INDIAN SOLAR ROOFTOP: DEVELOPMENT AND CHALLENGES

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Centre for Science and Environment (CSE) Roundtable Meeting
German Energiewende – Lessons for India's Solar Rooftop Programme

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Outline

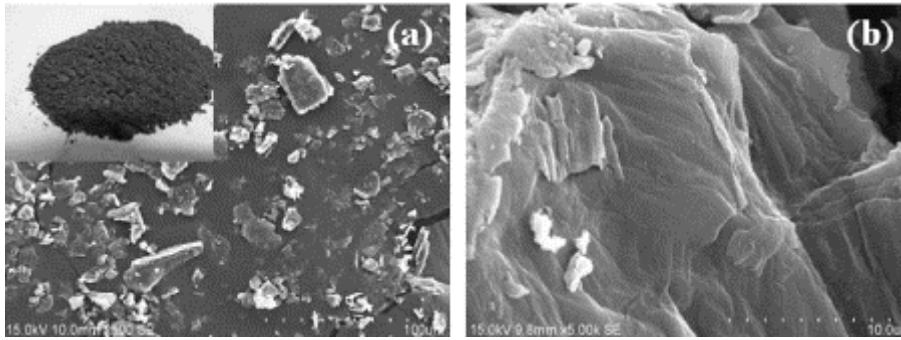
- Evolution of Rooftop PV models: Indian Perspective

- 5 MW Gandhinagar PV Rooftop Programme: Overview and Learning

- Policy, Regulatory and Implementation of a net-metering programme

About GERMI

1. Government Support
2. Industry Support
3. Applied Research
4. Fundamental Research
5. Higher Education
6. Professional & Vocational Training



Advantages of Rooftop Solar PV

- Social
  - Opportunity for consumer participation and investment
  - Higher employment generation and entrepreneurship options
- Technical
  - Low distribution losses
  - Last-mile support to grid stability, w.r.t. voltage & reactive power support
  - Creates case for smart grids
- Administrative
  - Widely accepted, Saves space
  - Lowest time to commission → technical and administrative
  - Lower investment in distribution infrastructure (for lower penetrations)
  - Can improve distribution grid capacity

Evolution of Rooftop Solar PV Installations for Gujarat

Model I: Capital cost borne by the Government

- Advantage:
  - Ease of implementation, and widely implemented.
- Disadvantage:
  - Ownership issues, and hence, maintenance suffers.
- Example: Most rooftop solar installations by various State Nodal Agencies (SNA).

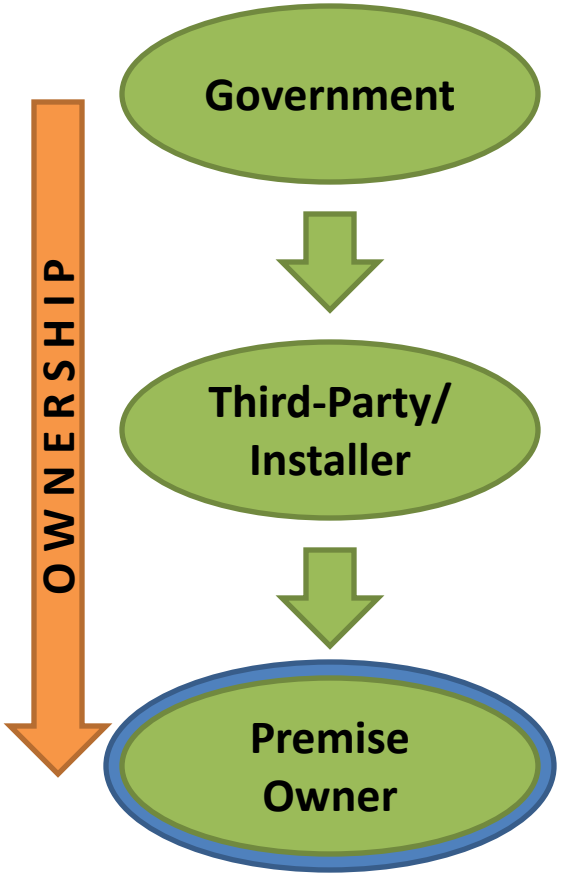
Model II: Public Private Partnership

- Example: 5 MW Gandhinagar Rooftop Solar Programme.
- Advantage:
  - Generation-based incentive ensures long-term utilization.
  - Government interaction with limited number of credible Developers.
  - Standard quality and optimization of PV installations.
  - No upfront cost to Government/ Utility.
- Disadvantage:
  - Property owners unwilling to sign long-term lease agreements.
  - Incentives from solar generation not enough compared to real-estate lease.

