7th Capacity Building Program for Officers of the Regulatory Commissions
IIT Kanpur

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Rooftop Solar PV Power : Potential,Growth and Issues related to Connectivity and Metering

30th January 2015

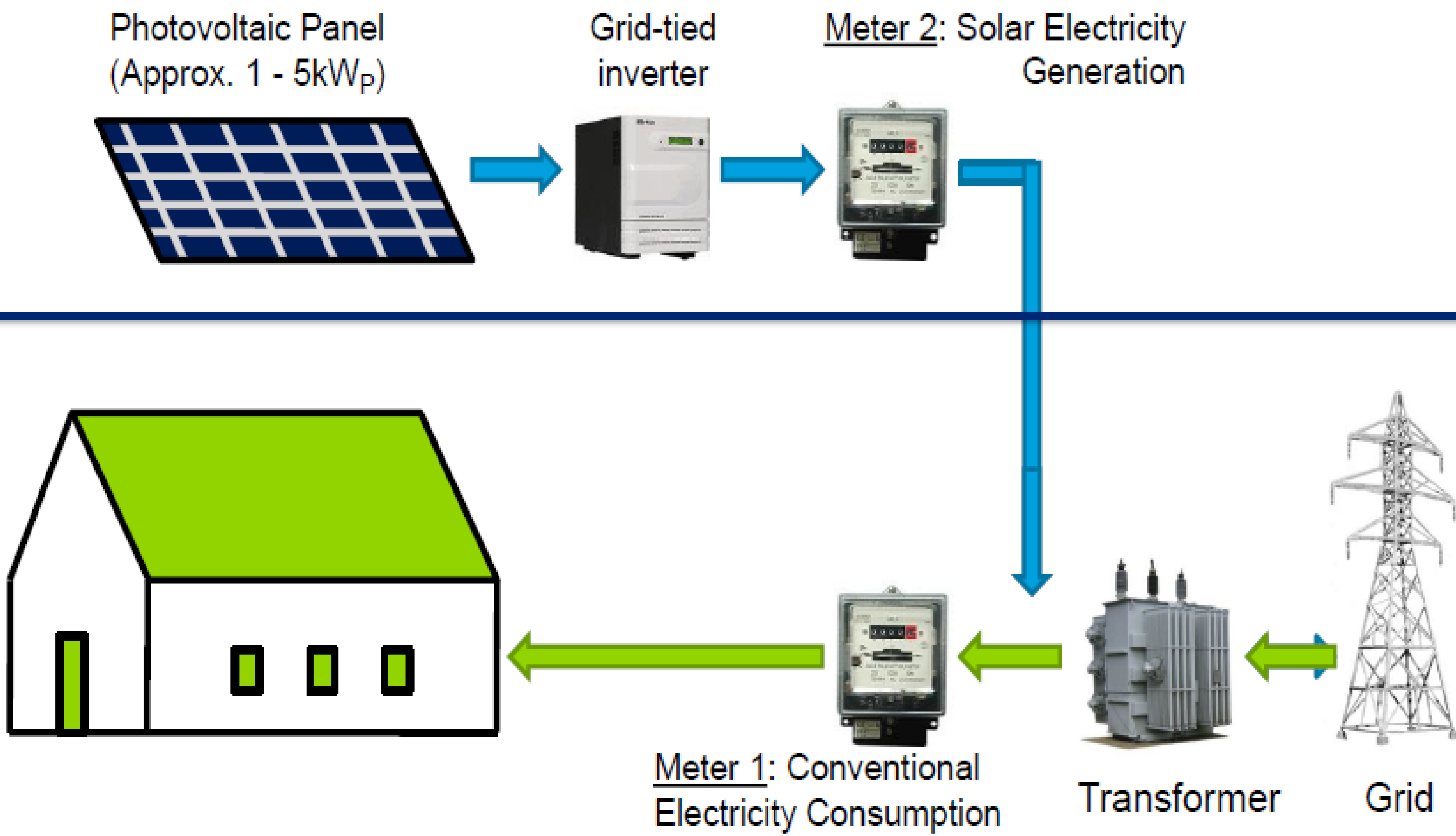
Solar Energy

- Limitless
- Clean
- Everywhere
- Free

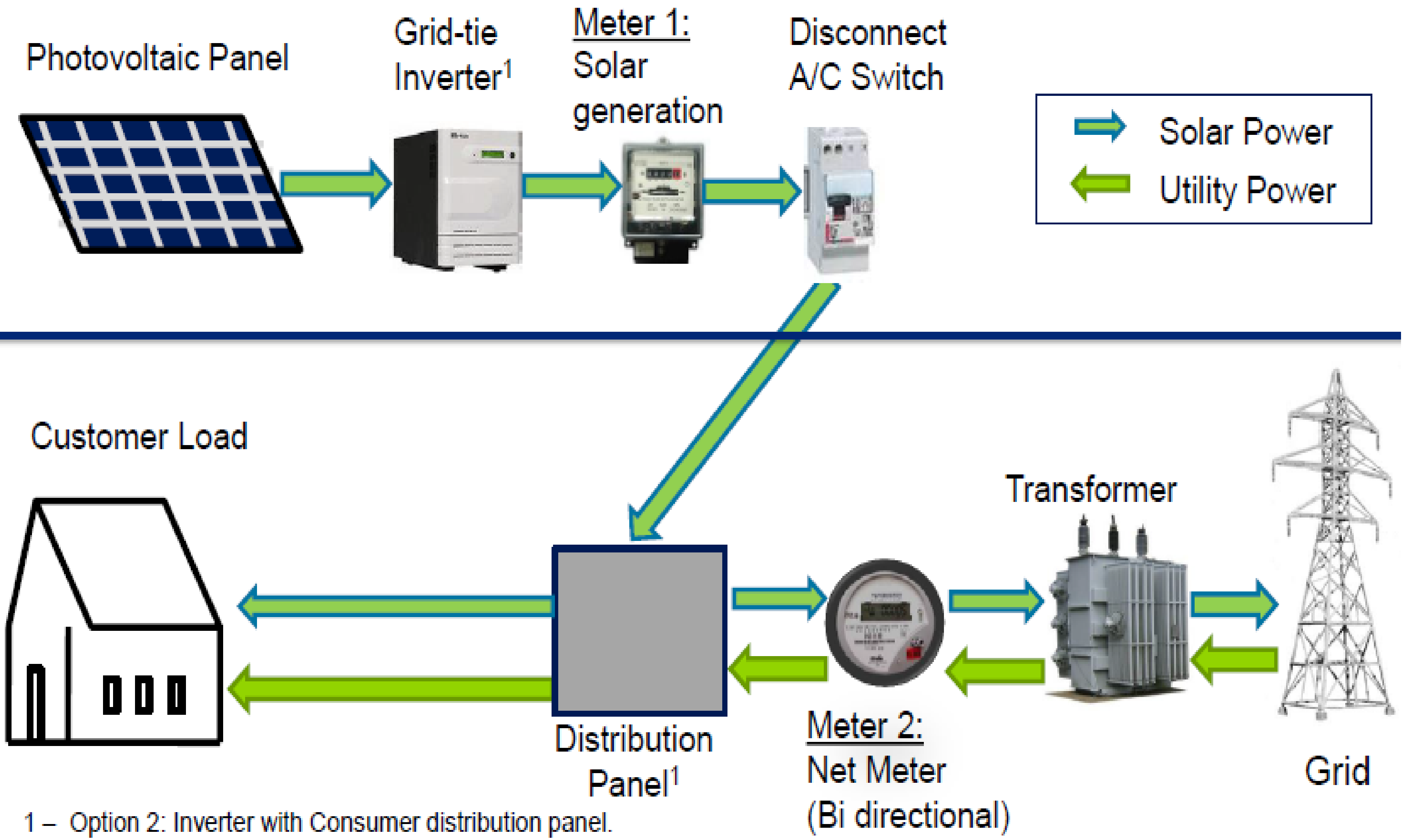
Contents of this presentation……

- **Rooftop Solar PV: Introduction and schemes**
- **Issues related to Connectivity**
- **Issues related to Metering Arrangement**
- **Way Forward**

