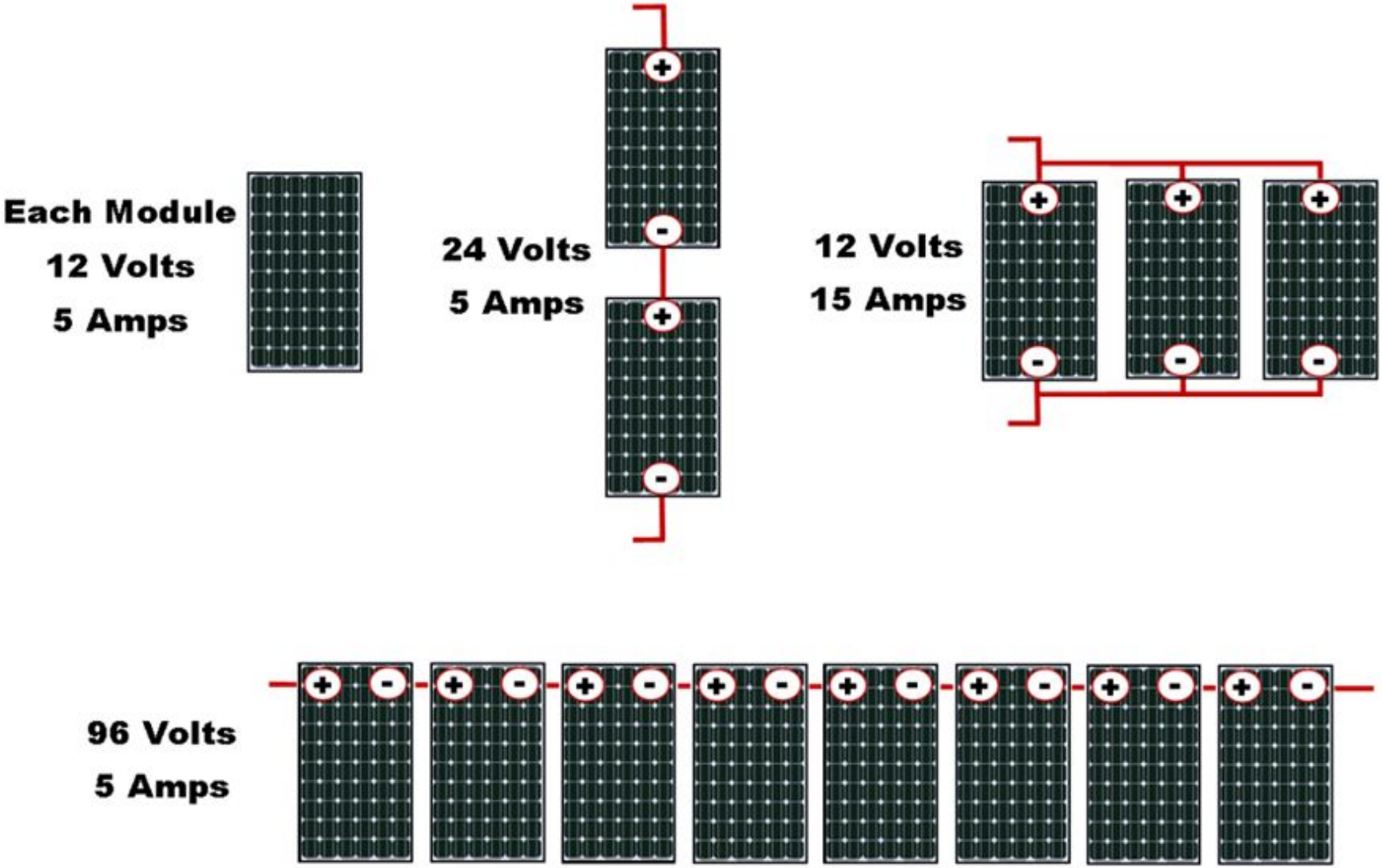
In contrast, a solar thermal collector supplies heat by absorbing sunlight, for the purpose of either direct heating or indirect electrical power generation from heat.

Solar Module/PV panel

A photovoltaic (PV) module is a assembly of photovoltaic solar cells. Each Photovoltaic modules generates and supplies solar electricity for commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts(W).

A single solar module can produce only a limited amount of power most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism.