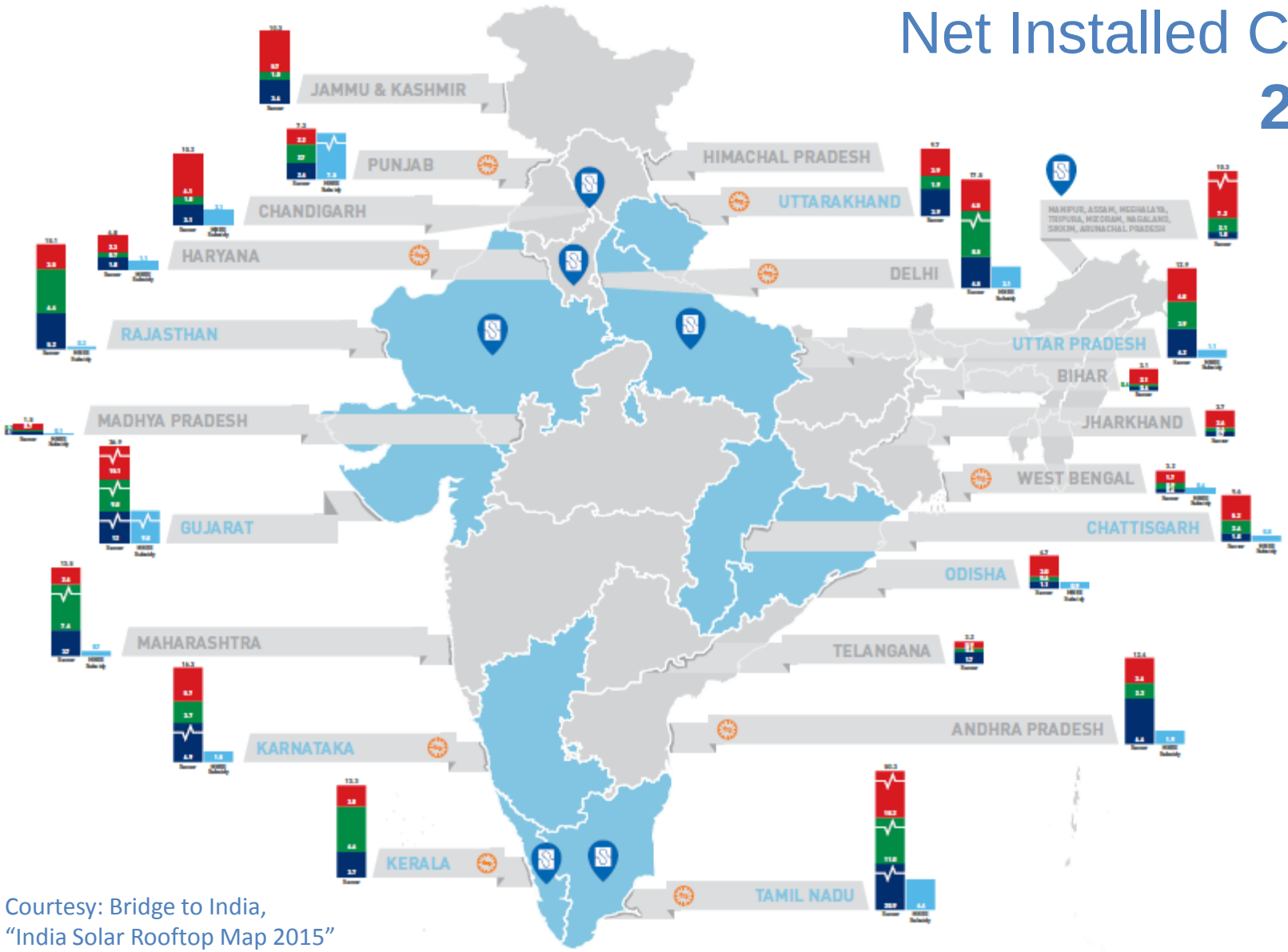
Model III: Individual Ownership (Proposed in Current Rooftop Solar Policy)

- Advantage:
  - Equal opportunity to smaller rooftop owners.
  - Ownership of individual is well-defined.
  - Investors reap the direct benefit of electricity and also become energy aware/ efficient.
  - Potential for widespread public deployment.
  - Model successful globally.
  - Other models (e.g. Third Party Ownership) are subsets.

