Rooftop Solar Initiatives

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MNRE Conference on Rooftop Solar Power

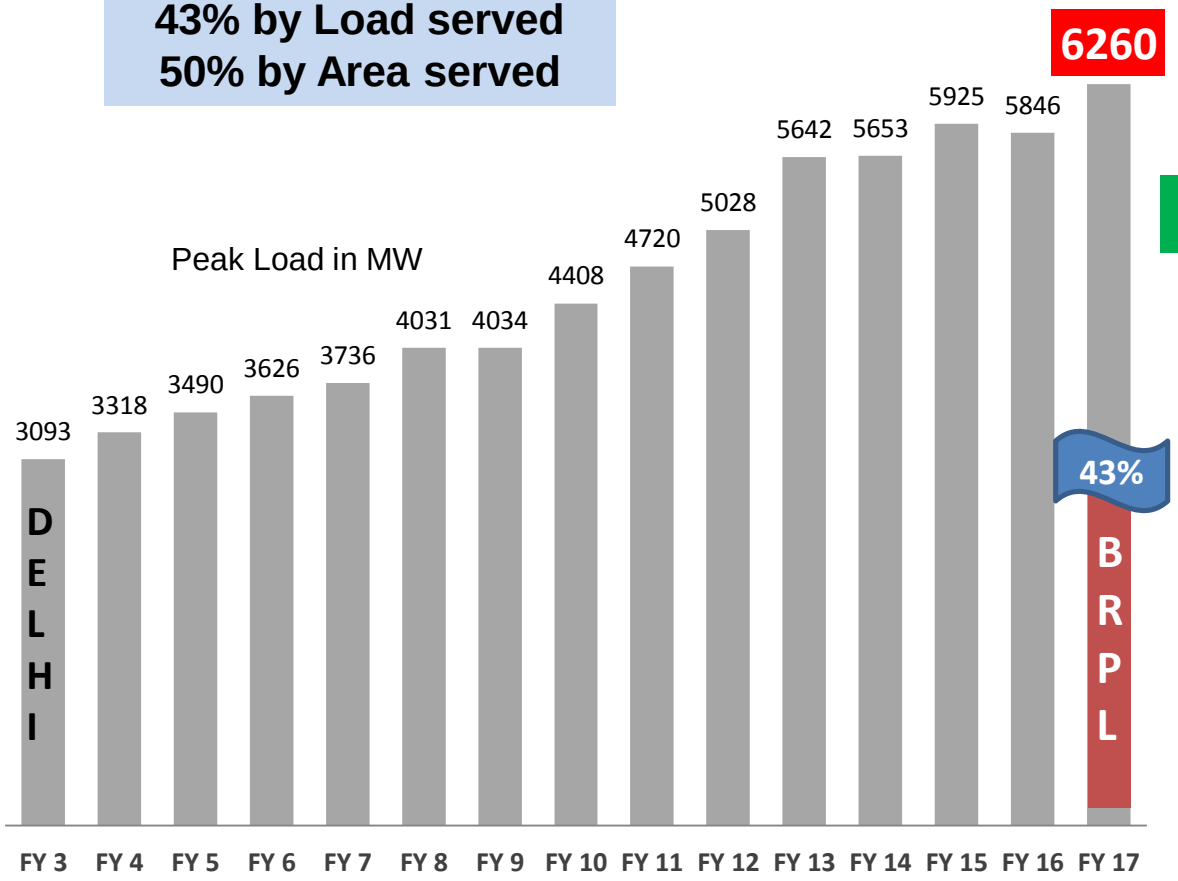
20th September 2016

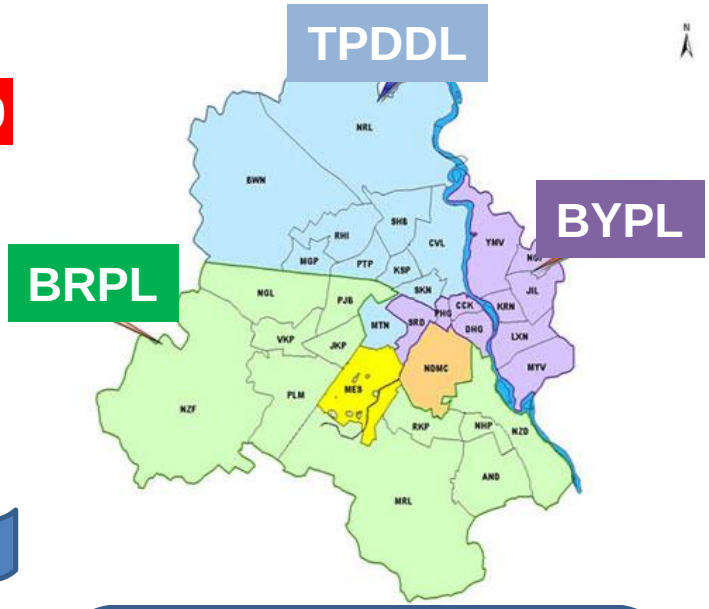
Agenda

- About BRPL
- BRPL Rooftop Journey till date
- Solar RPO Roadmap of BRPL
- Forward Path for Rooftop Solar
- Capabilities to be developed
- BRPL's Commitment

About BRPL

43% by Load served
50% by Area served





Delhi Power Demand (MW)

