





Solar Energy: Technology, Management & Regulations

Presented at UPES Dehradun on 6th Oct 2017

Saswat Sourav Panda

Assistant Manager: Sales Operations

Sunshot Technologies Pvt Ltd, Pune

Cell: +91-9897780844

Email: saswat223@gmail.com

Website: www.pandasolar.weebly.com

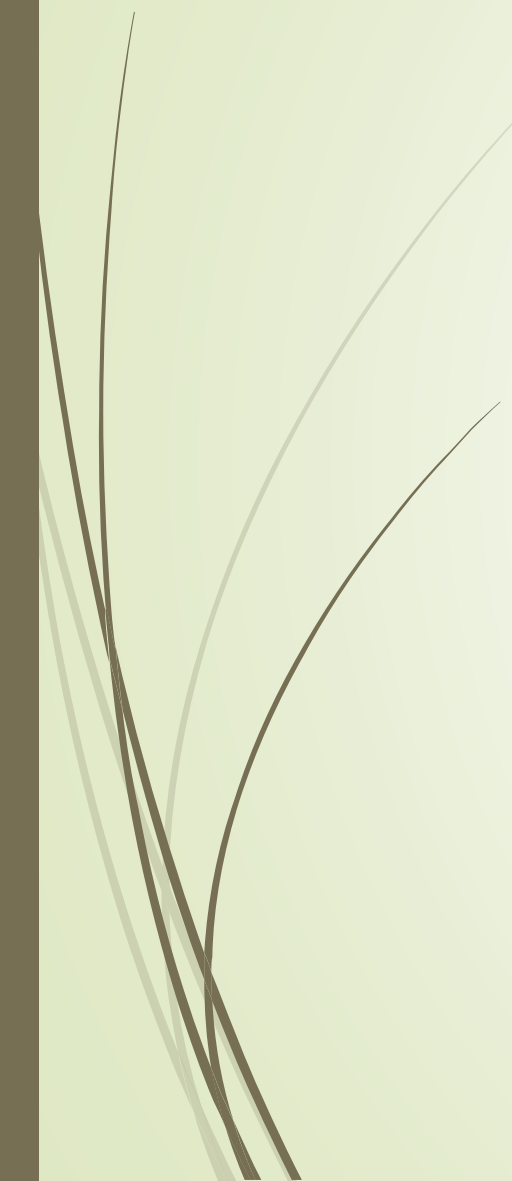


Objectives

- Introduction on climate Change, renewable energy, EV & Energy Storage
- Solar Energy technical & financial basics for MBA students
- Policy, Regulations & Acts
- Current Trends & Future Scenario
- Career & Entrepreneurship



Methodology

- PPT/ PDF on subject
 - Video reference
 - Q&A session
 - Industry Practice
 - Discussion
 - Feedback
- 

Day 1

- Energy Scenario
- Climate Change & Impact
- Solar Energy & Types
- Technology & Working
- Electricity Charges
- Module Manufacturing
- Recent News
 - Rewa Solar Plant
 - Anit-Dumping
 - Section 201
 - Net-Metering
 - SECI 1000 MW

Day 2

- Roof-top Solar Basic Concepts
- Roof-top Solar Evaluation
- Solar Financing (CAPEX & BOOT)
- Financial Calculations in excel
- Making a techno-commercial Offer
- Energy Storage, Electric Vehicle, Smart Grid & Monitoring
- FAQ's
- Starting a career
- Companies in solar

Roof-top Solar Life Cycle

- Lead Generation
- Site Visit & Technical Evaluation
- Basic Engineering Options
- Techno-commercial discussions
- Amendments to proposal & financial discussions
- Finalization of cost & system design
- PPA/ WO & PO
- Design Finalization & Approval, Procurement & Supply
- Installation
- Commissioning & completion of Punch points
- Project handover
- O&M
- Scrap