- Challenge:
  - Investment expected from someone who does not understand technology.
  - Capital subsidies required to incentivize participation (under net-metering scheme).
  - Direct dealing of DisComs directly with Customers.



Rooftop Installations in India (Nov. 2014)



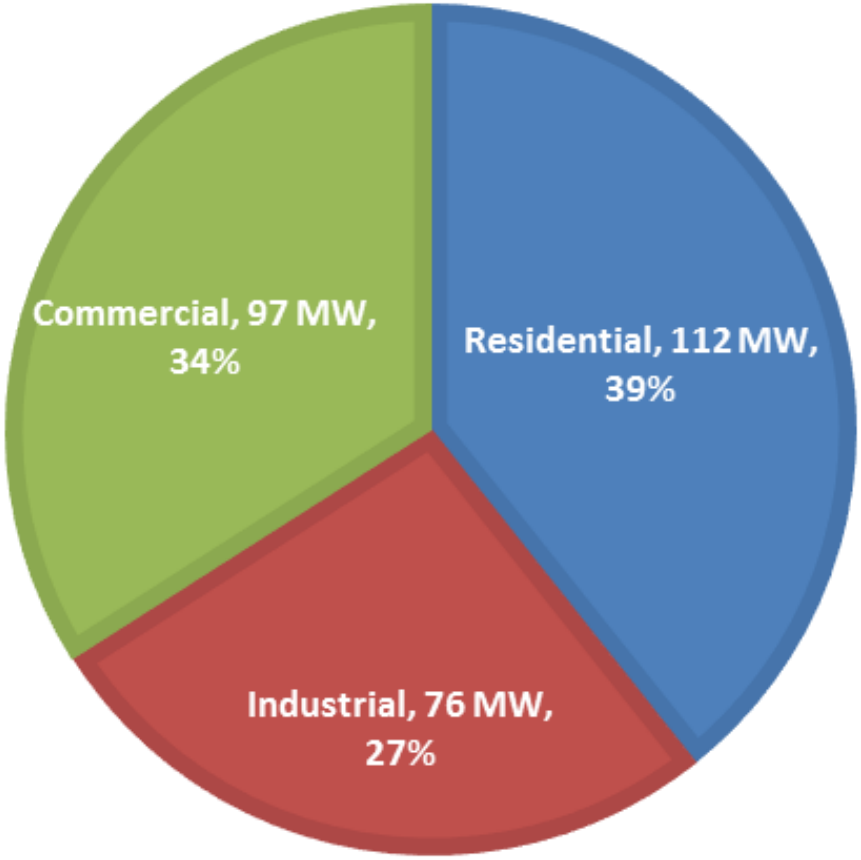
Courtesy: Bridge to India,
"India Solar Rooftop Map 2015"

Top 5 States

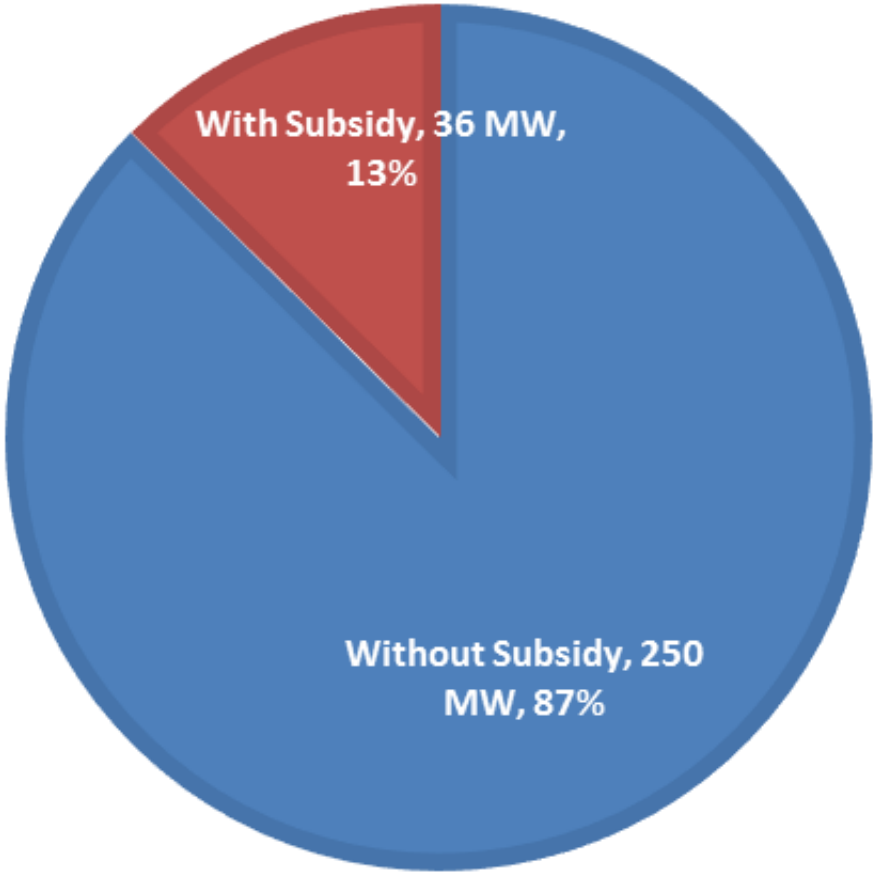
Sr.	State	Rooftop Solar Policy/ Regulation	Net-metering Policy	Capacity (MW)	Fraction
1	Tamil Nadu	Yes	Yes	50.1	18%
2	Gujarat	Yes	No	36.9	13%
3	Delhi	No	Yes	17.5	6%
4	Karnataka	Yes	Yes	16.3	6%
5	Rajasthan	Yes	No	15.1	5%
	Rest of India	-	-	149.1	52%
	TOTAL	**-**	**-**	**285**	**100%**