- 65% more than Mumbai
- 3 times of Kolkata
- 4 Times of Chennai

Over 102% growth in Peak Load served since privatization

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Performance since 2002

Parameter	UoM	July' 2002	March' 2016 *	% Change
Operations				
AT&C Losses	%	51.5%	12.8%	39%
System Reliability – (ASAI)	%	65%	99.86%	54%
Transformer Failure	nos	878	~30	97%
Peak Load	MW	1234	2427	97%
Street Light Functionality	%	45%	99.52%	121%
Customer Interface				
New Connection Energization Time	Days	52	7	87%
Meter Replacement Time	Days	25	3	88%
Provisional Billing	%	15	0.8	95%
Bill Complaint Resolution	Days	45	3	93%
Mean Time to Repair Faults	Hours	12	1.32	89%
Payment Collection Avenues – touch points	Nos.	20	2000	100 times
Consumers	Lacs	9.5	22.3	132%

*FY16 nos. are provisional

BRPL serves large no of small, domestic consumers & caters to high theft prone areas

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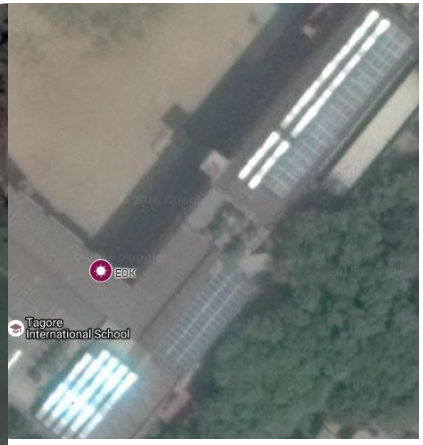
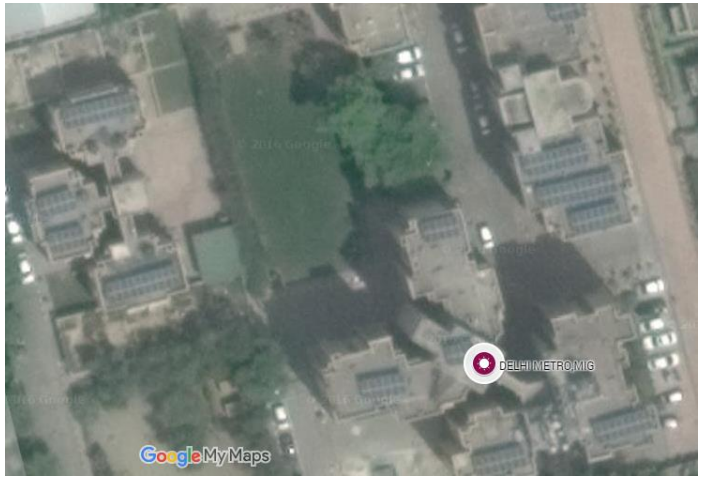
BRPL's Rooftop Journey till date