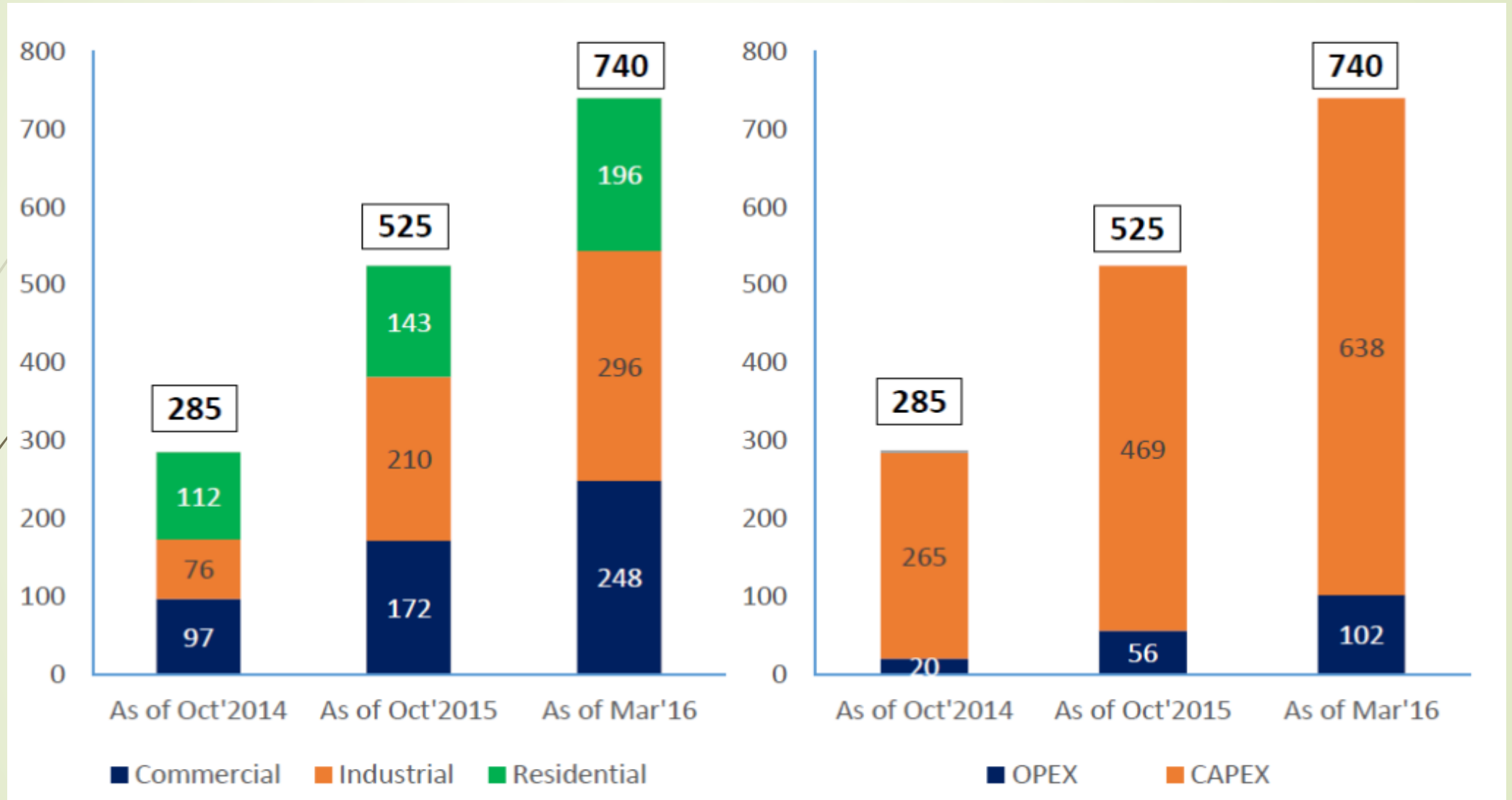
Roof-top Solar Basic Concepts

- Installed on roofs such as RCC, Metal Sheet, Curved Sheet, Asbestos, Traditional roofs, car park, etc
- More complex than ground mounted in terms of engineering & installation
- Suitable for roofs with structural stability