Gross Metered Rooftop solar

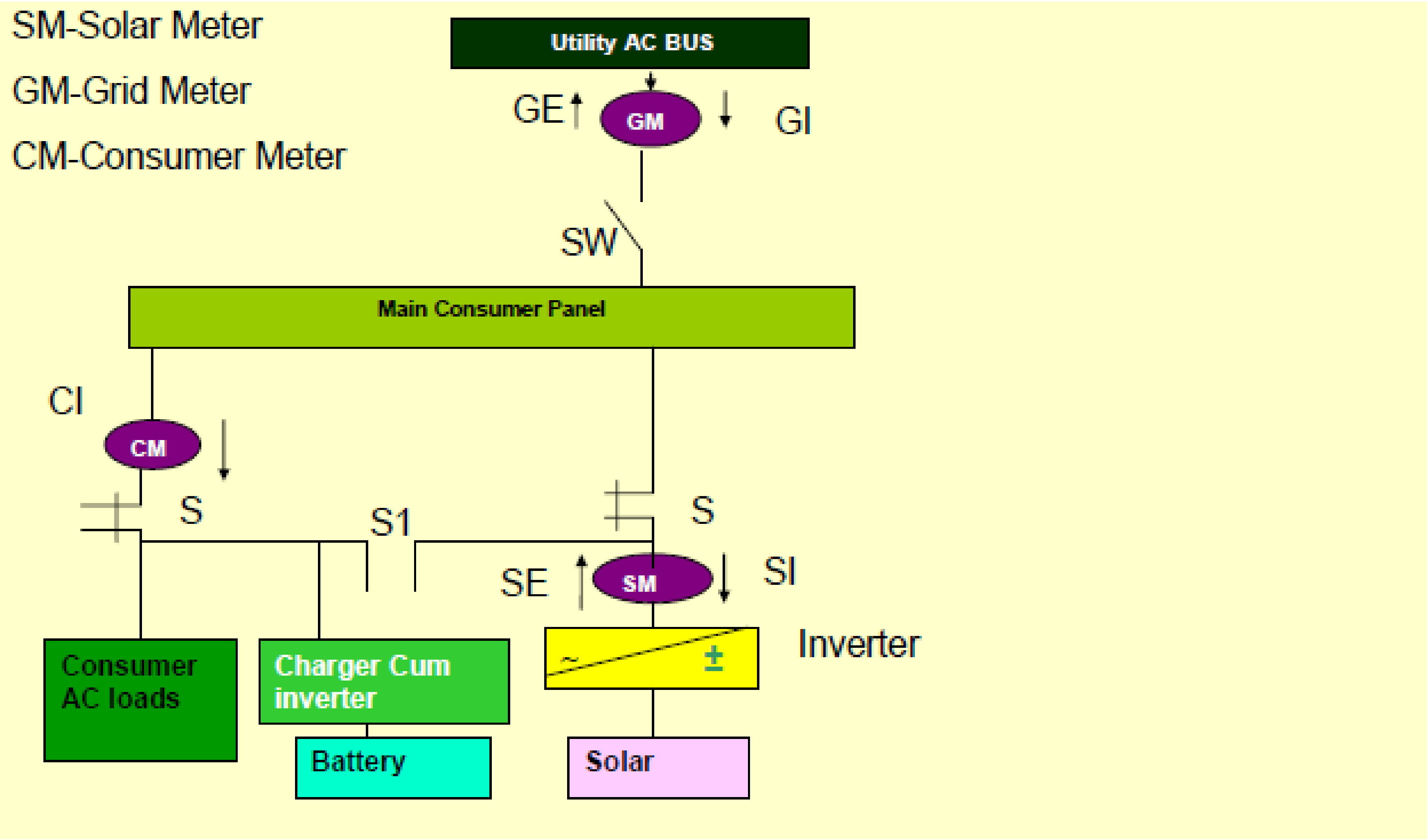


Net-Metered Rooftop solar

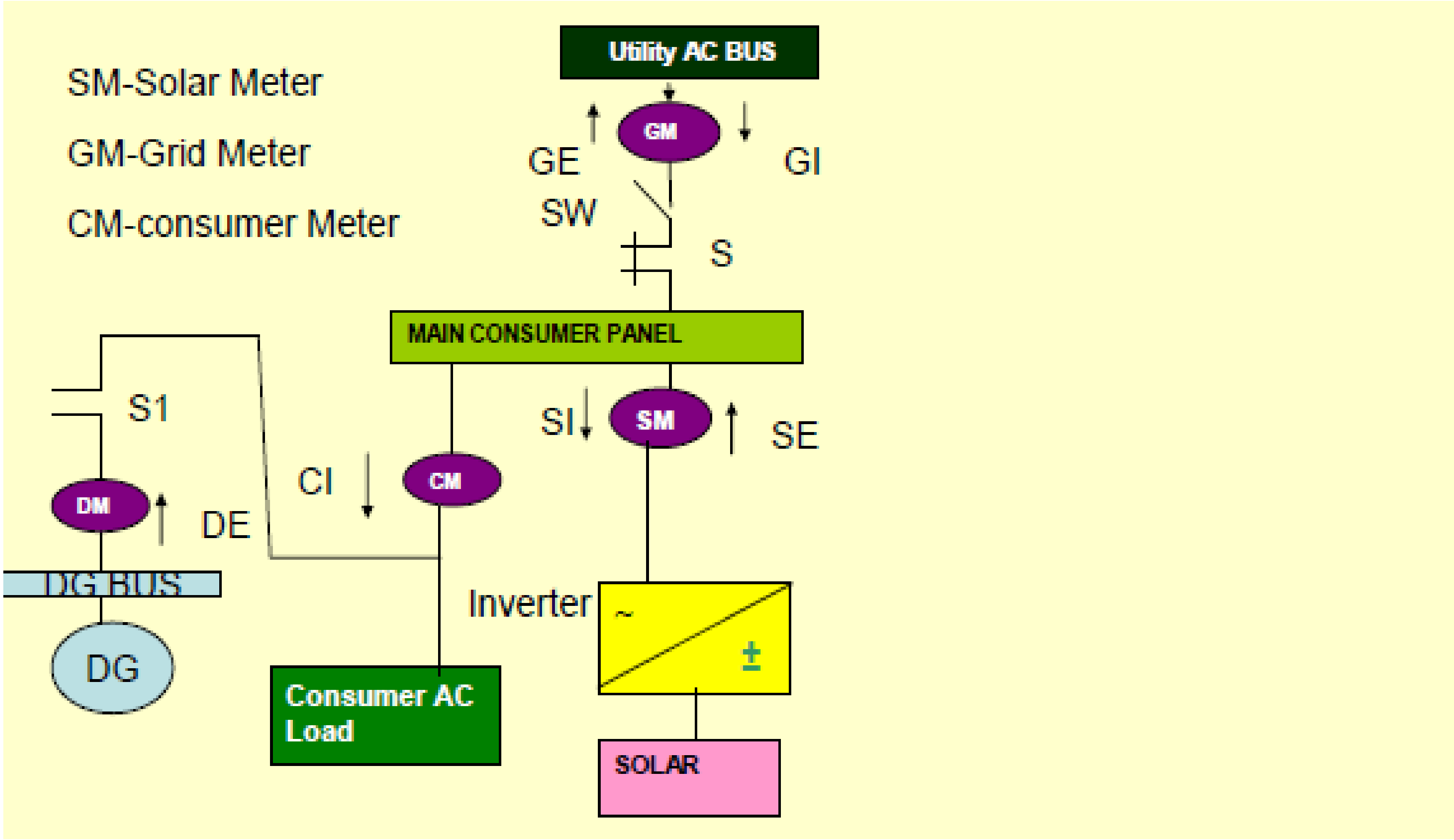


1 – Option 2: Inverter with Consumer distribution panel.

Grid Interactive Solar PV System With Full Load Battery Backup



Grid Interactive Solar PV System With Full Load DG Backup



Grid Connected Solar Energy Project Development

Globally, grid-connected solar project has followed 2 broad routes:

- **Utility driven solar project development:**

Large MW-scale centralized solar projects developed to meet renewable purchase obligations (RPO) of the utilities – either developed by utilities themselves or by third parties for their procurement.

- **Customer driven solar project development:**

Small-scale decentralized projects developed by electricity consumers on their own premises. Interest fueled by the declining cost of solar energy, fiscal incentives like feed in tariffs (FiT's), net metering and tax rebates, coupled with the increase in the cost of grid based conventional energy. Several hybrids of the above routes have emerged in specific markets, depending on the regulations, market opportunities and role of intermediaries. These are roof tops and BIPV opportunities.

Roof top Solar Power

The Concept

Every building whether home, industry, institution or commercial establishment can generate some solar power by installing PV panels on the roof top. Sometimes this can be a BIPV(building integrated).

Some Key Benefits

- Photovoltaic roof-top installations at the tail-end of the grid can enhance grid-stability and reduce losses
- Savings in land requirement and costs
- Savings in development of new transmission infrastructure
- Creation of value from under-utilized /unutilized rooftops
- Good choice for distributed power generation system
- BIPV can enhance esthetics of buildings

Benefits of Roof top PV

At national level, reduces requirement of land for solar Power. It reduces need for additional transmission infrastructure