Institute

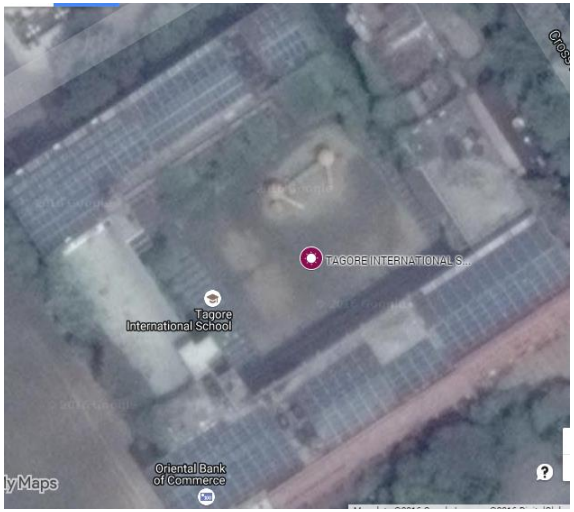
Schools



Stadium



Residential Complex



Commercial Complex

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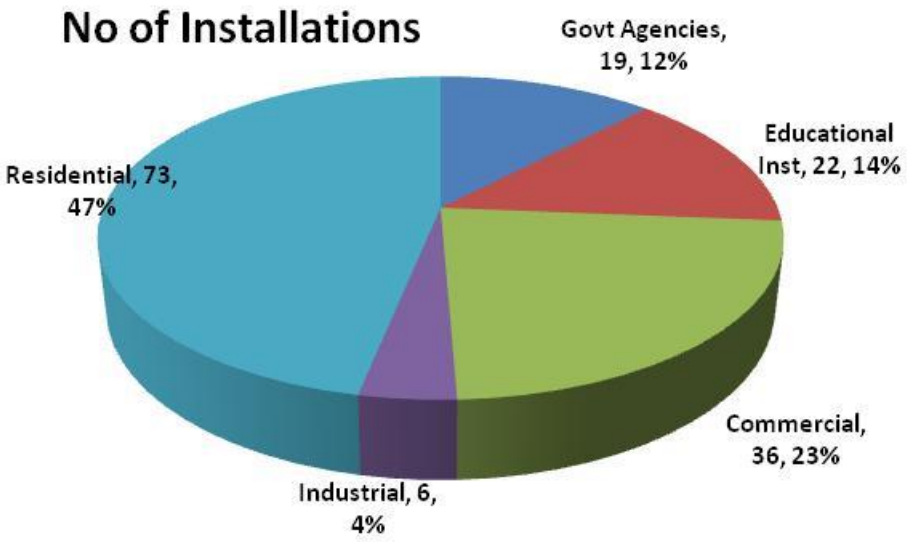
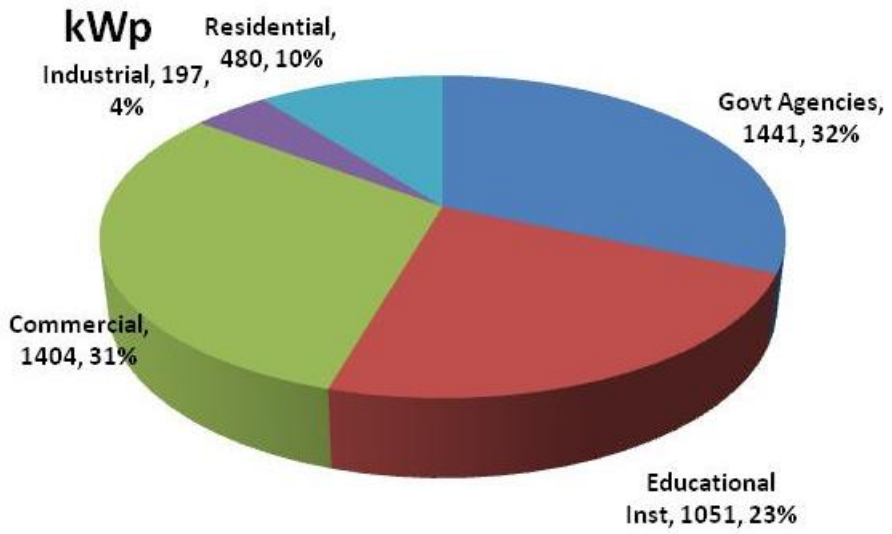
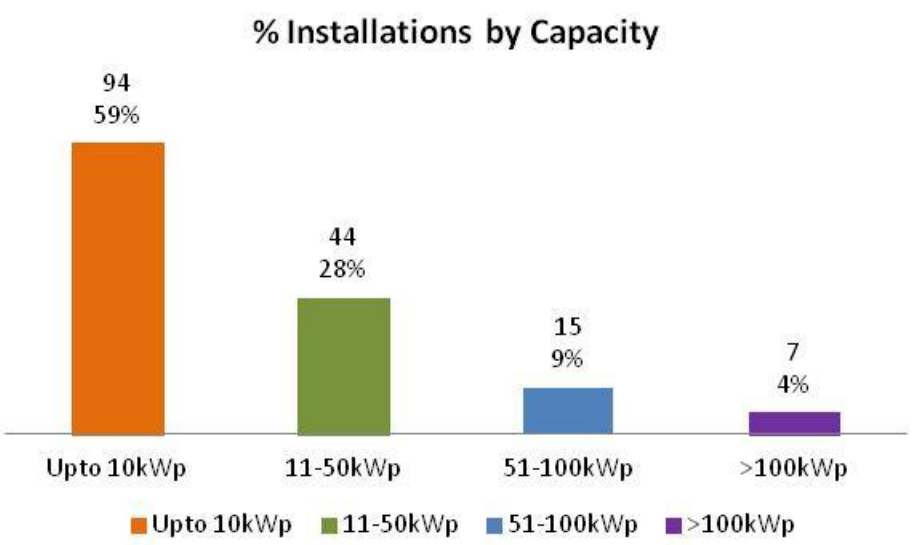
BRPL's Rooftop Journey till date

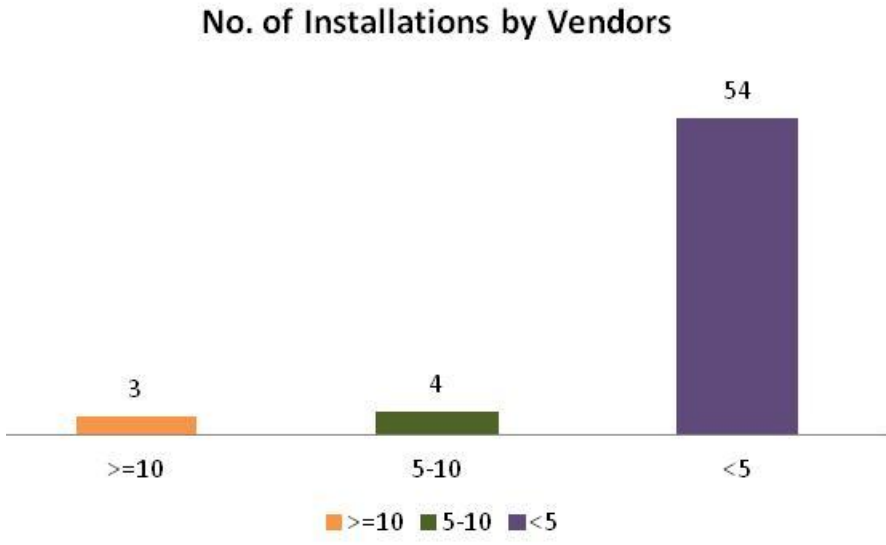




- 160 Installations, 4.57 MWp
  - Y1: 90 nos, 3.2 MWp, Y2 5 Months: 70 nos, 1.37 MWp
- Another 600 kWp in process
- Capacity of Solar 5.19 MW against sanctioned load of 29.7 MW **(17%)**
- Interest from all segments
- Higher Participation from Residential (nos) & Institutions (Capacity)

