Idam Infrastructure Advisory Pvt. Ltd.

Solar + Storage Systems – Business Models for Large Deployment

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Expert Talk on Solar, Storage & Hybrid Development

17 September 2020

Idam Infra – Service Offerings

Policy and Regulatory (P&R):

- P&R Analysis
- P&R Formulation
- Tariff Orders and Petitions
- Adjudication and Appeals
- Case Specific Arbitration & Litigation Support
- Regulatory Process Support
- Market Development
- Institutional Strengthening and Capacity Building

Corporate Advisory Services:

- Market Assessment and Business Entry Strategy
- Risk Assessment and Due Diligence
- Transaction Support Services
- Project Appraisal
- Project Design and Implementation Support
- Resource Efficiency
- Policy and Regulatory Support
- IT Solutions

Renewable Energy (RE) Services:

- RE Policy Analysis and Design
- Grid Integration of Renewable Sources
- RE Procurement Strategy
- RE Bid Process Management
- RE Technology Assessment
- Project Feasibility Development and Structuring
- RE Transaction and Due Diligence Support
- Capacity Building

Distributed RE Services:

- Policy Design and Analysis
- Regulatory Analysis and Process Support
- Market Assessment Services
- Project Structuring
- Techno – Commercial Feasibility Study
- Project Development and Project Management Support
- Battery Based Energy Storage
- Institutional Strengthening and Capacity Building

Energy Efficiency (EE) Services:

- EE Policy Advisory
- DSM Planning, Implementation and Regulatory Support
- Energy & Water Audit
- EE Technology Assessment
- Engineering & Project Management
- Monitoring and verification
- Carbon Foot Printing
- Institutional Strengthening and Capacity Building

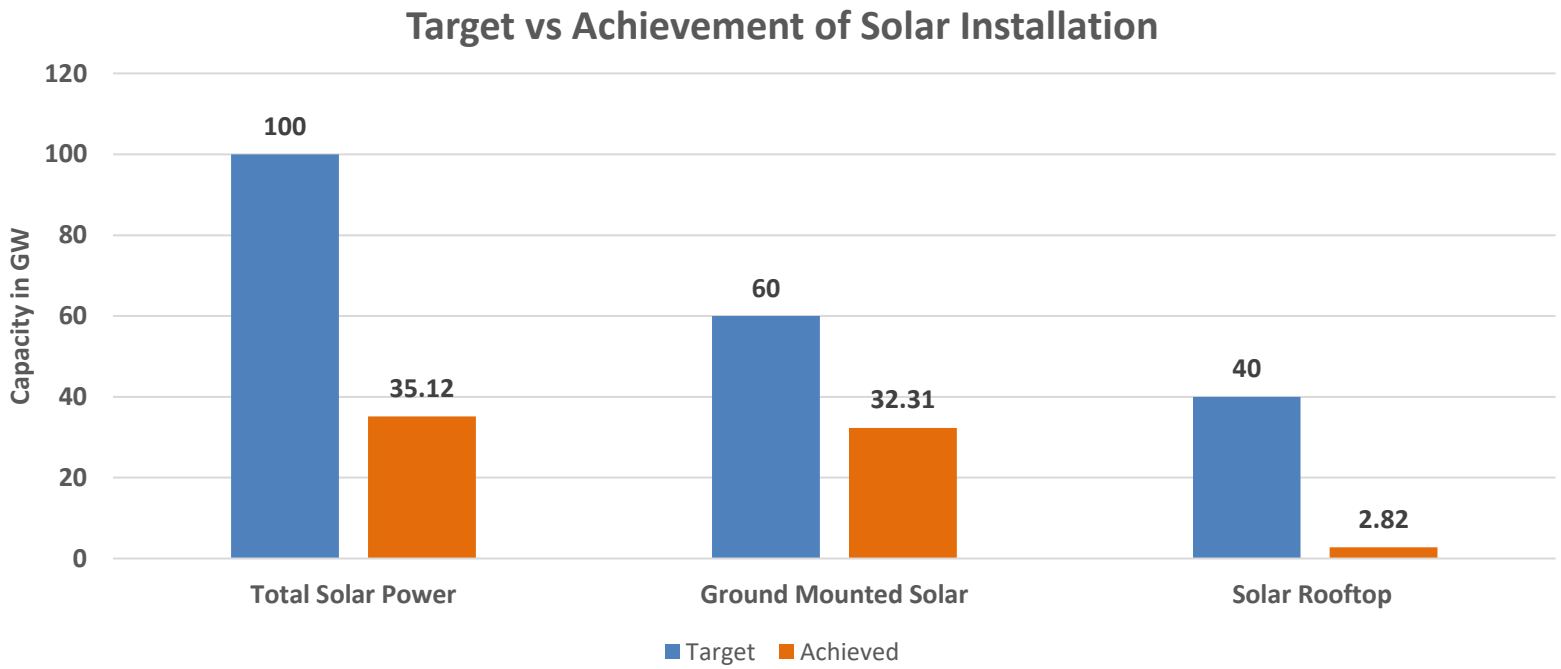
Information Technology Services:

- IT Consulting and Strategy
- Application Development and Support
- Database Development and Administration
- Offshore Software Development and Support
- Mobile Application
- Portal Development
- Website Design and Content Management Solutions
- Technical &Customer Support

Geomatics Services:

- Underground Utility and Cadastral Survey
- Aerial and Satellite Mapping
- 2D and 3D Geodatabase
- LiDAR Data Processing
- Orthophoto Generation
- Spatial Modelling
- Digital Elevation Model/Digital Terrain Model Generation
- Cadastral Maps Geo-Referencing and Digitization

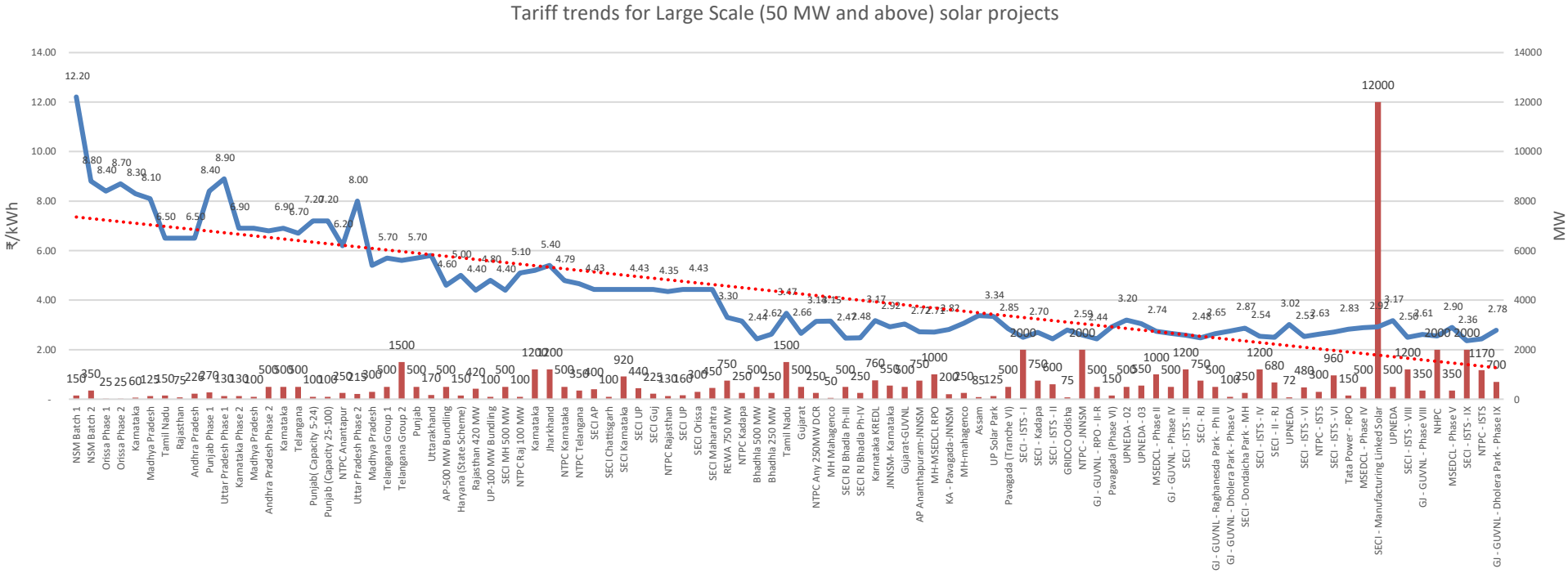
India’s ambitious solar target



India can't achieve solar target without significant storage capacity

Report Name	Publisher	Report date/ Target Year	Battery Storage need projection	Consideration
Developing a roadmap to a flexible, low-carbon Indian electricity system: interim findings	CPI (with TERI and NREL)	Feb-19/ 2030	60 GW	Considering flexibility provided by Thermal, Hydro (including PSH) and Batteries) and demand projection as done by TERI