For consumers, it

–Reduces the dependency on grid power.

–Mitigates diesel generator dependency.

–Long term reliable power source.

For Discoms, it reduces

–Day Peak load Demand

–T&D and conversion losses as power is consumed at the point of generation.

Most suitable for commercial establishments

–Max generation during peak usage time.

–Solar power cost is close to the commercial power cost.

–Solar power cost is fixed for 25 years

Concerns with Rooftop PV

Power quality: DISCOMs are apprehensive about the quality of the power being injected into their distribution grids. This is mainly to do with flicker, harmonics and DC injection.

Safety: Utilities are rightly concerned about the safety of their personnel, especially while working around the possibility of the formation of an unintentional island from the operation of the distributed solar PV systems.

Low voltage distribution grid: They are also concerned about the impact on the LV distribution grid (voltage levels, power factor, higher wear and tear of equipment, etc.) from high penetration of a large number of distributed solar generators.

Transaction Costs: Another logistical worry for utilities is the significantly higher transaction effort in terms of metering, inspection and certifications.

Two Significant Classes of Concern

Technical: Grid-integration challenge with likelihood of

– Reversal of power flows across the LT network.
– Breach of voltage regulations with tail-end generation feed
– Erratic behavior of LV protection systems

Commercial: Utility likely to have certain valid long-term concerns

– Loss of consumers / reduction in revenue in net-metering / captive operation
–Regulators don’t often factor in / compensate for the cost of grid support provided to distributed generators

JNNSM (Jawaharlal Nehru National Solar Mission):

The target capacity of rooftop projects under JNNSM Phase II is 200 MW (100MW for2013-2014, 100MW for 2014-2015).