Advantages

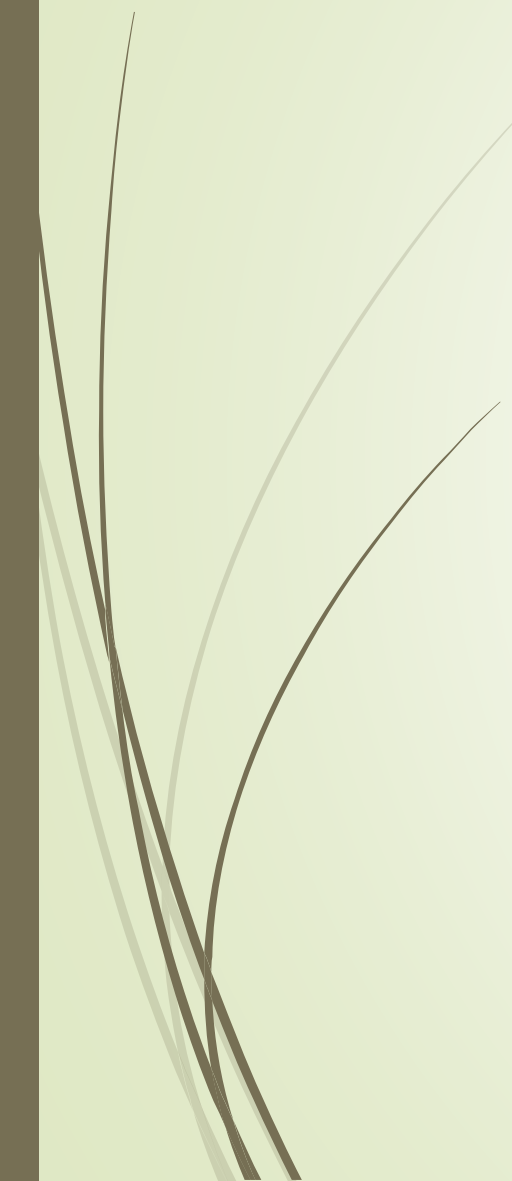
- Significant saving over the lifetime from the electricity cost
- Depreciation benefit
- Green power which reduces the carbon footprints
- Can be injected directly into existing LT panel without changes to existing system
- Minimum losses due to close proximity to consumption point
- Hassle free Operation & Maintenance

Installed Capacity





Financing Solar Projects

- ▶ solar PV capex / opex
 - ▶ production yield / monetization
 - ▶ project and equity IRR with and without debt
 - ▶ risk/reward characteristics that form the basis of finance
 - ▶ and recourse/non-recourse financing ideas
 - ▶ third-party ownership / solar-as-a-service (solar PPA, lease)
 - ▶ solar loans
 - ▶ solar securitization
 - ▶ peer-to-peer financing
 - ▶ yield-cost
 - ▶ solar financing for the poor/offgrid (eg: pioneered by Selco) etc
- 