			25 GW	Considering flexibility provided by Thermal, Hydro (including PSH) ,Batteries and Demand Side Management) and demand projection as done by TERI
Energy Storage System: Roadmap for India : 2019-32	ISGF (with Mac Arthur foundation and IESA)	2019 / 2032	67 GWh	At MV/LV level
			142 GWh	At EHV level
Least-Cost Pathways for India's Electric Power Sector	NREL	May-20/2047	237 GW	Considering capacity and demand growth are based on CEA National Electricity Plan and 19th Electric Power Survey (CEA 2018b)
Report On Optimal Generation Capacity Mix For 2029-30	CEA	Jan-20/ 2030	27 GW / 108 GWh	Considering mid term review of NEP-I for installed capacity taking 2021-22 as base year and EPS for Peak load and energy projection.

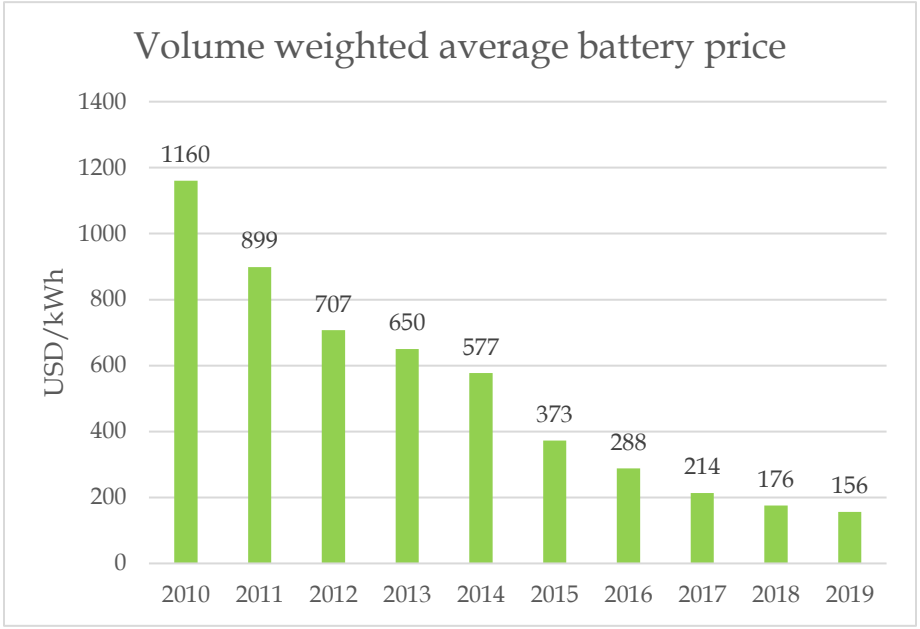
Reverse Auctions



- ~ 30 GW of Solar Capacity has been allotted through Competitive Bidding Process.
- Gradual increase in Solar Capacity over the years shows its acceptance while discovering the lowest Tariff of Rs. 2.44/kwh

Economics of battery storage–Trend

Recent report published by Lawrence-Berkeley National Laboratory shows that the LCOE for standalone BESS could reach Rs. 4.12/kWh by 2030.