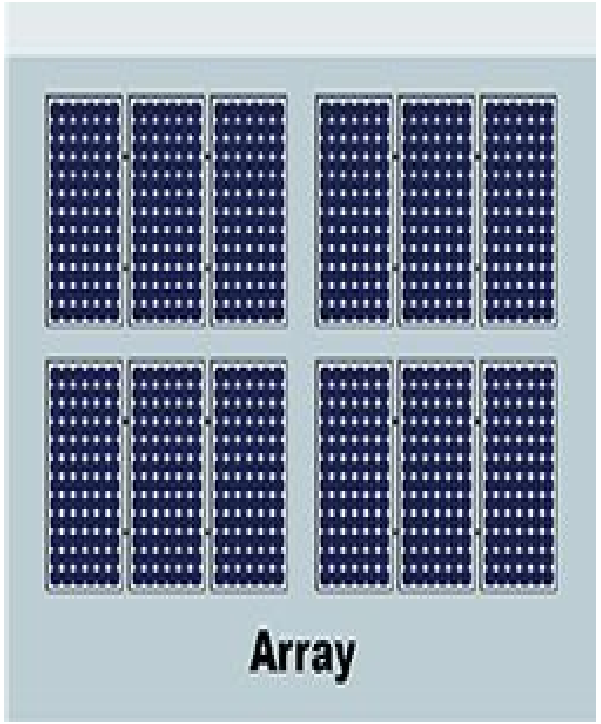
Series and Parallel connections



Strings and Arrays

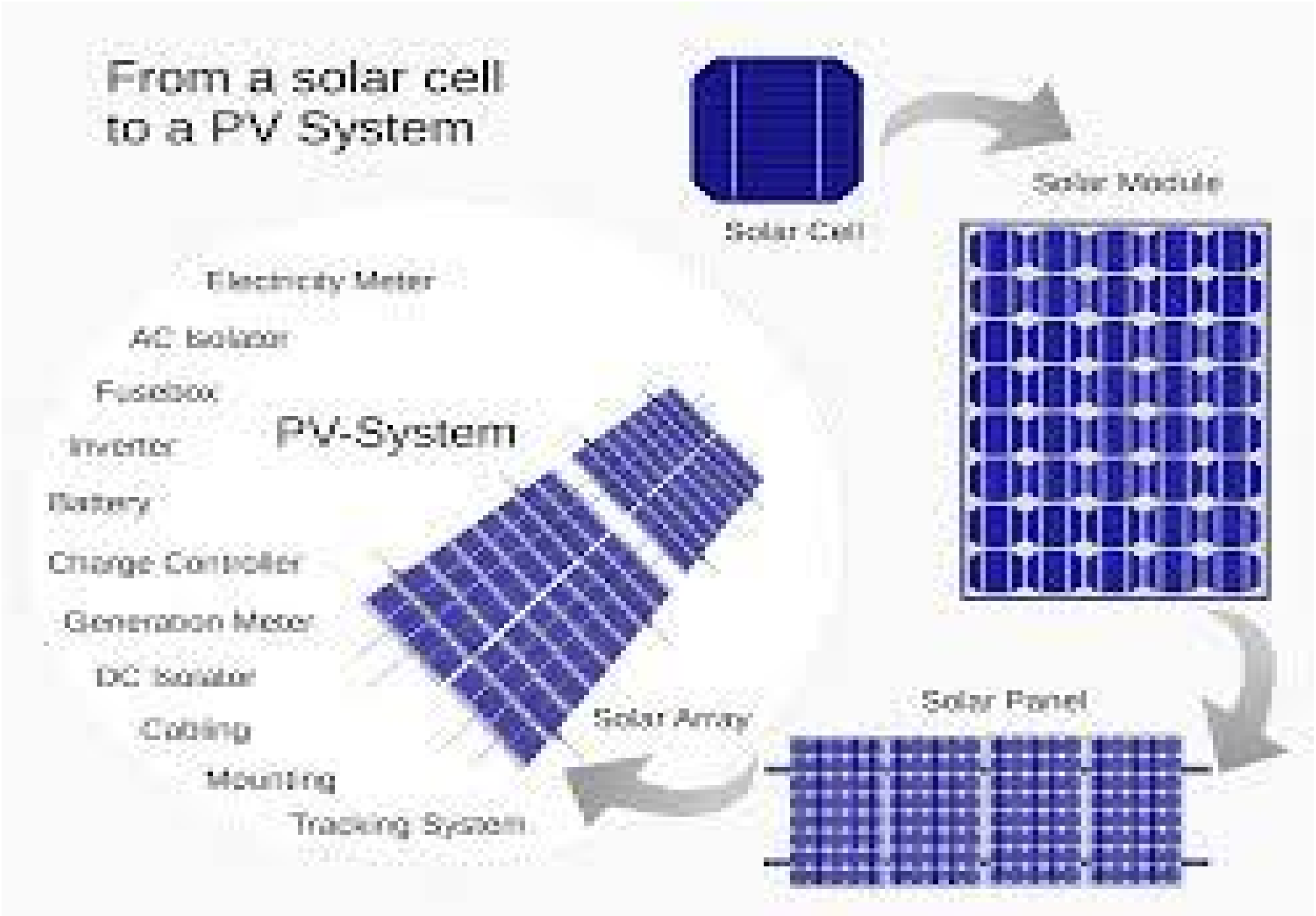
➢Combination of series connected PV modules are called a String.

➢In below figure, 4 strings with 3 SPV modules are connected.