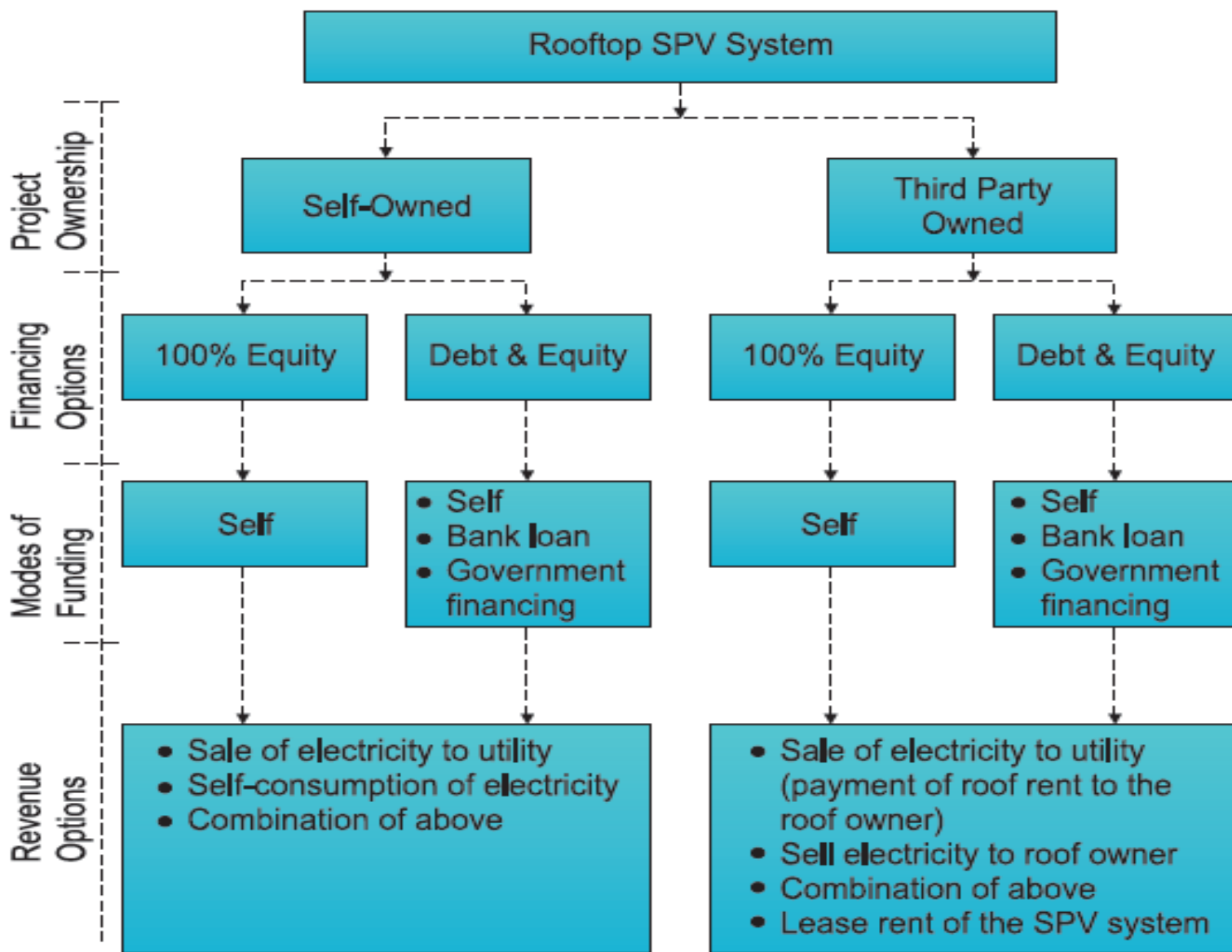
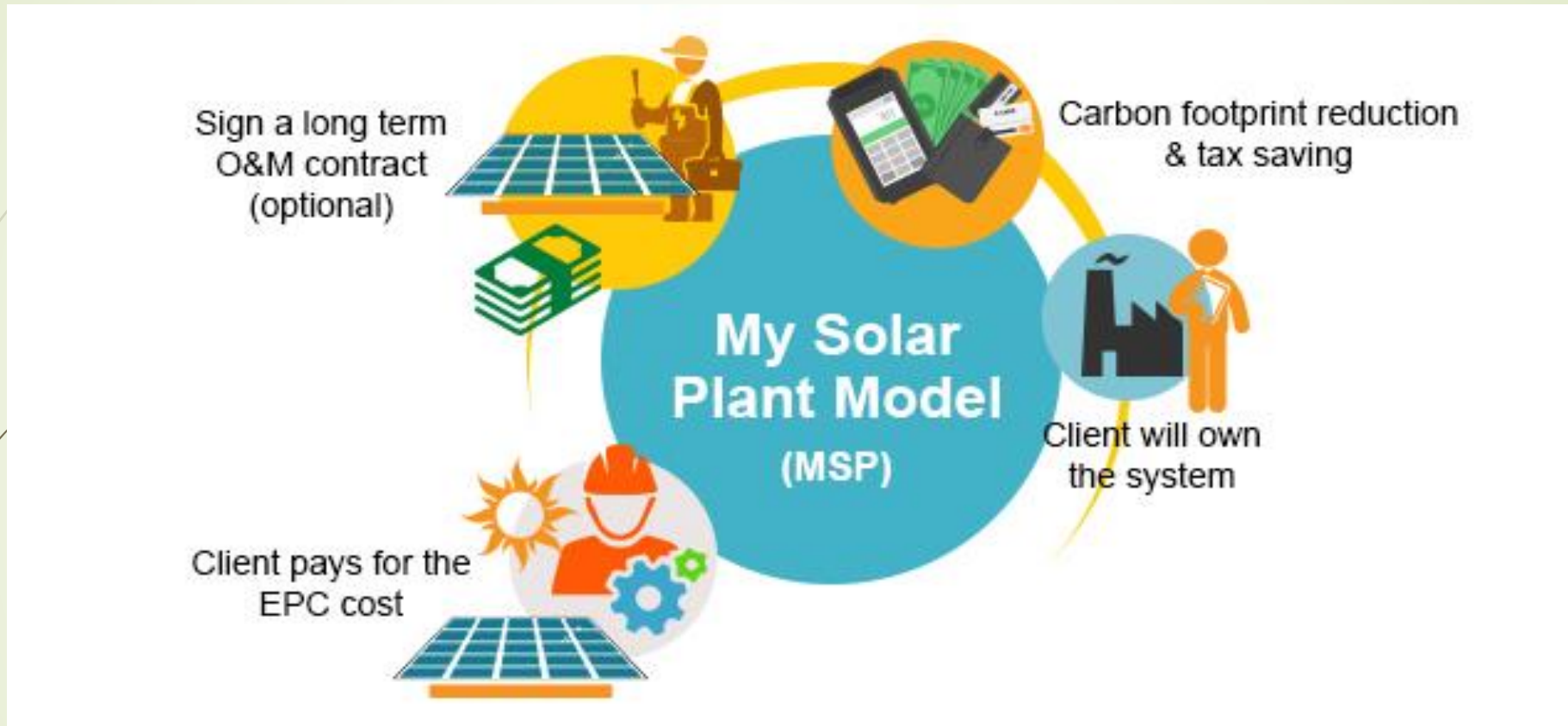