BRPL's Rooftop Journey till date





- Large Quantum of small size installations
- Large number of Vendors
- Very few focused Vendors
- Market still in early stages

Solar RPO Roadmap of BRPL

- Conditions
  - Achieve 8% of Input from Solar
  - Procure 75% of above from within state, mainly rooftop Solar
  - Procure rest 25% from VGF based projects
  - DERC will allow a reasonable trajectory and cumulative achievement
- MUs to procured from Solar – 926 MUs during FY 2021-22

Obligation as per Business Plan submitted to DERC		Energy Sales (Mus)	Energy Sales excluding Hydro(Mus)	Target Solar RPO (MU)		
				Total	Within State - RTS @75%	From Grid (SECI) @25%
Year	a	b1	b2 = b1*0.9 (Hydro share 10%)	c = a*b	d = 0.75*c	e = c - d
2017-18	1.00%	11,070	9,963	100	75	25
2018-19	2.50%	11,521	10,369	259	194	65
2019-20	5.00%	11,994	10,795	540	405	135
2020-21	7.50%	12,491	11,242	843	632	211
2021-22	**8.00%**	**12,866**	11,579	926	695	232

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Solar RPO Roadmap of BRPL

- Solar Capacity to be tied up in MW

Obligation as per Business Plan submitted to DERC		Target Solar RPO (MW)			Arrangement (MW)			To be Tied up (MW)		Yearly Addition (MW)	
		Within State - RTS	From Grid (SECI)	Total	Within State - RTS	From Grid (SECI)	Total	Within State - RTS	From Grid (SECI)	Within State - RTS	From Grid (SECI)
Year	a	f = (d*1000)/ 8760/0.16	g = (e*1000)/ 8760/0.19	h = f+g	i	j	k = i+j	l = f - i	m = g - j	n	o
2017-18	1.00%	53	15	68	3	20	23	50	(5)	50	0
2018-19	2.50%	139	39	178	3	20	23	135	19	85	19
2019-20	5.00%	289	81	370	3	20	23	285	61	150	42
2020-21	7.50%	451	127	578	3	20	23	448	107	162	46
2021-22	**8.00%**	496	139	635	3	20	23	492	119	45	12

- Need ~ 500 MW within state, mainly through rooftop solar PV @ 16% CUF
- Need to tie up 120 MW from other sources @ 19% CUF

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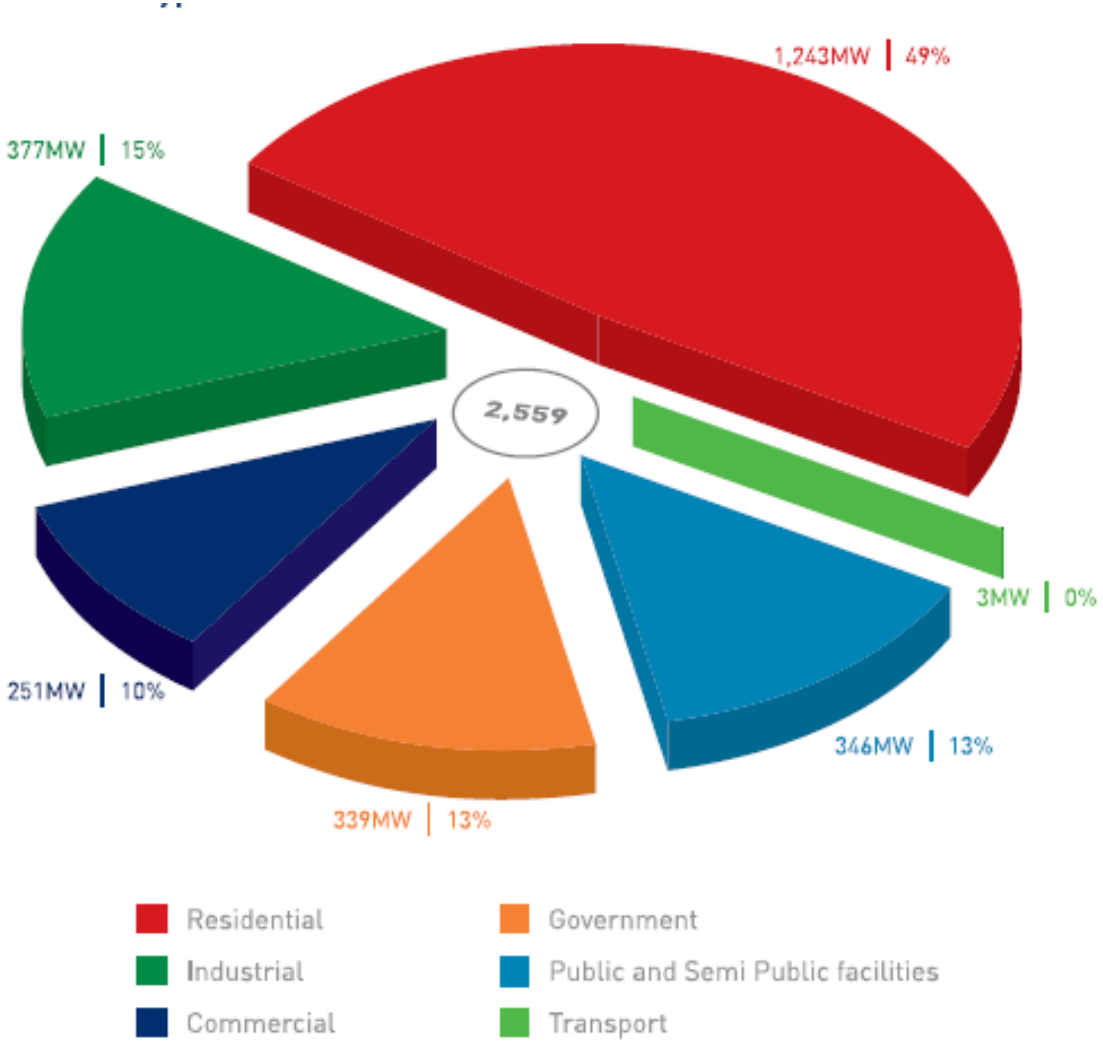
Solar RPO Roadmap of BRPL