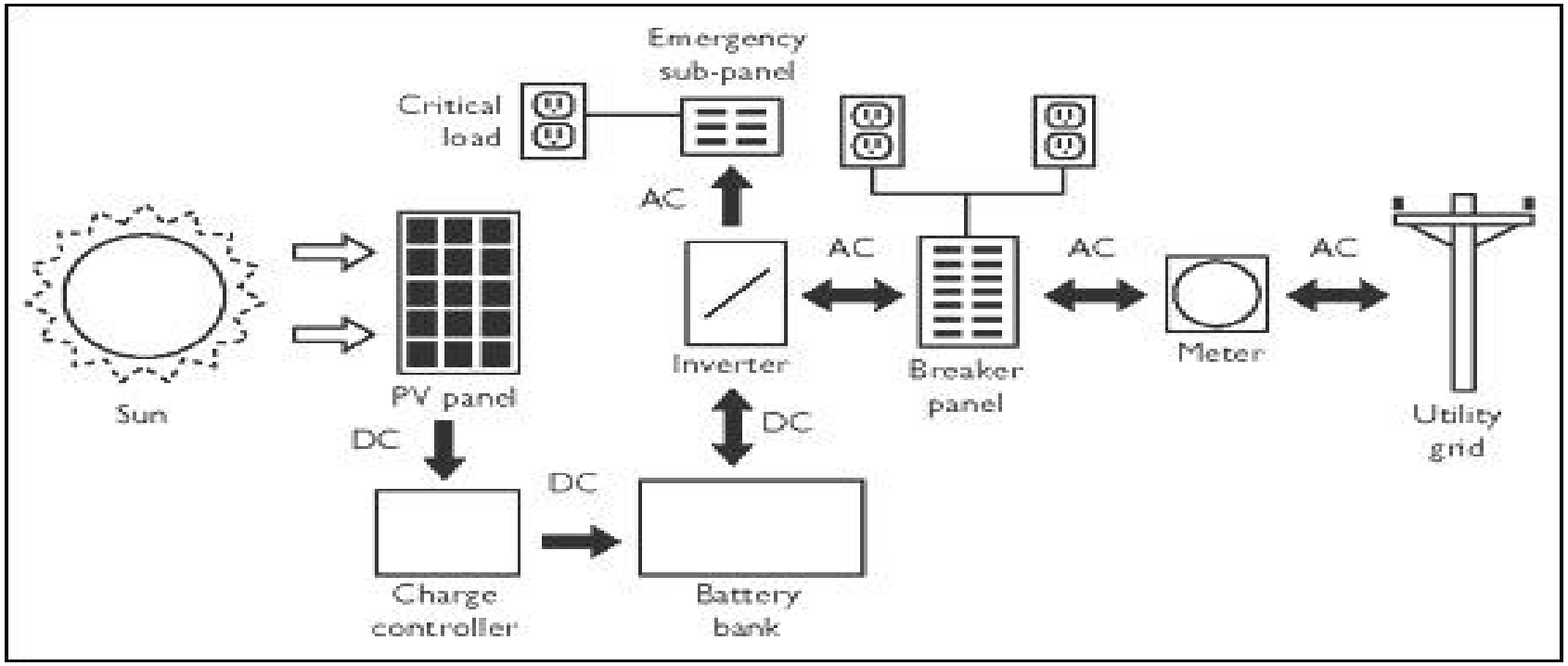


➢Array is constituted with 4 positive and 4 negative terminals (DC)

➢ From the Array Junction Box (AJB) generated DC power is feed to inverter.


From a solar cell to a PV System
Solar Cell
Solar Module
Solar Panel
Solar Array
PV-System
Electricity Meter
AC Isolator
Fusebox
Inverter
Battery
Charge Controller
Generator Meter
DC Isolator
Cabling
Mounting
Tracking System

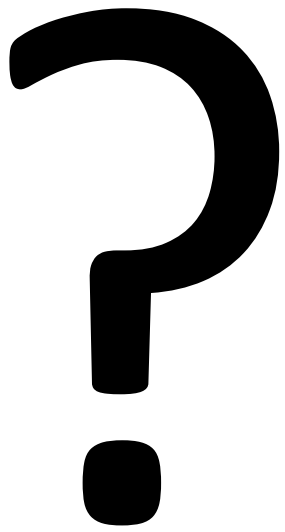
Complete PV System



Factors affecting rooftop Power Generation System/Plant

1. Shadow-free roof area. (100 Sft (10sqm)/ kW of capacity)
2. Panel efficiency.
3. Other considerations like Weight of PV Panel.
4. Module Mounting structure.
5. Withstanding wind pressure.
6. Tilt Angle and Orientation.

Any Questions



Case Study

Installation of 400 kWp Solar Power Plant with Netmetering System in G.Pulla Reddy Engineering College (Autonomous), Kurnool.