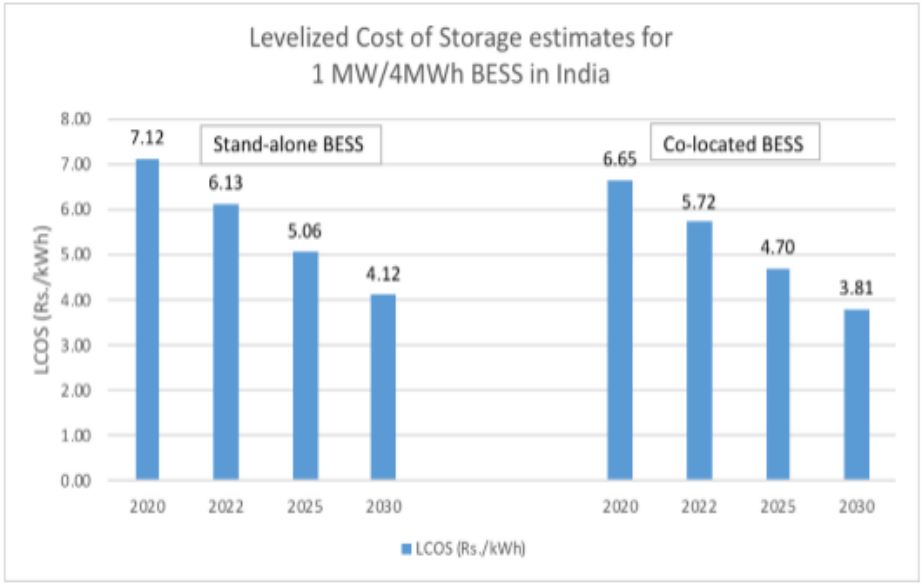
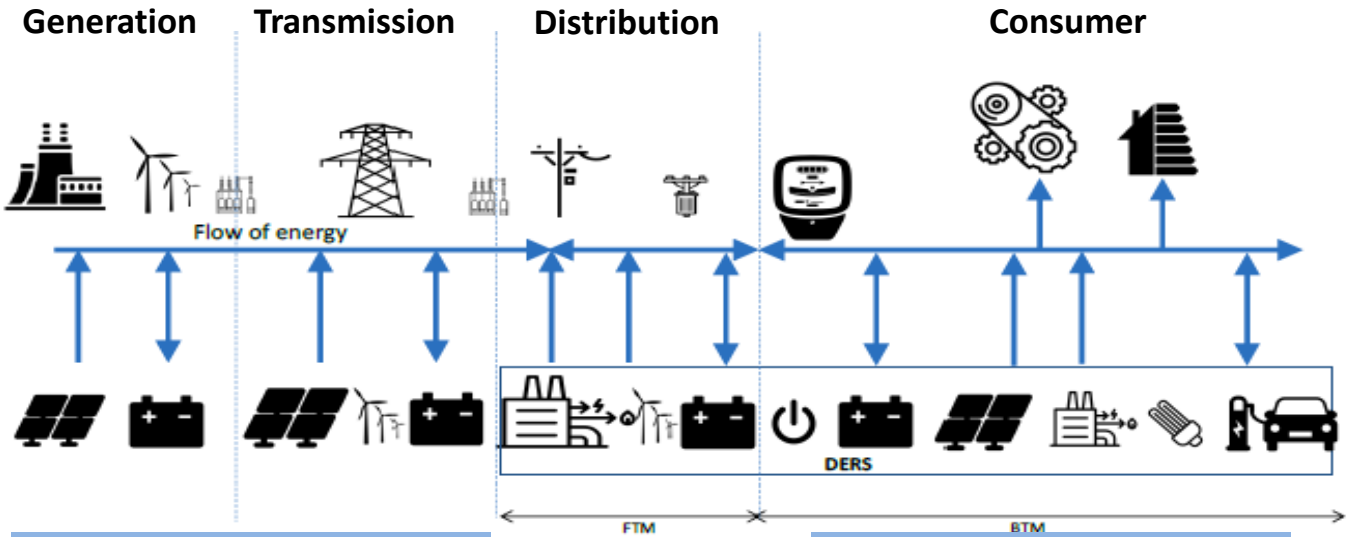
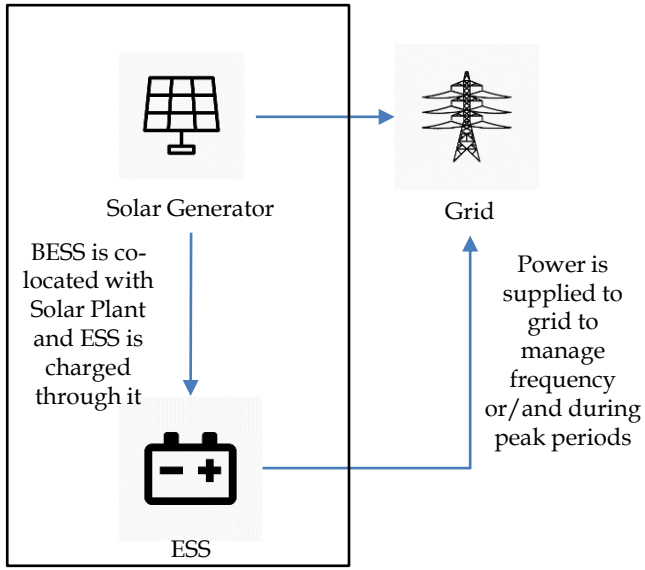