- Grid Scale Solar PV
  - Already tied up 20 MW with SECI
  - In process for another 120 MW to be available from 2018 onwards
    - Will replace our short term purchases during day peak
    - PPA @ Rs. 4.50/- without inter-state transmission charges and losses – will be favorable than short term purchases (uncertain prices) with interstate transmission charges and losses
- Within state Rooftop Solar PV
  - Currently under Net Metering arrangement
  - No **direct burden** but loss from revenue in high tariff slab
  - Near 0% technical losses for direct consumption
  - 50% Technical losses reduction if power absorbed at LT level
  - Will help in **shaving Day Peak** during summer when all transmission and Distribution elements are overloaded
  - Allows **Capex deferment** (if not avoidance)

Solar RPO Roadmap of BRPL



Source: DDA's Master Plan 2021, Delhi Zonal Plans and BRIDGE TO INDIA analysis

Rooftop Revolution : Unleashing Delhi's Solar Potential, Bridge to India, Greenpeace Report , 2013

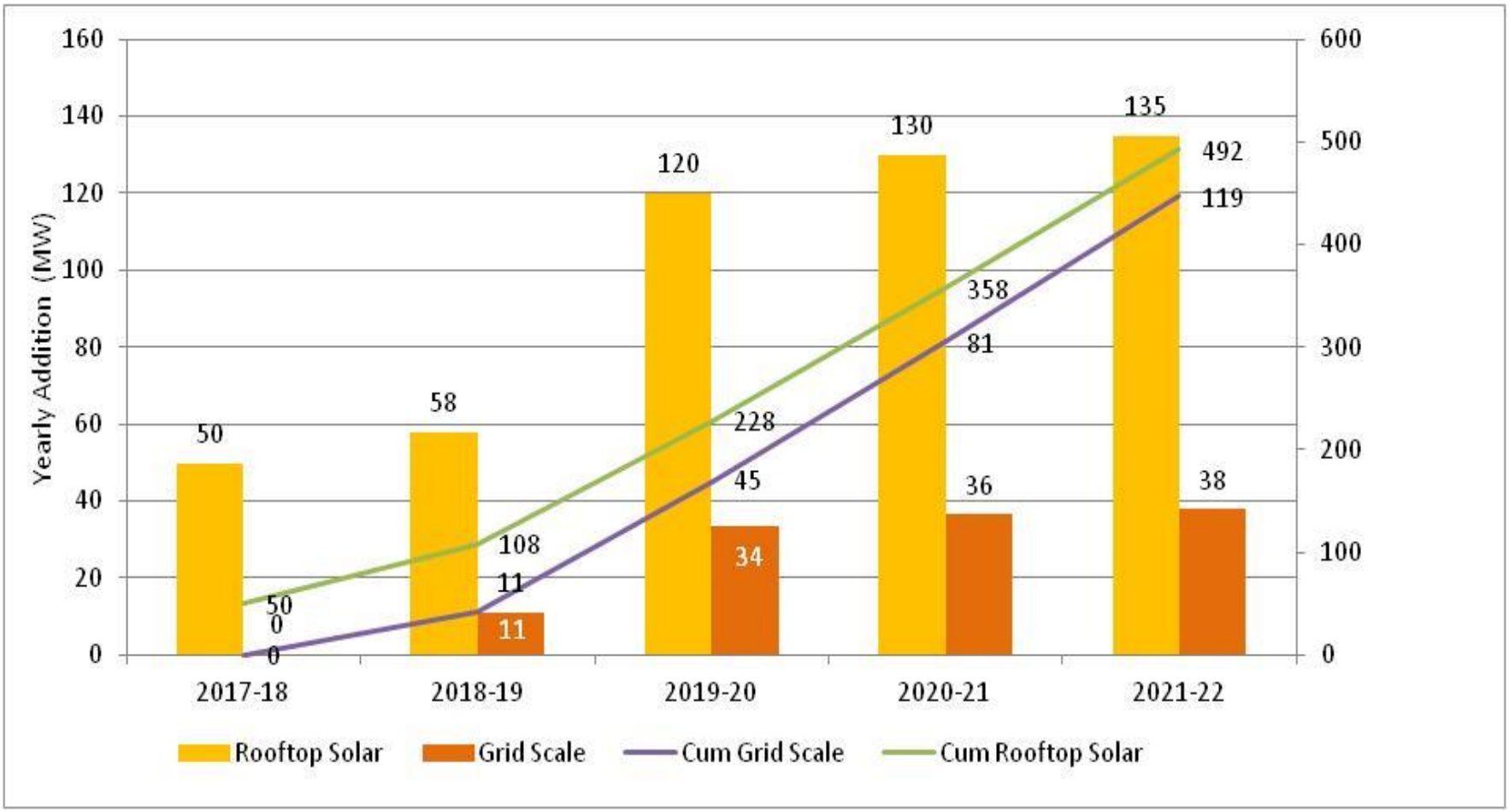
Solar RPO Roadmap of BRPL

- Estimated Roof Top Solar (RTS) Potential in Delhi – 2,557 MW
  - Out of above, 49% (1,253 MWp) represents potential of Delhi's residential buildings