Phase 1- 100kWp (System is Synchronized with Grid)

Phase 2- 100kWp (System is not Synchronized with Grid)

Phase 3- 200kWp (System is not Synchronized with Grid but synchronized with DG set)

(GPRDC- 100kWp with Netmeter System)

Phase-I : 100kWp Plant

Administrative Block –I & II

Technical Details:

Area of SPV : 1056 Sq.m,

No.of Modules : 417 (240Wp, 8A, 29V)

No.of Modules in Series : 26

Parallel Combination :16 (4*4)

Mounting Type : Fixed type

Inverters : 4*20 kVA

Phase-II: 100kWp Plant

ME -1 ,ME-2 & ECE -2

No.of Modules : 401 (250Wp, 8.16A, 30.7V)

23 panels in series,5 strings in parallel

22 panels in series,5 strings in parallel

24 panels in series,4 strings in parallel

20 panels in series,4 strings in parallel

Parallel Combination :16 (4*4)

Mounting Type : Fixed type

Inverters : 4*20 kVA

Phase-III: 200kWp Solar Power Plant

CSE block -57.6 kWp , CSE block 2- 40.32 kWp,
EEE block 1- 51.2 kWp Library- 51.2 kWp

No.of Modules : 626 (320Wp, 8.8A, 36V)

Inverters : 50kVA - 1

20kVA – 6

Mounting Type : Fixed type

SOUTHERN POWER DISTRIBUTION COMPANY OF ANDHRA PRADESH LIMITED

H.T. Bill for the month of: AUG-2017 — Dated: 05-08-2017

Payable on or before	20-08-2017	KNL077	
Contracted MD (KVA/HP)	250.0	G PULLA REDDY	
Specified Voltage (KV)	11.0	ENGINEERING COLLEGE	
Actual Voltage (KV)	11.0 (COMM-FEEDER)	NANDYAL RD 'B' CAMP PO	
Category	IIA	KURNOOL 518 002	

Reading on	03-08-2017	KWH	3501.10	KVAH	3570.40	K	0.54
Reading on	04-07-2017		3403.30		3469.60		
Difference			97.80		100.80		0.97
Multiplying Factor			400.00		400.00	400.00	
Total Consumption			39120.00		40320.00	216.00	
Monthly Minimum			5400.00			200.00	
Consumption Main			40320.00		Rec.TOD:9120.00		
			Colony			L & F	

							Rs.	P
Demand Charges	Normal rate	Rs	475	for	216	KVA	102600.00	
	Addl. Charge at	Rs	766	for	40320	KVA	308851.20	
Energy Charges	All Units	Ps		for		KVAH		
TOD Chgs from 6PM TO 10PM		Rs. 1.05		*	9120		9576.00	
Elecy. Duty ps.			6	for	40320		2419.20	
	Colony rate	Ps		for		KWH		
	L & F rate	Ps		for		KWH	423446.40	
							1406.00	

Sub Total	
Customer Charges	
Low Power factor Surcharge	
Transformer Hire Charges	
Capacitor Surcharge	
Late payment Charges	

**********Arrears as on 05-08-2017**********

	C.C.Charge	Surcharge
Court cases Rs.	0.00	0.00
Others Rs.	0.00	0.00
Total Rs.	0.00	0.00

****

Note:PAY YOUR BILL THROUGH THE
SBI A/C NO.62304442445
PARK ROAD BRANCH, KURNOOL
IFSC CODE:SBIN0020492

Other Charges	-62686.40
	362166.00
CourtCase LPC	0.00
Current Year Arrears As On 05-08-2017	0.00
NET PAYABLE	362166.00

Last Paid Amount 238924.00(14-JUL-2017)

RS.THREE LAKH SIXTY TWO THOUSAND ONE HUNDRED AND SIXTY SIX ONLY

Export details (in Rs) :

2015				
	Total Bill	Less Amount	Net Paid	Unit Price
Jan-15	413692	0	413692	6.90
Feb-15	400868	278	400590	6.90
Mar-15	445904	278	445626	6.90
Apr-15	513952	556	513396	7.25
May-15	507905	556	507349	7.25
Jun-15	366845	877	365969	7.25
Jul-15	338313	4678	333635	7.25
Aug-15	573151	2046	571105	7.25
Sep-15	569272	584	568687	7.25
Oct-15	605367	877	604491	7.25
Nov-15	454726	8187	446539	7.25
Dec-15	446845	1160	445685	7.25
	5636840	**20077**	**5616764**	

2016				
	Total Bill	Less Amount	Net Paid	Unit Price
Jan-16	405239	8120	397119	7.25
Feb-16	462535	1392	461143	7.25
Mar-16	573946	556	573390	7.25
Apr-16	262653	0	262653	7.40
May-16	532183	24460	507714	7.40
Jun-16	329062	0	329062	7.40
Jul-16	235433	0	235437	7.40
Aug-16	414096	8653	405443	7.40
Sep-16	526230	44162	482068	7.40
Oct-16	472805	8500	464305	7.40
Nov-16	422212	0	422212	7.40
Dec-16	392102	0	392102	7.40
	5028496	**95843**	**4932648**	