Courtesy: Bridge to India, “India Solar Rooftop Map 2015”

Rooftop Installation Split



Type of Roof



Influence of Subsidy

Courtesy: Bridge to India, “India Solar Rooftop Map 2015”

Gandhinagar Photovoltaic Rooftop Programme

- The Gandhinagar Photovoltaic Rooftop Programme (the "Programme") marks the first distributed power generation programme in India in its true sense.

- ***"Kilowatt-programme at a megawatt-scale"***

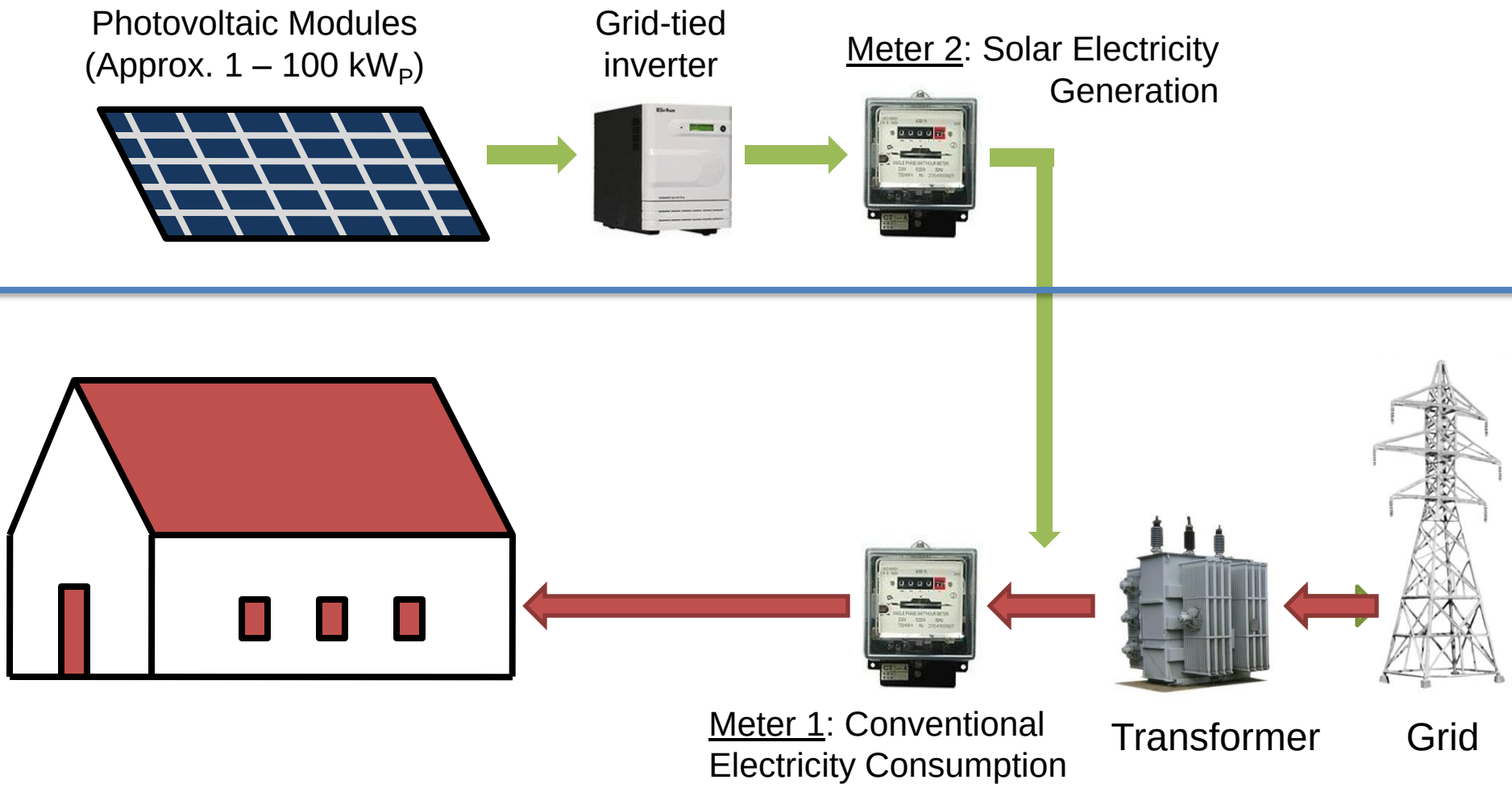
- **True <u>Public Private Partnership</u>**, brings together…
  - **Government**
  - **Developers**
  - **Regulators**
  - **Home owners**
  - **Utility**
  - **R&D**