  Source: Rooftop Revolution : Unleashing Delhi's Solar Potential, Bridge to India, Greenpeace Report , 2013
- Delhi's RTS Potential – 1,921 MWp

  Source: Study by National Institute of Solar Energy (NISE), MNRE, 2014
- BRPL Offices roof top space potential (~ 2.6 MWp)
  - South : 1,7503 sqm (~ 1.4 MWp)
  - West : 1,4302 sqm (~ 1.2 MWp)

Solar RPO Roadmap of BRPL



Achieve a very high growth in Rooftop Solar @ 100+ MW each year

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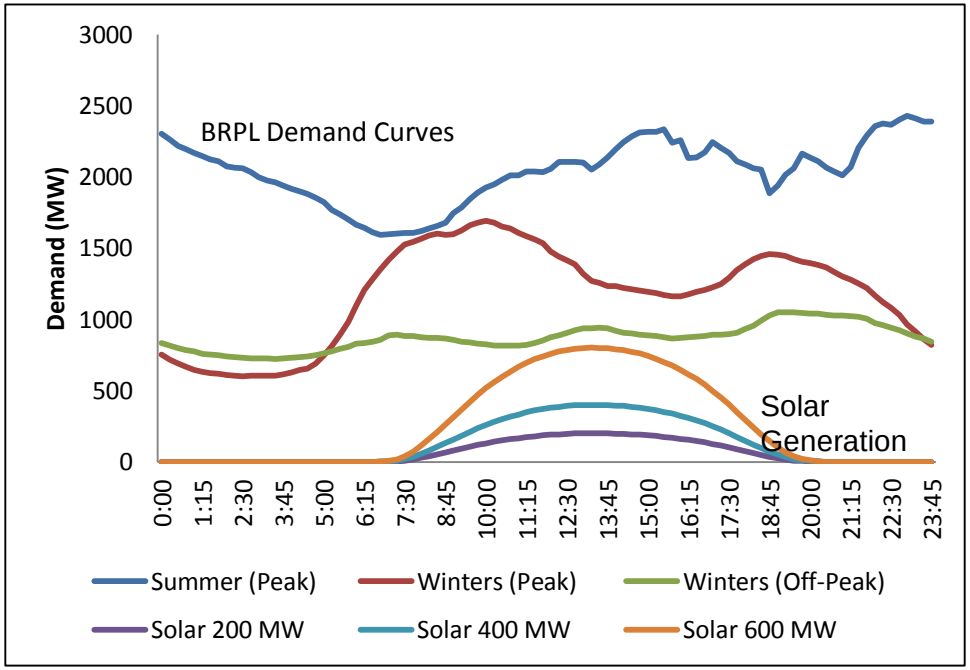
Impact of Solar on System Peak Load

- Peaking of Rooftop Solar Generation partly complements /offsets Peak Demand of Discom during the day
- 50% of solar generation off-sets Normal Hours and 50% off-sets peak hour load for TOD customers