2017				
	Total Bill	Less Amount	Net Paid	Unit Price
Jan-17	397431	0	397431	7.40
Feb-17	385500	0	385500	7.40
Mar-17	395431	0	395431	7.40
Apr-17	468634	35808	432826	7.40
May-17	552588	97066	455522	7.66
Jun-17	502968	81832	421136	7.66
Jul-17	362135	123211	238924	7.66
Aug-17	424852	62686	362166	7.66
	3489539	**400603**	**3088936**	

Year	Less Amount
2015	**20077**
2016	95843
2107*	400603
Total	516523

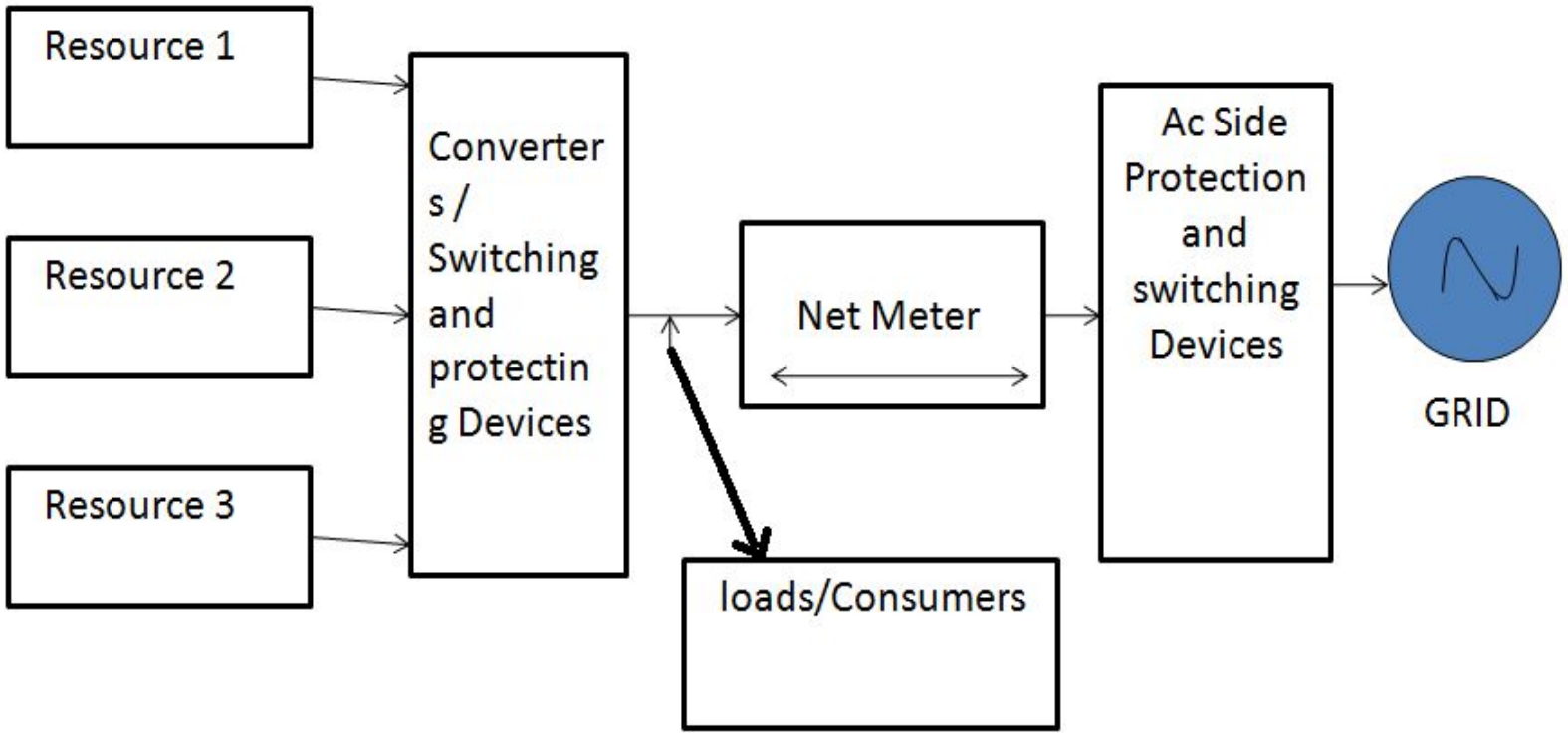
Exported Units from Our Plant to Grid

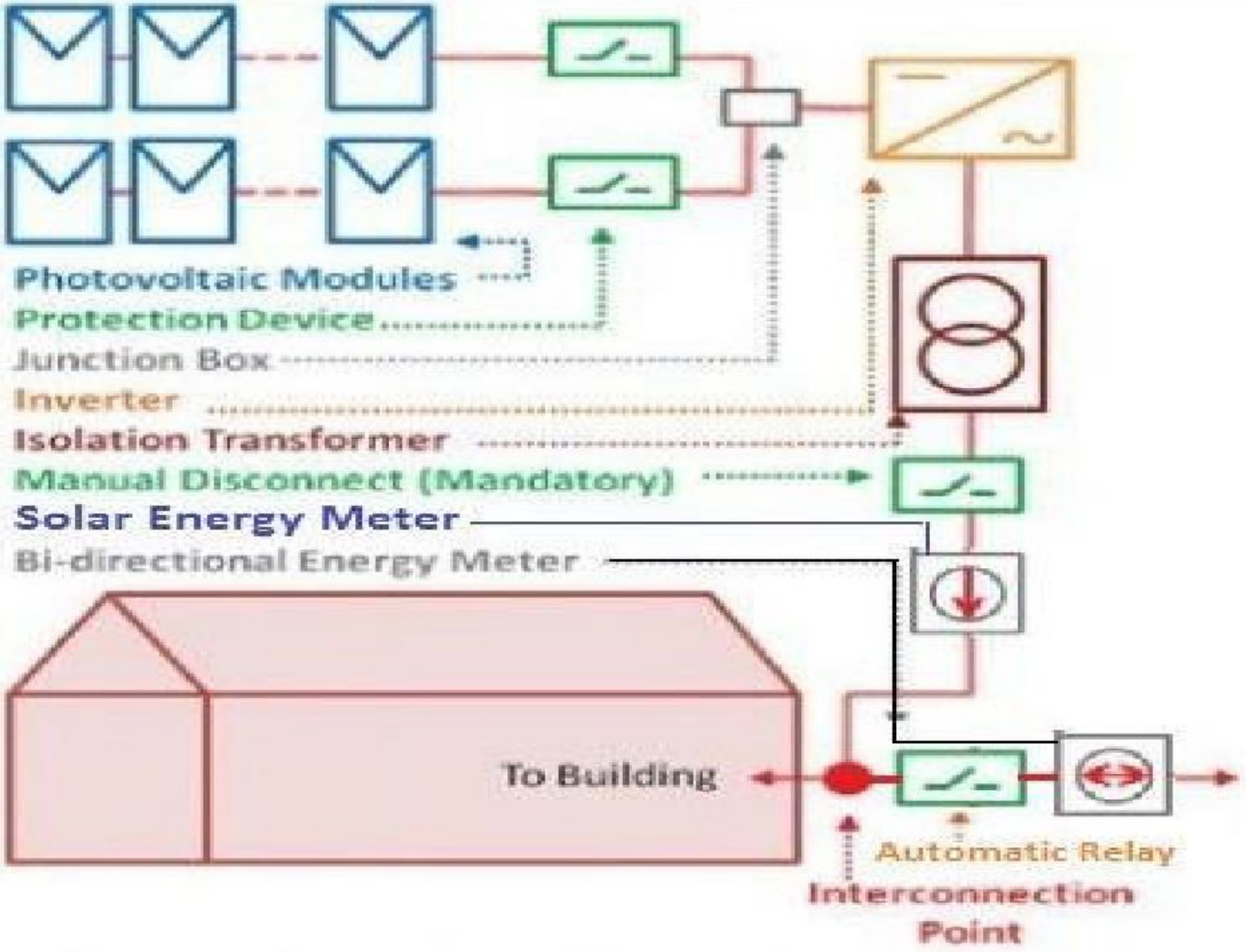
S.No	Month	No. of Units Exported in kWh
1	22-2-2015	0.42
2	22-3-2015	0.52
3	22-4-2015	0.79
4	22-5-2015	0.97
5	22-6-2015	1.48
6	22-7-2015	2.82
7	22-8-2015	3.52
8	19-9-2015	3.72
9	20-10-2015	4.08