Figure 5. Estimated LCOS for standalone and co-located BESS in India
Source: LBNL

Solar Plus Storage along electricity value chain



Solar + Storage Project



Renewable Energy Plant with co-located Energy Storage System

- Energy Storage System co-located with RE generator can provide firm power to the grid, thus maintaining grid stability
- This can reduce the fluctuation in the grid and help in better management of the frequency
- Energy Storage System co-located with RE generator can also be used to provide power during peak periods
- Utility can get the benefit of firm power from renewables or/and cheaper peak power during peak periods

SECI ISTS VII tender

Particulars	Description
Capacity Offered	Min: 50 MW; Max. 300 MW Max. allowable to single entity 600 MW
Business Model & PPA tenure	BOO & 25 years
Counter Party	SECI
Project Location	Generation may be **co-located/ different locations.** ESS has to be co-located with RE
ESS Capacity	**1200 MWh** *(equal to MW rating of Solar+Wind)*
Injection Point	**Single or Multiple(s)** by separate injection at Pooling point & having separate control
CUF	**At-least 40% (annual)**
Peak Power Supply	Daily: Min. 6 hours, Max. 8 hours
Tariff	**Two part tariff** Off – peak: ₹2.7/kWh Peak: ₹6.12/kWh and ₹6.85/kWh
Energy Arbitrage	At discretion of HPD between 0:01 and 5:59 hours ISTS/STU charges such as wheeling etc. in scoope of HPD