Aim of Programme

- Gandhinagar Photovoltaic Rooftop Programme aims for…
  - net 5 megawatt of photovoltaic installations…
  - in distributed kilowatt-sized photovoltaic systems…
  - through a PPP mode…
  - to promote clean energy and energy security...
  - as a part of the Gandhinagar Solar City Initiative.

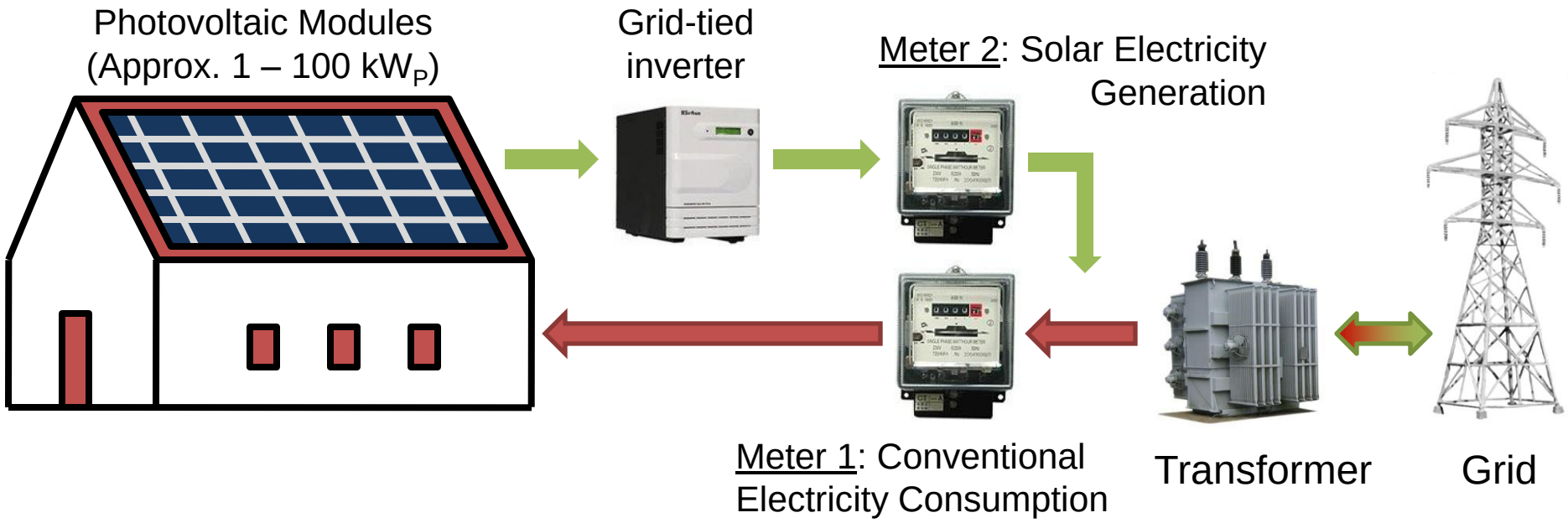
- Greater outcome of this pilot Programme:
  - Establish a practice/ philosophy of distributed solar and other energy generation.
  - Bring a level of comfort to all stakeholders for further scale-up.
  - Encourage public participation.