Figure 14: Different modes of financing based on system ownership

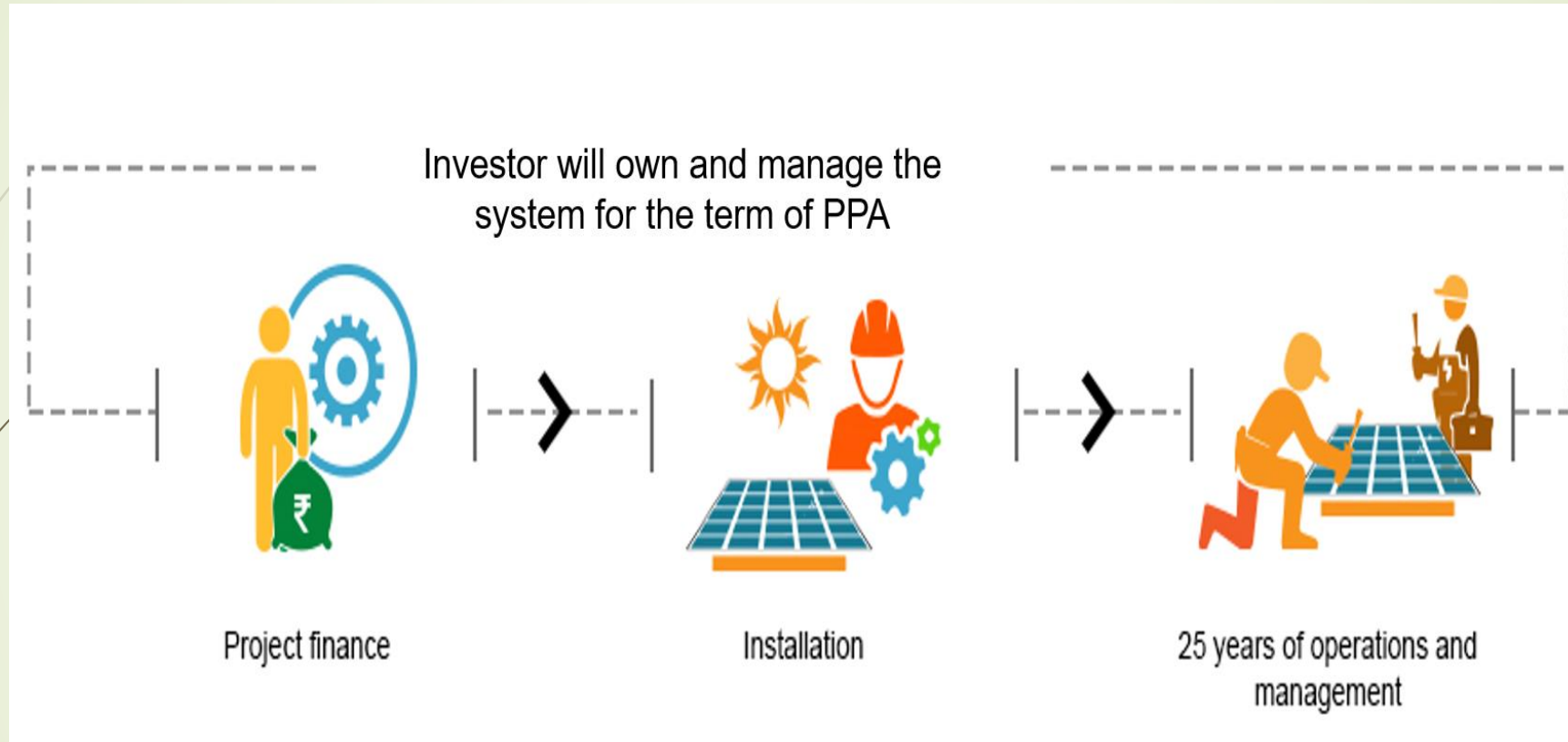
CAPEX MODEL



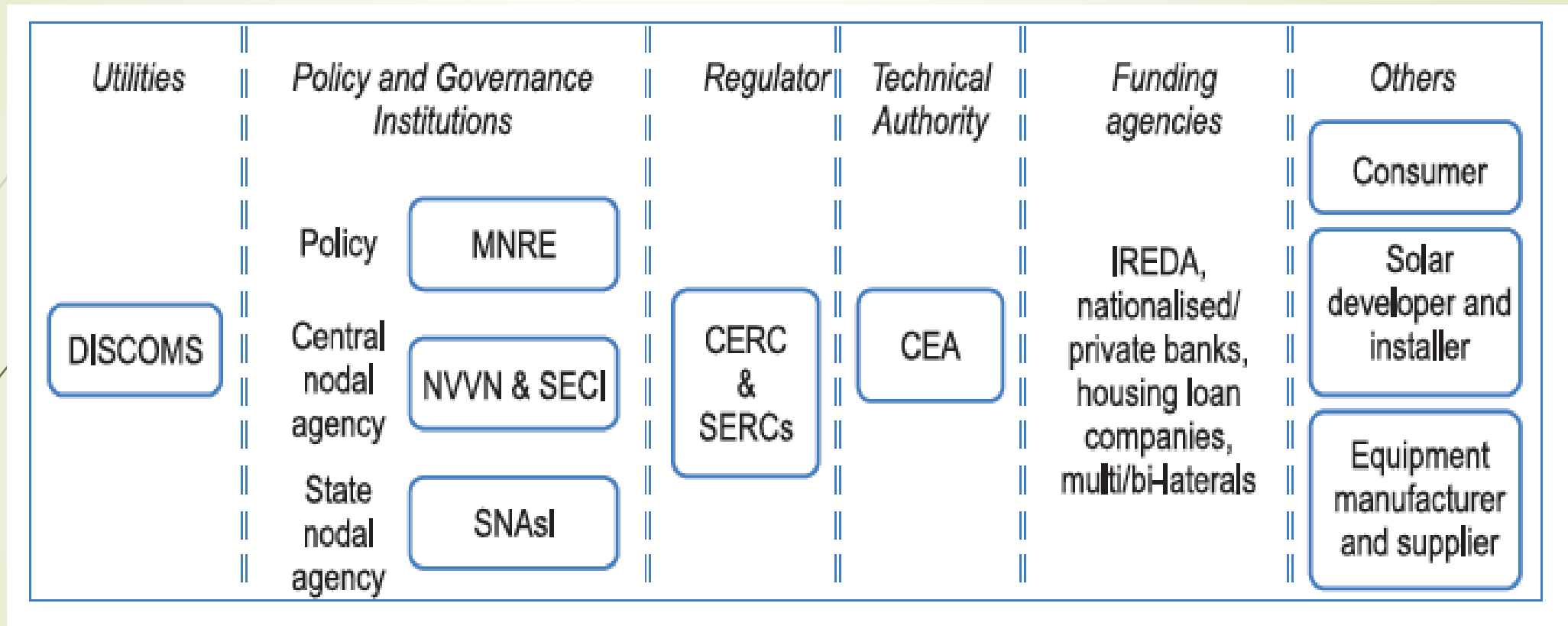
Payback 2 - 3.5 Yr

Low cost power (O&M Cost only) for 20+ years

BOOT/ OPEX/ RESCO/ PPA Model



Per Unit Energy Savings
No capital investment



Observations

- ▶ Power outage for about 1 to 2 hours and voltage fluctuation are experienced by all
- ▶ consumer categories in all cities except Gandhinagar
- ▶ Commercial and industrial consumers use generator set and residential consumers
- ▶ use inverter-battery set for power backup.
- ▶ Most consumers are willing to buy rooftop SPV.
- ▶ Power cut problem is predominant in residential and institutional segments. Inverters are used as back up. This results in wastage of grid electricity due to inefficient invertors and batteries, and losses in storage and conversion. It also reduces the available electricity for productive use.
- ▶ Consumers intuitively expect rooftop solar PV systems to reduce expenses on
- ▶ electricity and to assure reliable power supply even in case grid power outage. This
- ▶ however, is not being addressed in the current schemes.