Particulars	Description
Power Generation Requirement ***(for project rated capacity of 100 MW)***	• Daily Minimum: 300 MWh • Capable of delivering 50MW in any peak hour (limited to 6 hour blocks) scheduled by DISCOM through day ahead scheduling • Excess generation above 300 MWh during peak hours shall be compensated at off-peak rate
Peak Power Generation	• Permissible shortfall up-to 15% below minimum energy commitment, accounted monthly, beyond which penalty is applied • Penalty equal to the Peak tariff or tariff paid by DISCOM to meet the shortfall in supply, whichever is higher
Excess Generation	• Any excess generation over and above 10% of declared annual CUF will be purchased by SECI at its discretion {without any obligation to do so} at a fixed tariff of 75% of the Off-Peak tariff • In case of energy supply during Peak Hours over and above the mandated energy requirement (300 MWh), and in the event of such power being procured by the Buying Utility, the HPD will be paid energy charges @ Off-Peak Tariff

SECI ISTS RTC Tender

Particulars	Description
Capacity Offered	Min: 50 MW; Max. 400 MW
Business Model & PPA tenure	BOO & 25 years
Counter Party/ Buying Utility	SECI NDMC (200 MW) & DNH (200 MW)
Project Location	Generation may be **co-located/ different locations.** ESS has to be co-located with at-least one of the generation sources
ESS Capacity	RPD allowed to **resize ESS until 3 years** after COD (flexible to choose type)
Injection Point	**Single or Multiple(s)** by separate injection at Pooling point & having separate control
CUF	**atleast 80% (annual) & 70% (monthly)** Committed Annual energy: 100%
Technology & Interconnection Point	Technology Agnostic Interconnection at 220 kV or above
Developer Scope	Land, Connectivity & LTA
Tariff	1st year tariff with **3% escalation** Y-o-Y till 15th year & subsequently fixed thereafter

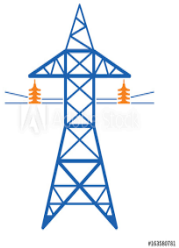
Particulars	Description	
Penalty Structure	Penalty for Monthly & Annual Shortfall	
Annual Shortfall Criteria	>77.5% to <80% CUF	<77.5% CUF
Penalty (Annual)	2* PPA Tariff (Energy Terms)	2*PPA Tariff + Tariff Escalation removed in the succeeding year (upto 15/16th year)
Monthly Shortfall Criteria	> 67.5% and < 70% CUF	<67.5% CUF for > 2 months
Penalty (Monthly) Calculated Annually	PPA Tariff /month * no of months with shortfall	PPA Tariff + Tariff Escalation removed in the succeeding year (upto 15/16th year)
Excess Generation	Excess Power allowed to be **sold in Open Market** – Priority to PPA requirement	
Grid Unavailability (Compensation to RE developer)	• > 4hrs: Gen Loss = [(Avg gen/hr during the billing month) × (no of hrs of grid unavailability in particular billing month)] **Backdown:** • Gen Compensation = 100% x [Scheduled energy × (no of backdown hours during the month)] x PPA tariff	