SECI :Total capacity 10 MW distributed among 6 major cities. The bid received good response in cities like Bangalore and Chennai and not so well in others. The selection will be based on lowest offered price.

Small grid connected rooftop PV plants (2 MW or less capacity, grid connection at < 33kV) are supported under the **RPSSGP** (Rooftop PV and Small Scale Generation Programme).

IREDA selected 78 rooftop projects of a total capacity of 98 MW from 12 states (Rajasthan, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Maharashtra, Odisha, Uttar Pradesh, Punjab, Haryana, Uttarakhand, Chhattisgarh and Jharkhand). As of September 2012, about 88 MW [Ref: JNNSM phase II document] of this 98 MW capacity

The mission's phase II has updated initiatives for off grid projects (25-100 kW), which now include:

- MNRE's 30% capital subsidy. With updated benchmark costs, this is Rs. 81/W for systems with battery backup and Rs. 57/W for those without.
- Promoter's equity should be at least 20% and the rest can be financed at the low subsidized interest of 5%/annum. The loan repayment is still 5 years.

State-level policies:
Certain states have also announced their own solar policies with initiatives for rooftops.

Gujarat: Gujarat already has 1.39 MW of rooftop capacity installed in Gandhi Nagar. It recently announced a rooftop scheme for development of 25 MW in 5 other cities. The DISCOMS will pay a feed-in-tariff for 25 years.

T**amil Nadu:** TN's solar policy 2012 includes a rooftop capacity target of 350 MW. In three phases of 100, 125 and 125 MW (per year), a total of 350 MW is to be developed during 2012-2015. Of this 50 MW is targeted from domestic customers who will receive a GBI of Rs. 2/kWh for the first two years, Rs. 1/kWh for the next two and Rs. 0.5/kWh for the subsequent two years. The remaining 300 MW will be from government buildings and government schemes for rural and urban lighting. It is first of its kind to announce GBI for rooftop projects.

Rajasthan: Rajasthan's policy 2011 aims to promote rooftop projects via RPSSGP as well as another 50 MW through 1 MW capacity plants selected through competitive bidding.

Kerala: Kerala launched its 10,000 rooftop power plants programme for 2012-2013. With each applicant eligible to apply for 1 kW only, the total capacity target is 10 MW. Due to the small per capita limit; the target audience will be only households and small cottage industries. Apart from the MNRE's 30% capital subsidy, the state is offering a discount of Rs. 39,000.

Haryana: Haryana's solar policy targets commercial and industrial entities. It has approved two pilot projects of 100 KW with a financial assistance of Rs. 75 lakhs each.

Karnataka: Karnataka's Solar Programme of 2009 targeted 25,000 Solar Roof Tops of 5-10 kW with net metering during next 5 years. So the total capacity potential is 250 MW. It has very recently (Jan 2013) released a tender for 1.3MW through 0.5-1kW household solar systems across some 1943 houses in several cities. The total tender cost was specified as Rs. 34 Crores.

Chhattisgarh: Chhattisgarh also mentioned in its recent solar policy (2012-2017) that rooftop plants can be setup under supported types of power generation plants. The total grid connected capacity target was 500-1000 MW by 2017, comprising of grid connected (which includes rooftops) and REC projects.

Largest Rooftop Solar PV Plant on a Single Roof Punjab 7.52 MW

Installed on rooftop made of asbestos sheet of area 94,000 sq. m.

Commissioned in June 2014

Experience in Other Countries

Key components for development of rooftop solar PV programmes	Germany	Japan	California
Incentive structures	• FIT, periodically updated	• Capital subsidy, Renewable Purchase Obligation	• Capital subsidy , tax credits, rebates
Long-term project viability	• Long-term FIT guarantee • Public participation in enhancing financing • Streamlined interconnection & permitting processes	• Soft financing • Streamlined interconnection and administrative approval processes	• Emergence of third-party service providers who take on the risks associated with the development and performance of the system
Metering arrangements	• Gross metering till now • Piloting net metering	• Net metering	• Net metering
Implementation (business) models	• Income from preferential tariff	• Savings in electricity bill	• Savings in electricity bill for rooftop owners • Lease payments and tax benefits to project developer or owner
Reasons for Programme Structure	• FiT's (gross metering) to encourage solar project development independent of the captive load of the consumers	• Higher retail tariffs & promotion of captive consumption were the key factors for choice of net metering	• Use of the net metering mechanism allowed regulators to facilitate the development of decentralised solar systems without significant cooperation from electricity utilities

Issue : Connectivity

- Issue: CEA regulations on connectivity do not recognize roof top connectivity at low voltage (say at 230V/415V) in the internal network of consumers connected at higher voltage level.
  - This is evident from the following definition of Draft CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulation, 2010:

"(9) ***"Interconnection point"*** *means a point on the electricity system, including a substation or a switchyard, where the interconnection is established between the facility of the Applicant and the electricity system and where electricity injected into the electricity system can be measured unambiguously for the Applicant;"* - This constraint is also amplified by various petitions filed by developers before SERCs

Central Electricity Authority has notified connectivity norms dated 30.09.2013

Issue : Connectivity.........cont.

Advantage of connecting at LT level:

- No need to step-up the solar inverter output (415 V) to HV levels (11 kV or above)
- Resulting into cost savings (transformers, switch gear etc.) and also avoid transformation losses
- Avoid line losses and achieve faster timelines for project implementation

Rooftop PV systems being smaller in size (10-500kW) likely to be connected to the grid at the distribution network at lower voltages (LT) like 415V level where it is to be consumed

Roof top Connectivity……. Need for clarity

- **CEA (Technical Standards for connectivity of the Distributed generation resources) Regulations need to address:**
  - What should be the appropriate voltage level for connectivity
  - Norms for capacity (kWp) restrictions for connectivity at each voltage level
  - Connectivity at LT level, even though consumer connection at HT /EHT

Classification of Photovoltaic system in Gujarat:

System Size	System Type	Evacuation Specification	Applicable Tariff
1 kW – 5 kW	Rooftop	230 V, 1 ϕ, 50 Hz	Kilowatt-scale Photovoltaic Tariff
5 kW – 100 kW	Rooftop	415 V, 3 ϕ, 50 Hz	
100 kW – 1MW	Rooftop/ Ground-mounted	11 kV, 3 ϕ, 50 Hz	Megawatt-scale Photovoltaic Tariff
1 MW – 4 MW	Ground-mounted	11 kV, 3 ϕ, 50 Hz	
> 4 MW	Ground-mounted	66 kV, 3 ϕ, 50 Hz	

Source: http://www.gercin.org/discussionpdf/en_1320228496.pdf

Uniform technical standards across states

Voltage (Volts)	State	240	240/415	415	11,000	11,000/33,000
System size (kW)	Gujarat	< 6		6-100	> 100	
	Uttarakhand	< 4		4-75	75-1500	1500-3000
	Tamil Nadu		< 4	4-112		> 112 (HV/EHT)
	Delhi (draft)		< 10	10-100		> 100 (HV/EHT)
	Kerala	< 5		5-100	100-3000	
	Punjab (draft)	< 7		7-100	>100	
	Karnataka	Up to 5		5-50	> 50	
	West Bengal	LV or MV or 6 kV or 11 kV or any other voltage as found suitable by the DISCOM				
	Chhattisgarh			50-100	100-1000	
	MNRE[166]	Up to 10		10-100		100-500
	SECI Scheme		Up to 10	10-100		> 100 (incl 66 kV)

Status of Grid Connected SPV Rooftop Projects Sanctioned to States/UTs/SECI/PSUs and Other Government Agencies

As on 31.12.2014

Sl. No.	State/UTs	Projects Sanctioned under MNRE Scheme to SNAs/State Deptts. (MWp)	Projects Sanctioned/Implementation Under NCEF					Total Sanctioned (MWp)	Achievements		
			NCEF - I BY SECI (26.6 MWp)	NCEF - II BY SECI (50 MWp)	NCEF-III BY MNRE to SNAs (54 MW)	NCEF -IV By MNRE to MGAs** (52 MW)	NCEF-V BY SECI to Ware houses (73 MW)		Under MNRE/ NCEF/ SECI (3 - 8)	Through their own resources*	Total
1	2	3	4	5	6	7	8	9	10	11	12
1	Andhra Pradesh	5.5	2	3.5	4	0	0	15	2.37		2.369
2	Bihar	0	0	1	0	0	0	1	0.00		0
3	Chhattisgarh	0	2.05	0	5	0	0	7.05	0.80		0.8
4	Chandigarh	6.06	0.5	0	2	0	0	8.56	4.46		4.46
5	Delhi	0	2	2	8	0	0	12	0.00	3.07	3.07
6	Gujarat	5.75	0	2	0	0	0	7.75	0.00	9.75	9.75
7	Goa	0	0	0	2	0	0	2	0.00		0
8	Jharkhand	0	0	2	0	0	0	2	0.00		0
9	Haryana	0	2	2	5	0	0	9	1.13		1.13
10	Kerala	1.28	0	0	5	0	0	6.28	0.00		0
11	Karnataka	0	2	3	0	0	0	5	1.50		1.5
12	Madhya Pradesh	5	0.25	1	0	0	0	6.25	0.10		0.1
13	Maharashtra	0	2	5	0	0	0	7	0.67		0.67
14	Odisha	0	1	0	4	0	0	5	0.86		0.86
15	Punjab	5	0	2	0	0	0	7	0.00	7.52	7.52
16	Rajasthan	6	3.25	1	0	0	0	10.25	0.30		0.3
17	Tamil Nadu	6.74	5	5	5	0	0	21.74	4.40		4.4
18	Tripura	0	1	0	0	0	0	1	0.00		0
19	Telangana	0	0	0	4	0	0	4	0.00		0
20	Uttarakhand	5	0	0	2	0	0	7	0.00	1.8	1.8
21	Uttar Pradesh	2	1.5	3	5	0	0	11.5	1.08		1.08
22	West Bengal	0	1	0	3	0	0	4	0.63		0.63
23	Ministry of Railways	0	2.5	0	0	0	0	52.5	0.00		0
24	Pending Allocation by SECI under NCEF	0	1.05	17.5	0	52	73	143.55	0.00		0
	Sub Total[A]	48.33	29.1	50	54	52	73	356.43	18.299	22.14	40.439

* Own resources - 7.52 MWp in Dera Beas, Punjab and 1.80 MWp in IIT Roorkee

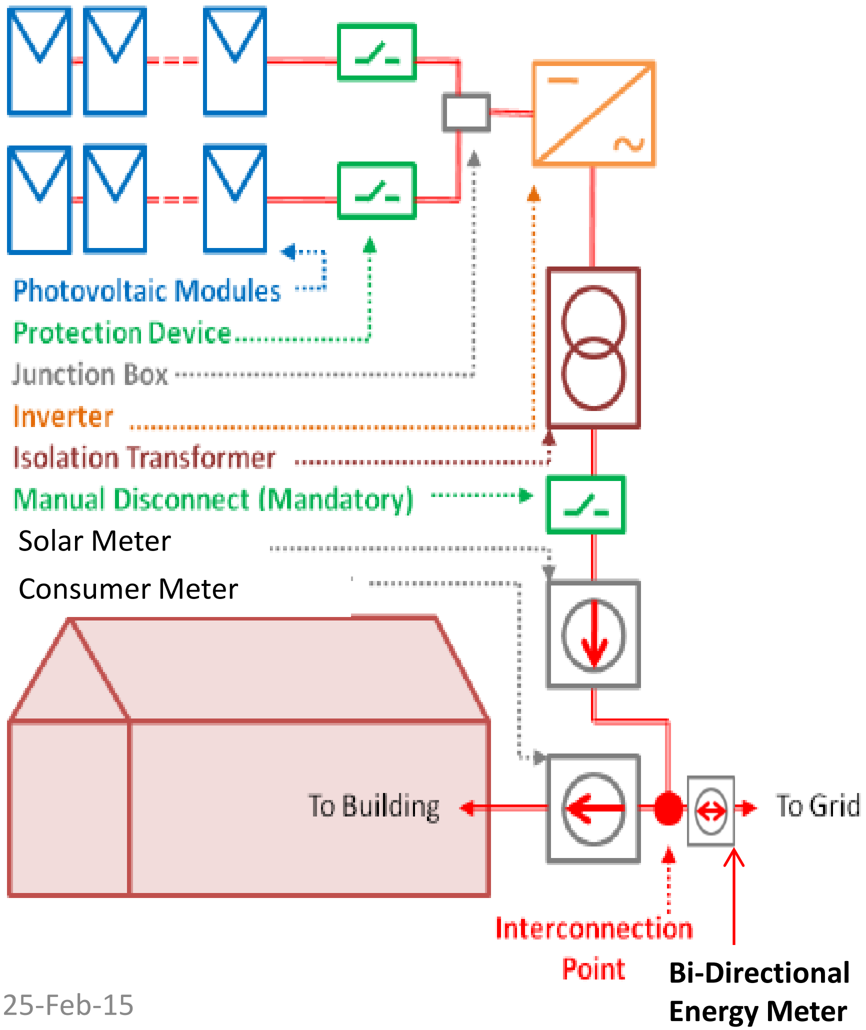
** Agency wise details given in Annexure