Summer Peak Period
Afternoon : 02:30PM to 04:00PM
Evening : 10PM to 12 Mid Night

Winter Peak Period
Morning : 09:00AM to 11:00AM
Evening : 06:00PM to 08:00PM

Winter Off-Peak Period
Relatively Flat Demand

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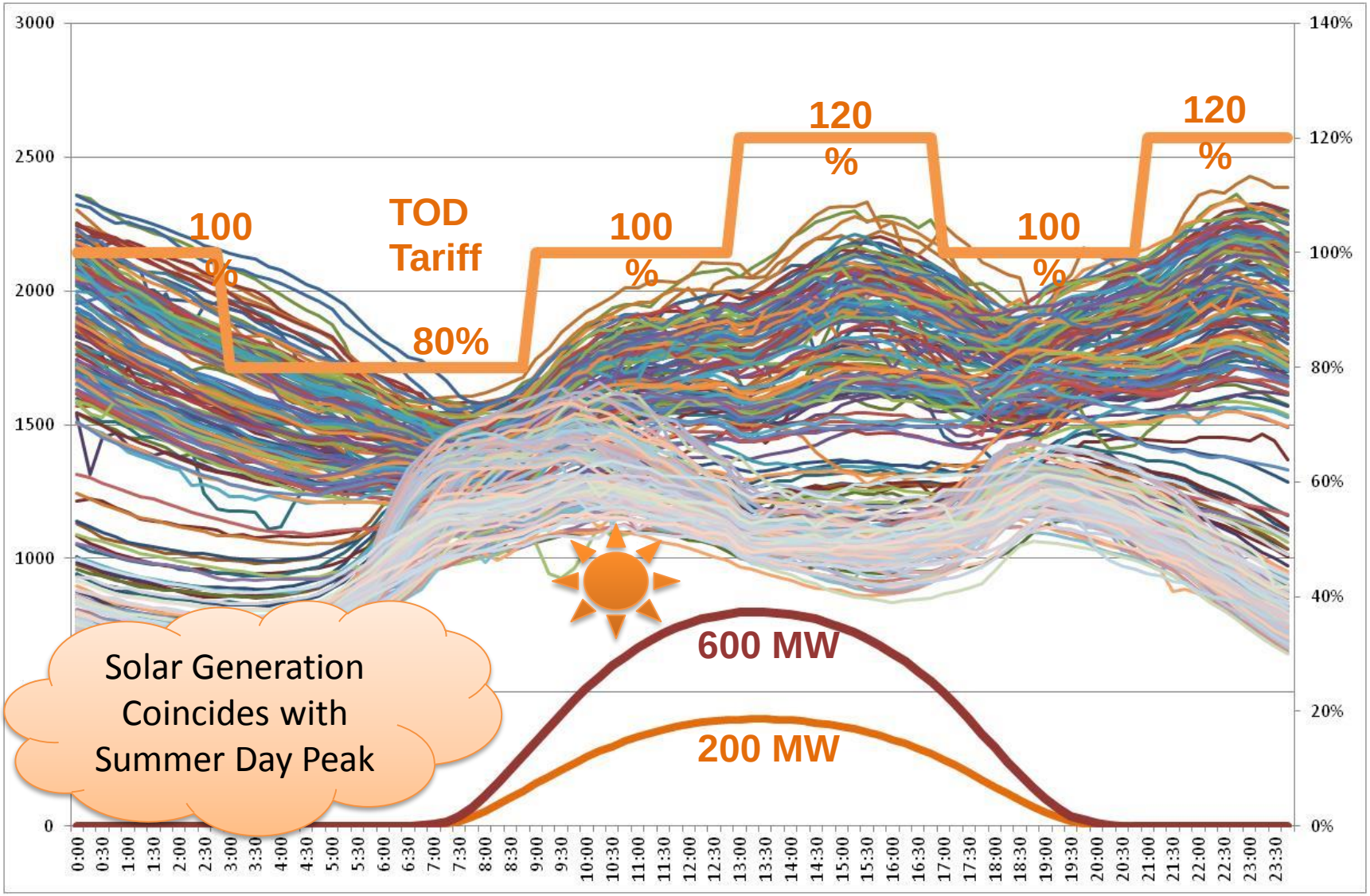
Max Penetration has to be planned with Winter Minimum Demand during Solar Peak Generation Time

BRPL Demand Curve and Solar Generation



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Can ~600 MW Solar PV be embedded in BRPL Network

Key Considerations

A. National Policy
   1. Energy Security
   2. Climate Change
   3. Electricity Shortages
   4. Electricity Access

B. Distribution Utility
   1. Ensure Electricity Access in a cost-effective way
   2. Provide Reliable Power Supply without Shortages
   3. Optimize Power Cost through Demand Forecasting and Power Scheduling

A3, A4 & B1, B2 are quite aligned but A1, A2 and B3 could be in conflict

With Such Diverse Considerations, high degree of collaboration is necessary to achieve the National Targets

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Role of Discom

- In the Value Chain of Rooftop Solar, Discom can play an important role in Project Development, Installation and Operation & Maintenance Stages
- Project Development Stage
  - Proactive assessment of RTS absorption at LT Feeder, DT and 11 kV
  - Help consumer in Tendering stage and ensure right equipment capable of meeting grid coordination requirements is installed
  - Help consumer/developer in assessing the benefits
- Installation
  - Facilitate timely Technical Clearances
- Operation and Maintenance
  - Monitor generation data and use for Power Scheduling and Performance Management services
  - Meter Reading, Billing and Collection services
  - System Protection coordination

Challenges of Large Scale Rooftop Solar

- Grid is a collective resource
- RTS cannot be viewed as a private option/decision
- It's a Multi Stakeholder Optimization
- RTS along with benefits, also brings certain responsibilities.
  - RTS will replace conventional generators to some extent, hence should be able to take over grid support role too
  - Cost Optimization should include life cycle costs and not just Capex.
- Performance of RTS and Inverter is as critical to the grid as it is to the owner
- Discom has to be proactive and must be prepared for various scenarios and consider RTS as a tool for providing supply
- Discom has to evolve into a role of System Operator from the current Network Maintenance and Power Procurement role

Challenges of Large Scale Rooftop Solar

- Solar PV has limited load following capability, hence need utility source for a reliable & quality power supply
- Distribution Networks not designed to include Generation, only for one way power flow
- Islanding poses Safety Hazard to personnel and over voltages to others in the island
- Can disturb Protection, Voltage Regulation and insert other Power Quality problems such as flicker, harmonics, DC Injection etc
- Reversal of power flow can bring in complex challenges thus limiting penetration at DT level

Support Required

- Involvement of Discoms
  - Technical Specifications and Interconnection Standards
  - Build in Incentives for Discoms
    - Ex: Netmetering billing arrangement
  - For Rooftop Solar, Discom should be the Nodal Agency
- Discom Capabilities to be Developed
  - Project Development
  - Trained & Skilled Manpower for Installation and Maintenance
  - Network Analysis and Load Flow Modeling & Testing Facilities
  - Integration and Operation of various Distributed Energy Resources while ensuring stable and reliable network (DSO)
    - Newer Technologies
    - Communication Networks
    - Data Analysis