Typical PV System Architecture



Advantages of PV System Architecture

- Relatively simple to install, operate and maintain.
- Most popular and globally accepted configuration.
- Disadvantage: No availability when grid is down.



5 MW Gandhinagar Rooftop Solar Programme

The Math!

11.21 Quoted Tariff

11.14 Regulator's Tariff + 0.07 VGF

8.21 Realized Tariff + 3.00 Rent

Top 10 Deals of Asia Pacific (2012) - Infrastructure Journal

DisCom (Torrent Power)

Power Purchase Agreement (PPA)
Tariff determined by Regulator

Rooftop Solar Project Developer

Project Implementation Agreement (PIA)

GPCL (Govt. Agency) for Viability Gap Funding

Rooftop Lease Agreement @ Rs. 3/- per kWh

Rooftop/ Terrace Owner

Successful Developers

- L1: **Azure Sun Energy Pvt. Ltd. ("Azure")**
- L2: **Ananth Solar Power Maharashtra Pvt. Ltd. ("SunEdison")**
  - A subsidiary of SunEdison Energy India Pvt. Ltd.

	Azure	SunEdison
Quoted Tariff:	**Rs. 11.21 /kWh**	**Rs. 11.793 /kWh**
GERC Relevant Tariff:	Rs. 11.14 /kWh	Rs. 12.44 /kWh
Torrent pays:	Rs. 11.21 /kWh	Rs. 11.793 /kWh
GoG-PIA (GPCL) Pays:	Rs. 0.07 /kWh	---

Capacity Split

GERMI

Azure Power

Sector	No. of Installations	Net Capacity
Government	21	2,001 kW
Residential	161	501 kW
Total	**182**	**2,502 kW**

SunEdison

Sector	No. of Installations	Net Capacity
Government	17	1,685 kW
Residential	113	501 kW
Total	**130**	**2,186 kW**

TOTAL

Sector	No. of Installations	Net Capacity
Government	38	3,686 kW
Residential	274	1,002 kW
Total	**312**	**4,688 kW**

Installations under 5 MW Gandhinagar Programme



264.04 kW @ Jivraj Mehta Bhavan Nos. 1, 2 and 4, Sector 10-b

60.48 kW @ Lokayukta, Sector 10

80.61 kW @ Govt. Arts College, Sector 15

80.61 kW @ Govt. Arts College, Sector 20

PV Installation on J.M. Bhavan

PV Installation on J.M. Bhavan (2)

More Installations

Challenges

- How appealing is the Green Incentive?
  - What is the value of my roof?
- How appealing is the Third-Party Model?
  - Am I willing to sign a 25-year lease agreement?
  - Why can't I invest and get all returns for myself?
- Interdependency of Contracts and Financial Closure:
  - Lease Agreement → PIA → PPA.
- Implementation:
  - Coordination between Statutory Bodies, Regulator, Chief Electrical Inspector, DisCom, Building Owners/ Govt. Departments, Developer, Financer, Project Management, Social.

Implementing a Net-Metering Programme

Net Metering Policy
(State/ Central Government)

Net Metering Regulation
(State/ Central Electricity Regulator)

Implementation Process
(Local Distribution Company)

Participation (& Procurement)
(Consumer + Installer)