Total no.of units exported to grid = 4.08 * 400 = 1632 kWh

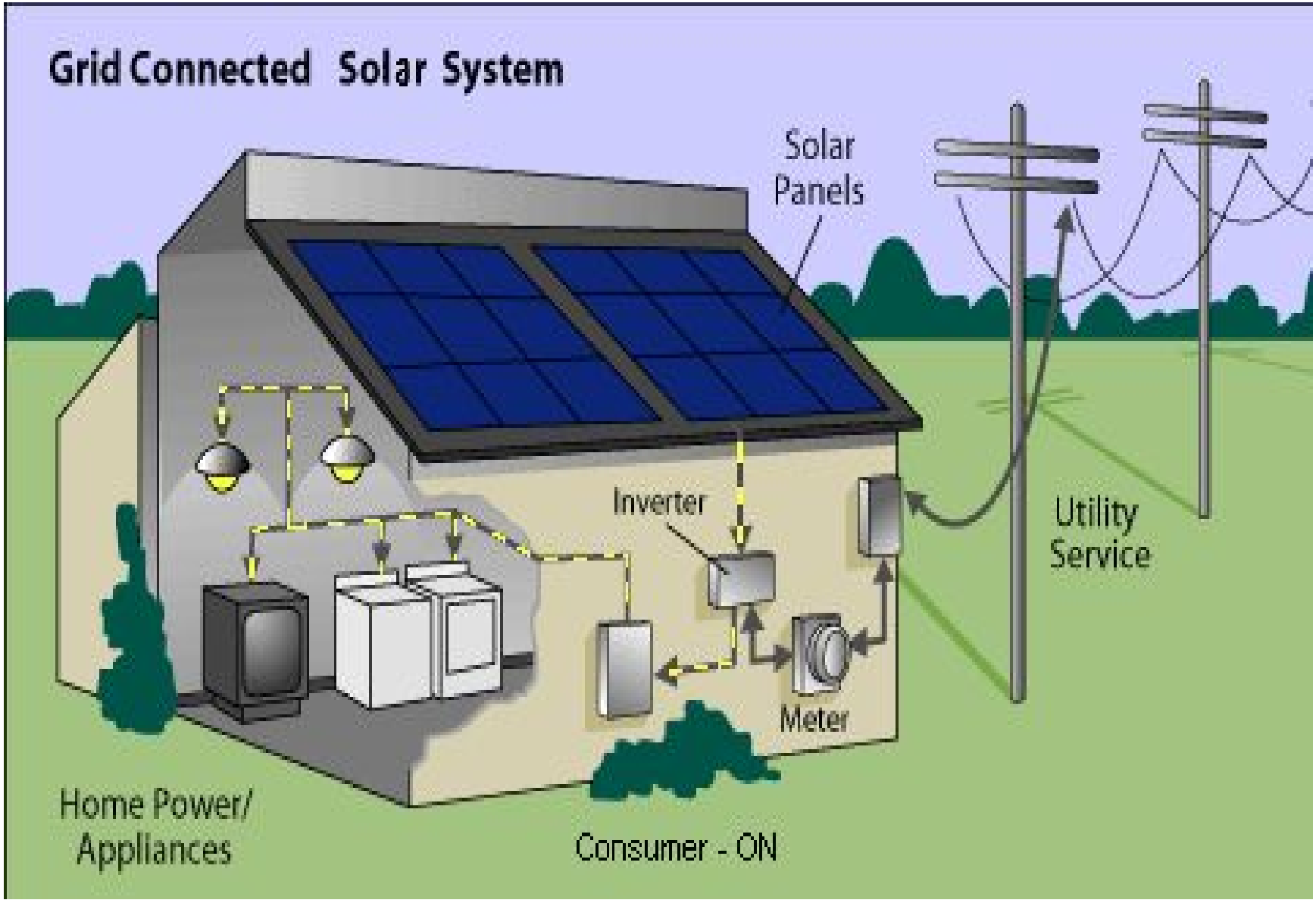
NETMETER

Netmeter / Net Energy meter (**NEM** or simply **net metering**), is a device which is used to measure the energy in bi-direction, it reads and records both import energy from grid and export energy to grid.





Net Metering Interconnection Schematic


Grid Connected Solar System
Solar Panels
Inverter
Utility Service
Meter
Home Power/ Appliances
Consumer - ON

ADVANTAGES OF SOLAR NETMETERING

- Injecting excess power from our own generation (PV Plant) to the power grid.
- Netmeters also provide information on energy saved by the system.
- It calculates 'power credits' on power injected into the grid.
- It encourages us to save power using 'Time of Use ' and other unique features present in modern net-meters.
- It reduces the pressure on the grid.
- Power can be also provided to neighboring homes.
- It reduces transmission losses.
- It makes the user more conscious of energy usage.

NET METER Vs GROSS METER

Net Meter	Gross Meter
A net meter calculates the net difference of the total power consumed to the total power generated.	A Gross meter measure the consumption and generation separately .
Should be a interval based one and should be read in periods. So that energy producer can confidently export energy to the grid.	Gross meter measures the entire output of the system separately.
confidently export energy to the grid.	Gross meter can help not only calculating the gross meter calculations but also net meter calculations

Solar Rooftop Policy/ Guidelines

Eligible Developers

- All registered companies, Government entities, partnership companies/ firms/ individuals and all consumers of Discom(s) will be eligible for setting up of Solar Rooftop Projects (SRP) for sale of electricity to Discom/captive use or for self-consumption, in accordance with the Electricity Act-2003, as amended from time to time.
- Group of persons/societies will also be eligible for setting up Solar Rooftop Projects (SRP) with SPV Technology for sale of electricity to Discom/captive use or for self-consumption.

- SRP with installed capacity lower than or equal to 56 kW shall be connected at LT level of distribution network. SRP with installed capacity of 56 kW above and up to 1000 kW shall be connected at 11 kV or 33 kv level of distribution network.

1. Requirements

- A Minimum vacant roof area of 10 Sq mtr or 100 Sq. Ft is required for installation of 1 kWp system.
- The Consumer shall have 3-Φ or 1- Φ supply service connection.
- Mandatory safety precautions / features shall be installed as per the norms.
- A Single bi-directional meter shall be installed for export and import.
- The standard equipment as per the norms of MNRE/APTRANSCO/DISCOM shall only be installed.