BRPL's Way Forward

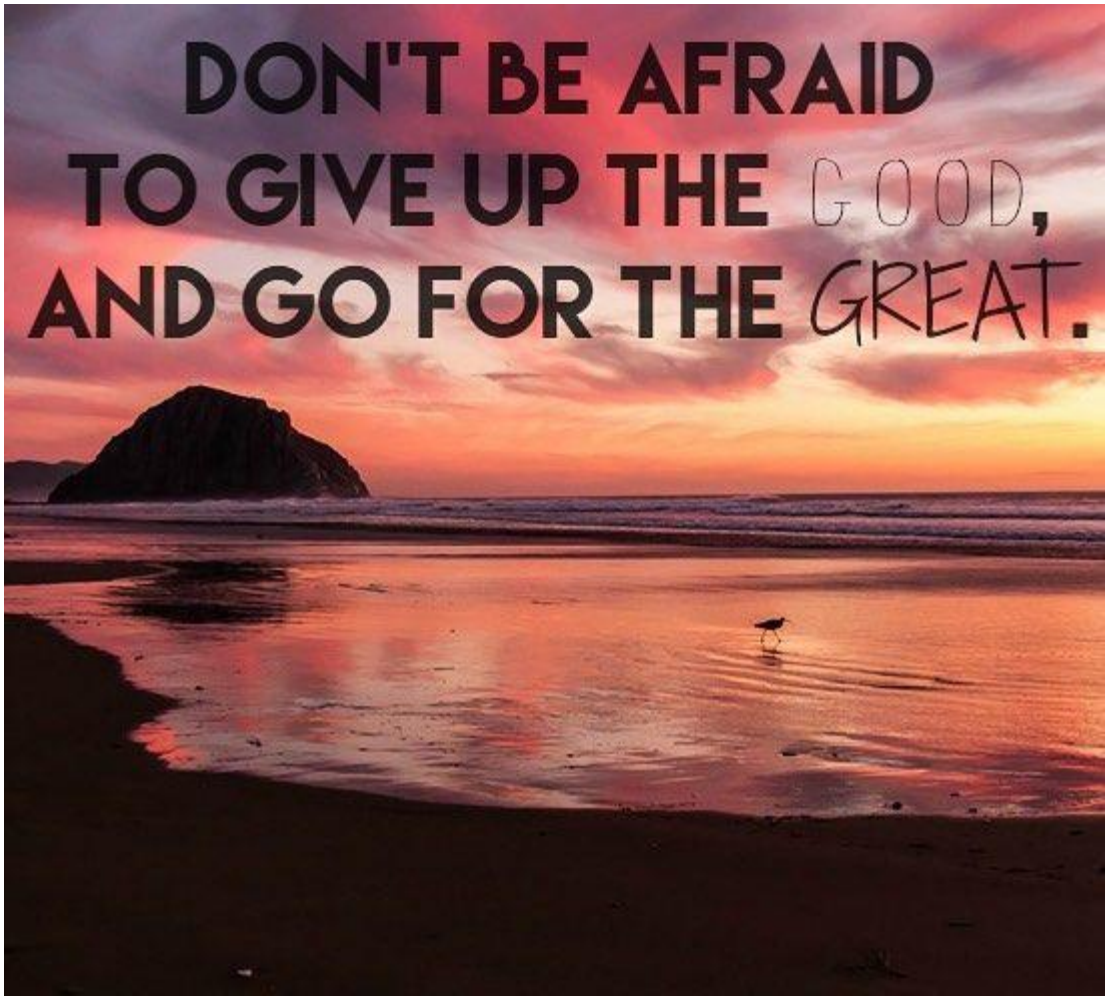
- First Phase was a Market Driven growth
- Time for Facilitated Growth
- To achieve Targets, Need Discom Driven Push
- As a Private Discom, BRPL shall
  - Take Proactive steps
  - Facilitate, Enable and develop New Business Models
  - Become a Role Model

BRPL's Way Forward

- Dedicated Team
- Consolidate all aspects of RTS
- Bring Transparency
- Detailed Analysis of existing installations
- **Technical Study** to be conducted with **GIZ's support**
- Move Towards Guaranteed Connection for RTS position
- **Actively Participate and Contribute** in all Capability Building Programs
- Making it a Win-Win-Win

Making it a Win-Win-Win

- **Safety**
  - No Compromise
  - ***Active*** Anti-Islanding
- **Preparedness** for Grid level Operations
  - Design to consider Utility's requirements of field testing
- RTS Inverters' **Reactive Power Support**
  - Inverter can supply continuously varying reactive power
  - Would need higher rated inverters to perform such function
- **Power Quality**
  - Inverters capable to operate within limits on harmonics injection
  - RTS can cause flicker in certain conditions, should be designed to isolate in such cases
- Ability to **respond to network contingencies**
  - Fault Ride Through
    - Voltage Ride Through
    - Frequency Ride Through (49.70 Hz to 50.05 Hz)
- **Future Strategies**
  - Energy Storage
  - Self-healing networks,
  - Micro Grids
  - Smart Grids and Smart Cities



Thank You

Challenges in Protection

- Increase in Fault Current levels
  - Fault at a point after RTS is connected
- False Tripping, Difficulty in Fault Passage Indication
  - Fault occurs in between Utility side and RTS in presence of a sectionalizer in between
- Dynamic Network – Varying Generation and changing Network Configuration
  - Dynamic and intelligent Coordination
  - Relay to Relay Communication
  - Load Flow Software needs to be upgraded