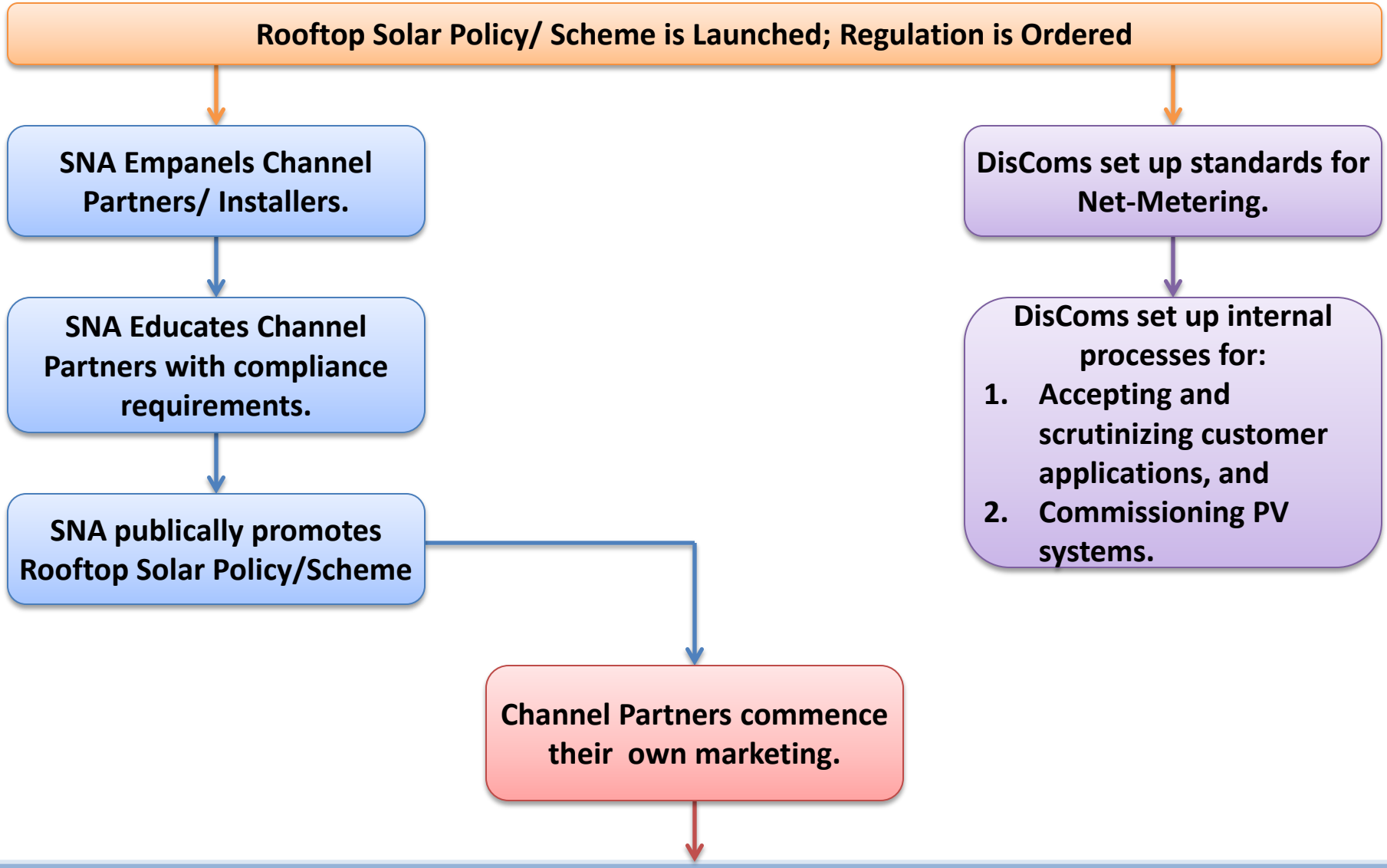
Installation
(Installer/ EPC Contractor)