S + S Plant connected at Distribution

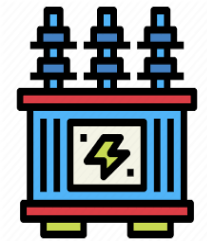
Solar + Storage Plant connected at 33kV

Solar + Storage Plant connected at 11kV

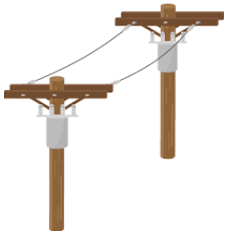
Large Scale Solar Power Plant



HT Transmission Line



33/11kV Sub-Station



LT Distribution Line

Solar Rooftop Installation

Consumer

Arrows indicate power flow direction

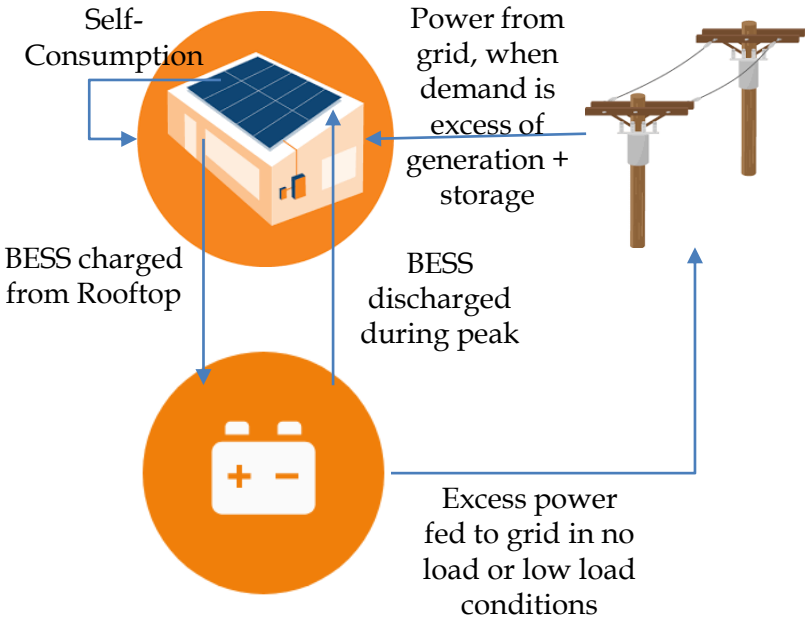
Cost of Generation – Decentralised Solar Plant

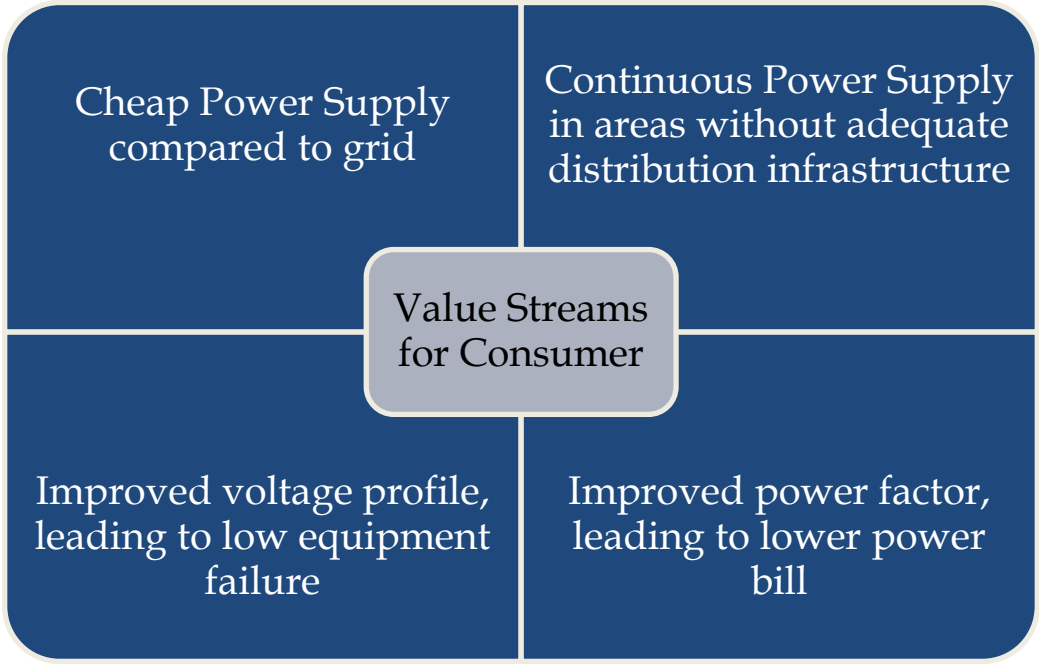
- Telangana
  - Telangana has opted for a distributed solar power generation program. Tenders were issued for solar power plants of capacities in the range of 50 MW to 200 MW to be set up in a distributed manner.
  - **Out of 3,630 MW of solar installation about 1,543 MW of the total solar power capacity in Telangana is on account of distributed solar projects.**
- Maharashtra
  - Decentralised solar plants of 300kW to 10MW capacity on vacant, un-used land near DISCOM substation.
  - Power from these plants is being fed to agriculture feeders, which is greatly benefitting both farmers and DISCOMs :
    - Quality and reliable day time electricity to farmers;
    - Savings on the Transmission network cost, reduced T&D losses for DISCOM
  - Under 'Mukyamantri Sour Krushi Vahini Yojana' in Maharashtra, EESL has signed 25 years PPA with MSEDCL for 500 MW decentralised solar power.
  - **MERC vide order dated May 21, 2020 has approved MSEDCL's proposal of procurement of 100 MW solar power at tariff of INR 3.11 per unit for 25 years from EESL.**
- **Integration of storage would provide several benefits to distribution companies.**