Issues relating to

Metering arrangement

Issue : Metering arrangements

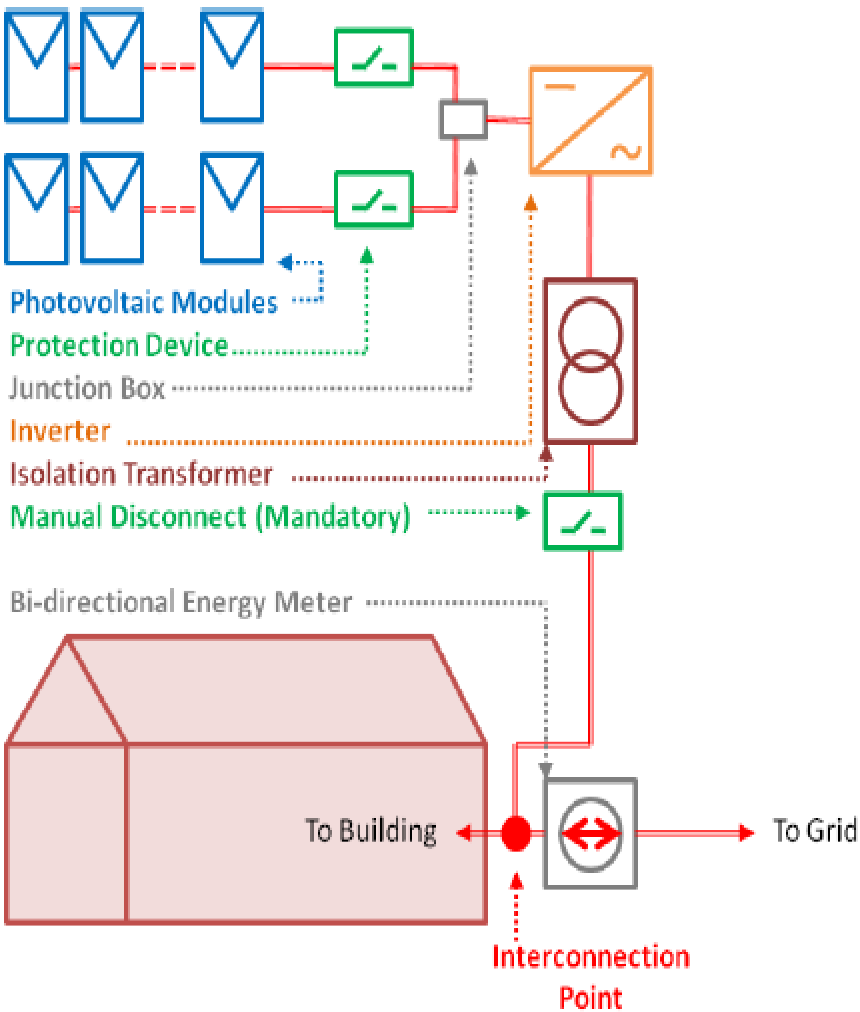
- **Connection philosophy of a feed-in meter interconnection system**



- The three-metering interconnection scheme is applicable where a separate feed-in tariff is allowed for feeding of solar electricity into the grid
- Energy is easily accounted for in this case through a dedicated feed-in meter (Solar Meter).
- Such schemes are popular in several European countries including Germany.

Issue : Metering arrangements

- **Connection philosophy of a net - metering interconnection system**



- **The net-metering scheme is applicable where conventional electricity and solar electricity are traded at the same tariff.**

- **As the cost of solar electricity is higher compared to conventional electricity, such a net-metering scheme has to be supported with additional subsidies to the Developer.**

- **Such schemes are popular in several countries including USA and Japan.**

Issue : Metering arrangements……..Cont.

Issue: CEA Regulations on Installation and Operation of Meters do not provide for metering arrangement of rooftop solar PV

- This is evident from the following provisions of the CEA (Installation and Operation of Meters) Regulations, 2006:
  - **Locations of meters**

    Generating Station : On all outgoing feeders

    Consumer Meter: Directly connected to any other system (Inter-State or Intra-State Transmission system): As decided by the Appropriate Commission
  - **Schedule: Meters shall meet the following requirements of Accuracy Class:**

    Interface meters : 0.2S

    Consumer meters : Up to 650 volts - 1.0 or better, Above 650 volts and up to 33 kilo volts - 0.5S or better
  - **Part II Standards for interface meters:** Interface meters suitable for ABT

Rooftop Metering arrangements ..Need for clarity

- **CEA Regulations need to incorporate appropriate metering system for rooftop PV and should clarify :**
  - Whether separate metering (Export/Import) arrangement or single meter with separate registry for Export/Import be insisted,
  - requirements for Main Meter/Check Meter/Standby meter, if any,
  - Metering Location,
  - Meter Accuracy Class for Consumer meter, Solar meter and Discom interface meter
  - Meter type,
  - Meter Sealing
  - Meter Reading
  - What facilities the meter should be capable of - data storage, ToD slot-wise, time-block, communication facility etc.

Key Challenges

–Grid Connectivity Issues

–Central Electricity Authority has notified connectivity norms dated 30.09.2013 –Some States like AP/Tamil Nadu/West Bengal have come out with connectivity norms

– Uniform technical standards across all states are required

– Penetration standards are required vis a vis the technology adoption on a long term basis

–Quality, Safety & performance standards

–Metering Standards and Net metering regulations

–Feed-in-Tariff for surplus power into the grid

–Commitment by DISCOMS to absorb surplus power

•RESCO model is being explored in addition to capex model.