Observations

- Reduction in utility electricity bill
- Minimal operation and maintenance cost
- A reasonable independence from the grid
- Economic value for unused roof space
- Green electricity
- Reliable electricity

Consumer's expectation

- Streamlined and user friendly processes for net-metering
- Easier loans and faster returns on investment (preferably 2–3 years)
- Annual maintenance contract (AMC) from the supplier
- Sale of surplus to utility
- Low capital investment by roof owner
- Low cost alternative to utility power



Solar BOOT & CAPEX Proposal
PPA Sample terms
Savings & Payback Calculations



Top States for Ground Mounted Projects

State	Rank	Installed Capacity (As on 31 st Dec, 2016)	Highlights	Key Drivers
Tamil Nadu	1	1591	<ul style="list-style-type: none"> • FiT at Rs.7.01 in 2015 • 1200 MW bid in 2015, received interest for a capacity of 3200 MW • Recent 500 MW tender, received just 300 MW of bids 	<ul style="list-style-type: none"> • High solar tariffs • Adani Power's 648 MW
Rajasthan	2	1318	<ul style="list-style-type: none"> • Tariff rates as low as Rs.4.34 for the NTPC bid in 2016 • Major chunk of SECI's 750 MW allotted to Rajasthan 	<ul style="list-style-type: none"> • Abundant barren land with high solar insolation levels
Gujarat	3	1159	<ul style="list-style-type: none"> • FiT until March, 2015 • Tariff rates were very high initially, at about Rs.15 in 2009 	<ul style="list-style-type: none"> • Excellent solar FiT rates until March, 2015 • High credit rating of utility along with ease of business transactions

Top States for Ground Mounted Projects

State	Rank	Installed Capacity (As on 31 st Dec, 2016)	Highlights	Key Drivers
Andhra Pradesh	4	980	<ul style="list-style-type: none"> • AP 500 MW bid in 2014 saw tariff rates at Rs.5.25 – 5.98 ,with 3% escalation • NTPC - 250 MW commissioned in 2016 – Sale to AP Discoms at Rs. 6.16 	<ul style="list-style-type: none"> • Installed capacity was mainly tariff driven • Wheeling Charges exemption for Third Party Sale & Captive • Cross Subsidy Charges exemption for Third Party sale – first 5 years
Telangana	5	973	<ul style="list-style-type: none"> • Telangana- 500 MW bid in 2014 saw tariff rates at Rs. 6.46-6.9 • Tariff rates for the 2016 bids - Rs.4.66-5.57 	<ul style="list-style-type: none"> • Similar to Andhra, installed capacity mainly tariff driven • Wheeling Charges exemption for Captive, Cross Subsidy Charges exempt for Third Party Sale
Madhya Pradesh	6	840	<ul style="list-style-type: none"> • SECI's VGF Scheme contributed 210 MW in 2015 • 750 MW Rewa Project with record low tariffs 	<ul style="list-style-type: none"> • SECI Projects at a tariff of Rs.5.5 in 2015 • M.P 100 MW bid, 2014, tariff – Rs.6.475 - 6.97 • 135 MW Welspun Project, 2012, tariff – Rs.8.05

Top States for Ground Mounted Projects

State	Rank	Installed Capacity (As on 31 st Dec,2016)	Highlights	Key Drivers
Punjab	7	545	<ul style="list-style-type: none"> • 250 MW bid in 2015 saw tariffs at Rs.6.88 – 7.21 	<ul style="list-style-type: none"> • High tariffs
Maharashtra	8	431	<ul style="list-style-type: none"> • Utility tariff rates at Rs. 7.21-11.5 for industrial and Rs. 6.60-13.01 for commercial sector 	<ul style="list-style-type: none"> • High degree of industrialization • Very high utility tariff rates for the C&I sector – solar a cheaper alternative
Karnataka	9	328	<ul style="list-style-type: none"> • 300 MW Farmer's Scheme – tariff rate – Rs.8.4 • State also introduced high FiT rates at Rs.9.56 for rooftop projects in 2015 	<ul style="list-style-type: none"> • Special schemes like Farmer's Scheme with high FiT rates • Wheeling, banking, cross subsidy charges – fully exempt for 10 years, for plants commissioned between 2013-2018
Uttar Pradesh	10	239	<ul style="list-style-type: none"> • Tariff rates in 2016 at Rs.4.78 • Earlier bids in 2013 saw rates at 8.01-9.33 with 3% escalation 	<ul style="list-style-type: none"> • Scope for alternative RE sources poor