Key Policy and Regulatory Aspects

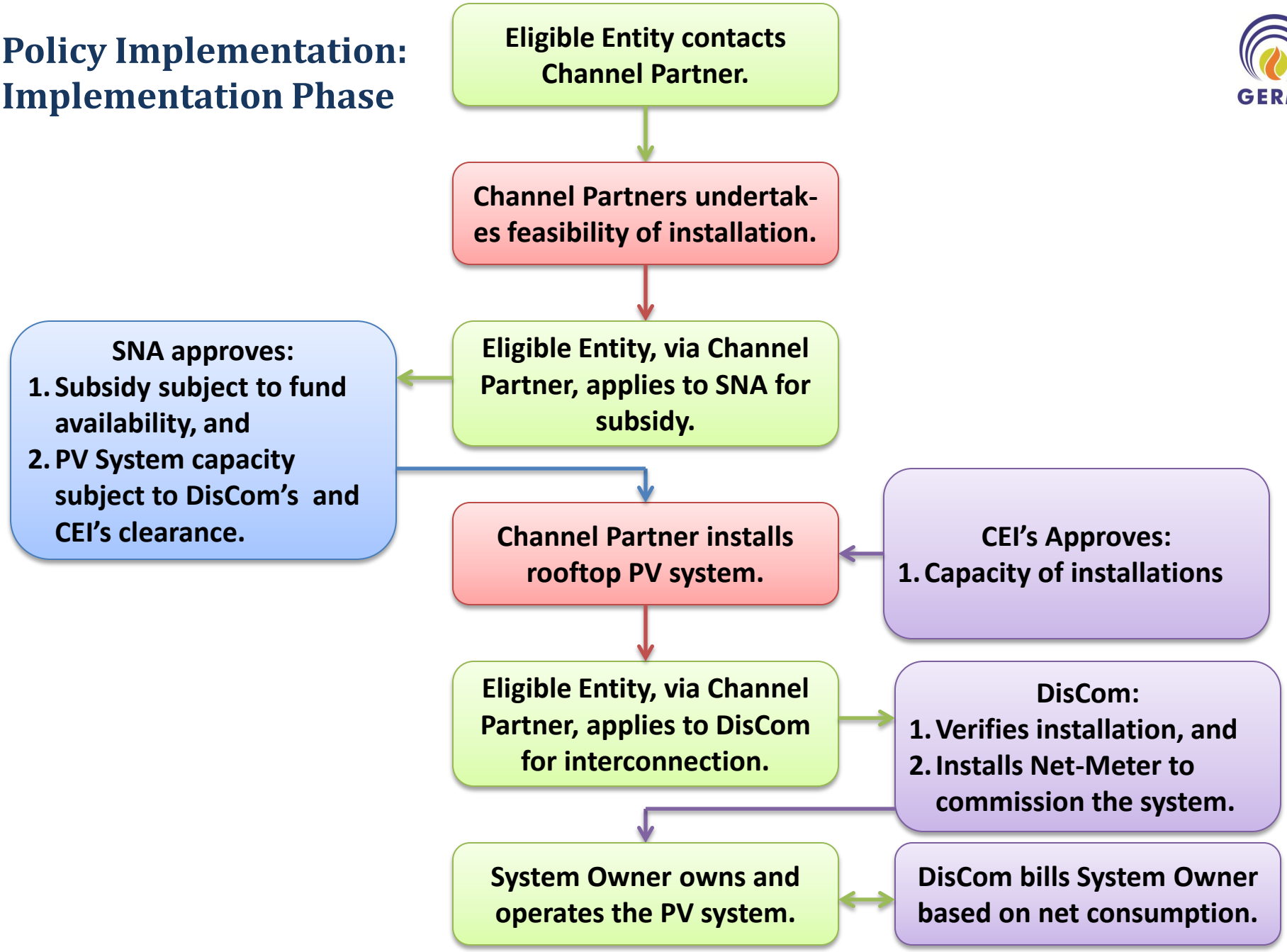
- Policy addresses…
  - Targets
    - Capacity in MW; RPO, etc.
  - Incentives
    - Capital subsidy, generation-based incentive, etc.
  - Any other promotion
    - Duty exemption, wheeling exemption, etc.

- Regulation addresses…
  - Capacity limit of an individual rooftop solar installation?
    - Any, less than sanctioned load, limited by DT, etc.
  - Treatment for surplus generation at the end of the billing cycle?
    - carried forward to next bill, purchased by DisCom at APPC/ retail tariff/ feed-in tariff, etc.
  - Timeline for implementation process

Implementation Methodology



Policy Implementation: Implementation Phase



DisCom's Specific Pre-Processes and Formats

Sr.	Activity	Format	Process
1	Budgetary Approval	Internal noting	
2	Shortlist (EPC) Installers	Tender	• Bid Process Coordination • Train Installers for standards and processes
3	Shortlist Third-Party Engineers (TPE)	Tender	• Bid Process Coordination • Train TPE for standards and processes
4	Publicity Campaign	Advertisement	• Communication

DisCom's Specific Processes and Formats

Sr.	Activity	Format	Process
5	Survey status of existing distribution transformers	Recording (in ERP?)	• Field survey
6	Accept an application for interconnection	Application form	• Train field staff • Technical vetting
7	Scrutinize application and approve	Synchronizing report	• Load & power flow study
8	Intimation of approval to Consumer	NOC for installation	• -
9	Accept application for commissioning	-	• Schedule commissioning inspection
10	Commissioning Inspection and Testing	Commissioning report by CEI	• Coordinate with TPI • Enter into ERP of DisCom

DisCom's Specific Post-Processes and Formats

Sr.	Activity	Format	Process
11	Bill Reading	ERP/ Format modification	• Train field staff
12	Billing	ERP Modification	
13	Rebates	ERP Modification	• Computation and payments
14	Dispute resolution	-	• -

Conclusion

- Rooftop PV is simple and well-established globally.
- The objective and scale of any net-metering programme have to be very clear upfront.
- The Electricity Act provides ample provision to undertake a net-metering programme.
- Well-defined implementation is key to success of a net-metering programme.

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