–Awareness / Promotion in Tier II cities

"Rooftop Solar PV has huge potential and the government policies and regulations should be enabling to promote large scale deployment"

Inverter and power quality

The inverter is at the heart of the solar PV system ensuring power quality and grid integration. The three important technical parameters which can affect the quality of the power being injected into the grid are harmonics, flicker and DC injection. In each of these three parameters, existing CEA regulations follow global best standards (See Section 3.1) as noted below.

- Harmonics- IEEE 519, wherein THD < 5%
- Flicker- IEC 61000
- DC injection - IEEE 1547 standard, wherein the maximum permissible level is 0.5% of the full rated output at the interconnection point.

Our market survey shows that today's inverters are capable of meeting these standards, thus addressing the power quality concerns of distribution utilities.

WAY FORWARD

Amendments to the CEA's 'Technical Standards for Connectivity of the Distributed Generation Resources' Regulations, 2013

a. Modifications in existing voltage/frequency functions and new additional functions:

The CEA presently permits the system to function within a range of 80-110% of the nominal voltage, and between a 47.5-51.5 Hz frequency band.

b. Consider allowing intentional islanding:

An additional function of special relevance in India (with occasional black/brownouts during daytime) is 'intentional islanding'. This feature allows the solar PV system to disconnect from the grid in the event of a grid failure and continue to supply pre-decided critical loads on the consumer side of the meter[177]. This is possible in two ways, (a) the hybrid inverter works in an off-grid mode, and continues to charge batteries which power certain loads or (b) the inverter continues to function in grid-tied mode in synergy with the larger backup system, most likely diesel based generators. The second option is more feasible for larger

c. Distribution transformer level penetration:

Global experience indicates that a 15-30% threshold is a relatively conservative benchmark and that significantly higher penetration can be reliably integrated with existing technical solutions. **Hence the CEA should recommend SERCs to automatically allow distributed PV interconnections with a simplified approval process on a First Come First Served (FCFS) basis up to the threshold of 15-30%.**

d. **Advanced future inverter functions:** There are certain advanced inverter functionalities[181] (such as limiting maximum power output, providing status and measurements on current energy and ancillary services, supporting utility commands to connect/disconnect, etc.), which can be useful for grid management in high penetration scenarios. Most of these advanced functionalities need communication protocols in place to communicate with the utility or power markets. Such communications possibilities also allow changing pre-set inverter parameters in response to changes in the power system. A committee headed by the CEA including utilities, manufacturers, developers, NCPRE, Central Power Research Institute (CPRI), etc. should critically look into all such advanced functionalities and recommend revisions to technical regulations from time to time.

e. **Testing:** Section 5 (8) (2) of the CEA regulations mandates measuring DC injection, harmonics and flicker prior to commissioning and once a year thereafter. This should be made applicable only above a certain project size (say > 100 kW).

Germany has no active permitting process for installations smaller than 30kW and does not require visits by the distribution grid operator or other local permitting authorities.

Distribution Grid Adaptations:

- Network reinforcement and increasing cable and transformer capacity, thereby directly increasing the grid's PV hosting capability
- Voltage control through On Load Tap Changer for MV/LV transformer and booster transformers along long feeders
- Reactive power support though Static VAR Compensators (SVC)

Consumer Side Adaptations:

- Additional inverter functions (LHVRT, LHFRT, power-frequency droop characteristics, reactive power support as a function of local voltage, etc.) supporting grid integration of distributed solar and providing grid support. "Advanced inverters can mitigate voltage-related issues and potentially increase the hosting capacity of solar PV by as much as 100%"[174].
- Reducing injection of solar PV power into the grid to overcome voltage and congestion issues through
    - increased self-consumption of PV
    - curtailment of power injected at PCC by limiting it to a fixed value
    - storage during periods of peak solar generation
    - load shifting through tariff incentives or demand response

Uniform technical standards across states

Solar system size and connection voltages

Certifications and inspections

Table 11: A possible framework for certification and testing

System size	0 - 10 kW	10 - 100 kW	> 100 kW
Equipment certificates, especially for inverters	Standard test certificate from accredited laboratory declaring conformity with CEA standards[184].		
System installation certificate (pre-commissioning)	Self-certification with appropriate declaration for safety.	Certified Energy Auditor/ Licensed Electrical Contractor/Self-certification for MNRE accredited channel partners (1A certification)	Certified Energy Auditor/ Electrical Inspector
Annual testing	NA	NA	Only for high penetration zones

Note: System owners would need to provide an appropriate declaration for safety with the

“What Matters for Successful Integration of Distributed Generation”:

As far as India is concerned, the CEA has not stipulated any penetration limit in its regulations. However some SERCs are specifying penetration limits in terms of a percentage of the DT’s rated capacity. Tamil Nadu mandates that the penetration of distributed PV into the grid shall not exceed 30% of the distribution transformer (DT) rated capacity while Delhi and Punjab have proposed 15% and 30% respectively 172. Kerala, on the other hand, had initially proposed a limit of 50% of the DT capacity but has finalized a different metric allowing up to 80% of minimum daytime (8am-4pm) load.

We need a uniform technical standards across all states

"In many cases, even when PV penetration is substantially above 15%, the supplemental studies do not identify any required system upgrades. There are many circuits across the United States and Europe with PV penetration levels well above 15%, where system performance, safety, and reliability have not been materially affected." [169]

Significantly higher penetrations are also being managed effectively. Germany presently has an installed capacity of 35,700 MW (as of December 2013). 65% of this capacity is at the LV level (230 V / 400 V) and 35% at the MV level (11 to 60 kV)[170]. More significantly, maximum instantaneous power provided by PV in comparison to the load between May and September (varying between maximum of 67.7 and minimum of 34.7 GW) has already reached 49%. However, since most of

Penetration

A larger penetration may be allowed, based upon DT capacity and on studies which assess anti-islanding ability, ground fault over-voltages (if generation is not effectively grounded), over-current device co-ordination and voltage regulation. Detailed loading, voltage profile and fault studies may need to be conducted based on the preliminary screening checks to further understand the impacts of distributed PV on the grid and its hosting capacity.