Top States for Rooftop Projects

State	Rank	Installed Capacity (As on Sept,2016)	Highlights	Key Drivers
Tamil Nadu	1	132	<ul style="list-style-type: none">• Highest contribution came from industrial sector, 74%	<ul style="list-style-type: none">• High degree of industrialization• Capacity allowed equal to that of sanctioned load
Maharashtra	2	89	<ul style="list-style-type: none">• Utility tariff rates at Rs.7.21-11.5 for industrial and Rs.6.60-13.01 for commercial sector	<ul style="list-style-type: none">• High degree of industrialization• Very high utility tariff rates , both for C&I
Gujarat	3	69	<ul style="list-style-type: none">• FiT rates offered between Rs.9.28-8.03 from 2012 - 2015	<ul style="list-style-type: none">• Offered high FiT rates until 2015• Ease of transactions in the state

Top States for Rooftop Projects

State	Rank	Installed Capacity (As on Sept, 2016)	Highlights	Key Drivers
Haryana	4	57	<ul style="list-style-type: none"> Govt identifies cluster of public/private buildings (possible plant sizes up to 1 MW) and invites IPPs to rent the rooftop space to develop projects IPPs, chosen based on the lowest bid, to sell the power to HPPC (Haryana Power Purchase Centre) IPPs can also choose to sell power to the owners of the premises and sell the excess to HPPC 	<ul style="list-style-type: none"> Ease of approvals ensured with single window clearance Rooftops made available for IPPs
Punjab	5	55	<ul style="list-style-type: none"> World's largest single rooftop power plant, 11.5 MW in Beas Dera Campus 	<ul style="list-style-type: none"> 85% of installations from commercial sector Well defined Net Metering Policy
Karnataka			<ul style="list-style-type: none"> Net Metering for C&I to be 	<ul style="list-style-type: none"> FiT rates set from 2015- March, 2016 at

Top States for Rooftop Projects

State	Rank	Installed Capacity (As on Sept,2016)	Highlights	Key Drivers
Rajasthan	7	46	<ul style="list-style-type: none"> Excess energy compensated at Rs.7.5 per unit without AD, Rs.6.63 per unit with AD 	<ul style="list-style-type: none"> Well defined Net Metering policy with excess energy compensated at high tariff rates
Delhi	8	35	<ul style="list-style-type: none"> Utility tariff rates for C&I at Rs.8.8-9.5 	<ul style="list-style-type: none"> High tariff rates for the C&I Sector GBI at Rs.2 for the residential sector for a period of 3 years since March, 2016
UP	9	33		
Andhra Pradesh	10	32	<ul style="list-style-type: none"> Utility tariff rates for commercial sector at Rs.7.03-9.15 	<ul style="list-style-type: none"> High tariff rates for the Commercial sector Choice between Net Metering and Gross Metering

Drivers for Rooftop Solar Projects

Drivers	Level of difference that can be made	Ease of execution to enable driver
Degree of industrialization	High	Low
Relatively high utility tariff rates for C&I	High	Low-Medium
Optimal Metering Mechanism – Net Metering, attractive FiTs	High	Medium- High
Ease of approvals	High	High
Capacity relative to Distribution Transformer	Medium	Medium
Percentage capacity relative to sanctioned load	Medium	Medium
Subsidies / Incentives	High	Low

Major Bottlenecks Faced By States

Bottlenecks	Segment Affected	States Worst Affected	Suggestions to Overcome the Challenge	Notes
Poor credit worthiness of the Discom	Ground-Mounted Projects	Tamil Nadu, Rajasthan, U.P	Compliance with UDAY Scheme	All three states part of the UDAY Scheme – expected to cause financial turn around
Grid Curtailment	Ground-Mounted Projects	Tamil Nadu, Rajasthan	Optimal framework for grid and RE management	Gujarat has a well defined process for eliminating curtailment risk –day ahead forecast and scheduling, well-defined hierarchy for flow of orders , ramping of transmission and evacuation infrastructure
Land Acquisition and Availability	Ground-Mounted Projects	Telangana, Maharashtra, U.P	Proactive implementation of the terms laid out in solar policies on land acquisitions	A total of 125 projects were stalled in 2014 in Maharashtra due to land acquisition issues
Delays in approvals	Ground-Mounted and Rooftop Projects	U.P, Punjab	Enforce deemed conversion status for land, ease other clearances and approvals	Introduction of single window clearances, especially for the rooftop sector can accelerate growth
Lack of Planning for Special Schemes	Ground-Mounted and Rooftop Projects	Punjab , Karnataka	Tie-up with agencies with sound knowledge in regulatory and financial frameworks for power projects	Punjab Farmer's Scheme had to be scrapped midway owing to economic considerations. Karnataka's Rs.9.56 rooftop scheme also had to be later revised