II. General Information

- Solar rooftop NetMetering services are introduced and registered as per G.O Ms No : 22, 27 &58
- Eligible Developers are free to choose either net or gross metering option for sale of power to Discom. Applicable tariff for either of the cases shall be equal to the Average Cost to Serve (ACoS) of the Discom which will be determined by APERC every year.
- Also, Eligible Developers can install Solar Photo Voltaic Plants (SPV) on walls of their buildings.
- Eligible Developers will have to apply only through online mode to the Discom – either on their websites and/or with help of designated meeseva / Integrated customer service centers(CSC).

- Eligible developer can install SPV plant of more capacity than their contracted load whereas maximum allowable capacity under single-phase service is 3 kWp and maximum allowable SPV plant capacity under LT category is 56 kWp.
- Eligible Developers are allowed to avail the relevant subsidies and incentives from MNRE and from other Departments applicable from time to time.
- The eligible subsidy may be processed through NREDCAP (Nodal agency) or Channel Partners of MNRE, GoI. The sanction and release of the subsidy will be as per the guidelines issued by MNRE from time to time.

- No prior approval of Chief Electrical Inspectorate General (CEIG) is required in case of an SRP connected at LT level of distribution network up to 10 kW capacity.
- Incentives / Other Charges/ Administrative Fee - No Distribution losses and charges will be collected from the Eligible Developers /Group /Society /Individuals by the DISCOMs. All other charges shall be applicable as per the Tariff Order amended from time to time. The registration and facilitation fees shall be paid by Eligible Developer to Nodal agency as specified in the Policy.
- The insurance coverage can be optional for the LT Consumers opting Solar Net metering scheme. However, the consumers/ Solar Power developer may be advised to take insurance coverage to avoid risks at the time of accidents.
- The Solar rooftop developers/ MNRE channel partners maybe allowed to attend the departmental procedures on behalf of applicant, except in case of signing the agreement.

- Pre existing rooftop Solar PV Projects with or without battery support can be allowed to avail net metering facility. They will not get any subsidy under solar net metering policy/ guidelines issued.
- After application to the DISCOM's , DE (O) has to issue Technical feasibility report . (For HT consumers – DTR ratings)

Points to be verified in feasibility report :

- Bank account details of the consumer.
- Verifies the proposed system has no battery support.
- Verify CT /PT , CT meter /HT meter ranges as it is singe phase / 3-phase service.

- If 3-Φ H.T service, Capability of distribution transformer.
- System is Installed within sanctioned load or not?
- All devices shall meet IS & IEC standards (as per MNRE standards)
- CEIG approval for above 10kW capacity of LT service (No CIEG certification for below 10kW)
- During the time of SPV plant synchronization to the grid . The DE(o) ,DE (metering) shall inspect , calibrate and then seal the bi-directional meter, and DISCOM persons has right to visit the entire system at any time as per the Electricity act 2003.

Billing and Payment

1. Consumer can receive net import / export bill , indicating that it is net export to grid or net import from grid.
2. In case of net import bill, consumer shall settle the same as per existing norms.
3. If it is net export bill then the credit amount shall be carry forward to next month for adjusting for the next month bill.
4. No credit amount will be deposited to consumer account.
5. Any modification/ amendment in the Policy and change in law would be made applicable and corresponding amendment(s) will be made in the agreement from time to time with the approval of state Government ERC.

Safety, Security & Insurance

- The Consumer is required to provide an appropriate protection system on their incoming side/ consumer premises with the feature of “Islanding the SPV Generator” when incoming supply fails or any interruption on the connected line due to failure of equipment/line or Line Clear taken for carrying any maintenance work.
- As a part of security check, “Islanding the SPV generator” shall have to be checked up for its healthiness twice in a year.
- In order to meet the expenditure that may arise due to failure of the connected protective and switch gear, the Consumer is required to provide an insurance coverage of 5,00,000 per annum.

Metering Arrangement

- The consumer shall bear the entire cost of metering arrangement including its accessories.
- The installation of meters including CTs & PTs, if applicable, shall be carried out as per the departmental procedures.

Source :

1. *MNRE website*
2. *NREDCAP website*
3. *APERC website*
4. *APSPDCL website*
5. *ERO, APSPDCL, Kurnool.*
6. *Dept. of EEE, GPREC, Kurnool*
7. *Some other references.*

MOTIVATION AND GOAL

- Renewable energy resources are clean and environmental friendly.
- They provide many immediate environmental benefits by avoiding the emission of greenhouse gases and to help conserve fossil resources as electricity supply for future generations.
- The entire world is encouraging the development of renewable energy to make the world clean, eco friendly and also sufficient in the energy sector.
- The Government of India is encouraging the development of renewable energy in the anticipation that it will provide at least 30% of electrical energy by 2020 in India.
- The Government also aims for a major reduction in CO2 emission by 2020.

- ✓ Renewable simply means that the source can be rejuvenated to provide an almost endless supply of energy.

- ✓ Non-renewable sources are those that are prone to running out.

Questions

THANK YOU