Intentional islanding

This intentional islanding feature is mentioned as a note in the CEA 'Installation and Operation of Meters', 2006 draft 178 amendment regulation released in 2013, but is omitted in the final CEA 'Technical standards for connectivity of the distributed generation resources', 2013 regulations.

Indian Rooftop Market Potential

- Market can be estimated as below:
  - Total households in India
    - % having flat, concrete roofs (pucca housing)
    - Area per average roof
  - Total institutional rooftops in India
    - % having flat, concrete roofs
    - Area per average roof
  - Total rooftop area suitable for PV
  - Size of one PV Panel
  - Potential – number of panels that can fit in total rooftop area
  - Power per panel
  - Total MW Potential = # of panels x power per panel
- The calculations are based on Census 2001
- An extra factor of 50% growth may be applied to above potential, to account for the growth until 2010

Roof top PV potential in INDIA

- According 2011 Census India is having
  - 330 million houses.
  - 166 million electrified houses.
  - 76 million houses uses kerosene for lighting.
  - 1.08 million houses are using solar for lighting.
  - 140 million houses with proper roof (Concrete or Asbestos / metal sheet).
  - 130 million houses are having > 2 rooms.

- Average house can accommodate1-3kWp of solar PV system.

- The large commercial roofs can accommodate larger capacities.

- As a conservative estimate, about 25000 MW capacity can be accommodated on roofs of buildings having > 2 rooms alone if we consider 20% roofs.

Conservative Estimate ~237GW Potential Market

Sl #	Customer	Loc	Grid Access	No. (in mn) (A)	% with concrete roofs (B)	Units with concrete roofs (A x B=C)	Rooftop Area (m²)/ unit (D)	Suitable for PV per roof % (E)	Suitable Area (mn m²) (C x D x E = F)	No. of panels (mn) (F/1.6= G)	Potential Market (GW) in 2001 (G x 0.23= H)	Potential Market (GW) in 2010 (H x 1.5= I)
1	Resi	Urban	OG	53	48%	25.6	65	30%	498	311	71.59	107.38
2	Resi	Urban	OFG	2.8	10%	0.3	50	30%	4	3	0.58	0.86
3	Resi	Rural	OG	55.1	25%	13.8	45	30%	186	116	26.74	40.11
4	Resi	Rural	OFG	82.6	16%	13.2	40	30%	159	99	22.86	34.28
5	Insti	Urban	OG	3.6	49%	1.7	150	60%	157	98	22.57	33.85
6	Insti	Urban	OFG	0.2	25%	0	130	60%	4	3	0.58	0.86
7	Insti	Rural	OG	2.8	35%	1	120	60%	71	44	10.21	15.31
8	Insti	Rural	OFG	1.2	28%	0.3	100	60%	20	13	2.88	4.31
Total						56			1,100		157.98	236.97

- *Calculations based on 2001 consensus*

Flush / Flat Mounting Options

Mounting options for all flat-roof types
Mounting options for all flat-roof types
Many solar rail and clamp mounting options
Gravel and tar roofs
Membrane roofs

Tilt-Up Penetrating Mount Options

Most popular tilt-up mount
Non-penetration options for membrane roofs
With or without thermal separation
Virtually any flat roof
Solar panel "roof penetrating systems"

Non-Penetrating Mounting Options

Low-cost ballast-mounted solar systems
Easy installation
No penetrations required
Consideration for all flat-roof solar projects

Building Integrated SPV (The art of merging)

- Power source
- Building material
- Reduced costs
- Decentralised generation of electricity
- Improved aesthetics

BIPV


SUNPOWER

Thank you!

Petition for connectivity and metering for rooftop solar project under REC mechanism at HERC.........1/2

Background: Emergent Ventures India Pvt. Ltd. (EVI) has filed a petition for connectivity and metering for rooftop solar project under REC mechanism in Haryana on 13.02.2012 as appropriate regulations /standards were not place.

Issues with the rooftop solar project:

- DISCOM not agreed to provide connectivity at 415 V internal grid of industry
- DISCOM did not provide clarification on connectivity and metering even after reminder of HERC
- State Nodal Agency suggested that metering guidelines need to set up by SLDC
- SLDC is yet to come up with procedure for metering captive power projects (which also includes rooftop solar project)

Petition for connectivity and metering for rooftop solar project under REC mechanism at HERC……….2/2

Prayers of the Petition:

- To specify a protocol for connectivity of the 250 kW solar rooftop plant into 415 V internal network and for injection of surplus electricity into the distribution system of DHBVN (local DISCOM)
- To approve the metering arrangement on LT side
- To consider the plea for the 250 kW rooftop plant for other similar cases as the same can be replicated in future and not as a unique case. This will encourage other industries/investors to develop solar rooftop systems in Haryana.

Present Status:

- DISCOM is yet to come up with their response for connectivity and metering for rooftop solar projects under REC mechanism
- During 1st hearing (on 5th July, 2012) is Respondent (DHBVN) requested for adjournment as they were not prepared with the response. HERC has asked to submit the response in next 10 days before hearing on 25th July.

MERC : Case 173 of 2011
Tata Power Renewable Energy Limited v/s MSEDCL.....1/2

- Tata Power Renewable Energy Limited (TPREL) developing a 500 kWp rooftop solar project on the roofs of Tata Motors manufacturing unit at Pimpri in Pune

- Tata Motors's Pimpri having connection at 220 kV

- Various options for connectivity
  - Option-1: Inter-connection to transmission system at 220 kV;
  - Option-2: Inter-connection to 22 kV MSEDCL Akurdi Substation (Distribution system); and
  - Option-3: Interconnection at 440 V internal dis. System of Tata Motors

- Cost implications at estimated cost of Rs 615 Lakh (Option-1), Rs 215 Lakh (Option-2) and Rs 35 Lakh (Option-3) (preferred option)

MERC : Case 173 of 2011
Tata Power Renewable Energy Limited v/s MSEDCL

- TPREL preferred Option-3 due to avoidance of line loss and faster timelines for project implementation
- Option-3 would entail addressing issues of grid connectivity, metering arrangement and energy accounting and settlement, which require clarity
- MERC directed that a Working Group may be formed to study the present policy framework for grid connectivity and off-grid policy framework for rooftop PV installations along with suitable metering arrangements, energy accounting issues
- CEA and MNRE representative are also part of working group