Benefits of Solar Plus Storage to Discom

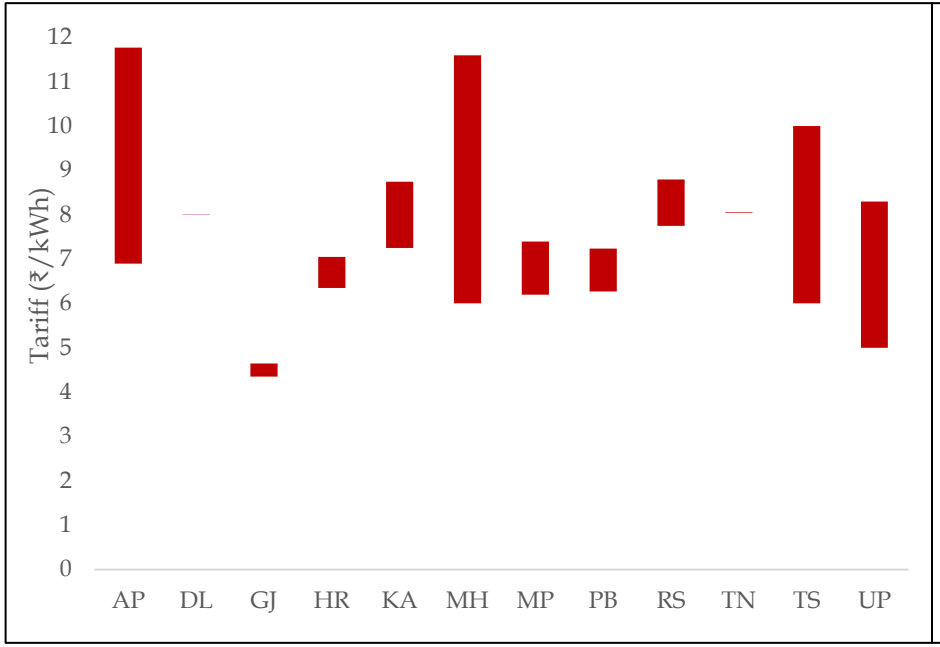
Deferment of Infrastructure investment	• BESS optimally sized to offer peak power support can help defer infrastructure investment by extending the life of transmission and distribution equipment due to reduced loading.
Reduction of distribution losses	• By reducing power flow on the distribution network during peak period, the overall technical losses of the utility are reduced.
Support to DRE	• Battery energy storage helps balance the fluctuations in supply resulting from the variability of renewable energy generation sources in the network.
Voltage Support	• BESS can help maintain a flat voltage profile of the network by controlling the active power flow especially the high voltage during peak generation hours of solar PV by absorbing the excess generation
Reduction of UI penalties	• The UI penalties resulting from excess or shortfall of scheduled power can be reduced or avoided with the help battery storage system by absorbing or supplying the difference in power
Reliability Improvement	• By mitigating peak demand shortages, outages resulting from load shedding can be minimized thus improving the reliability of service of the utility.

Solar Rooftop with Battery & attached Value Streams

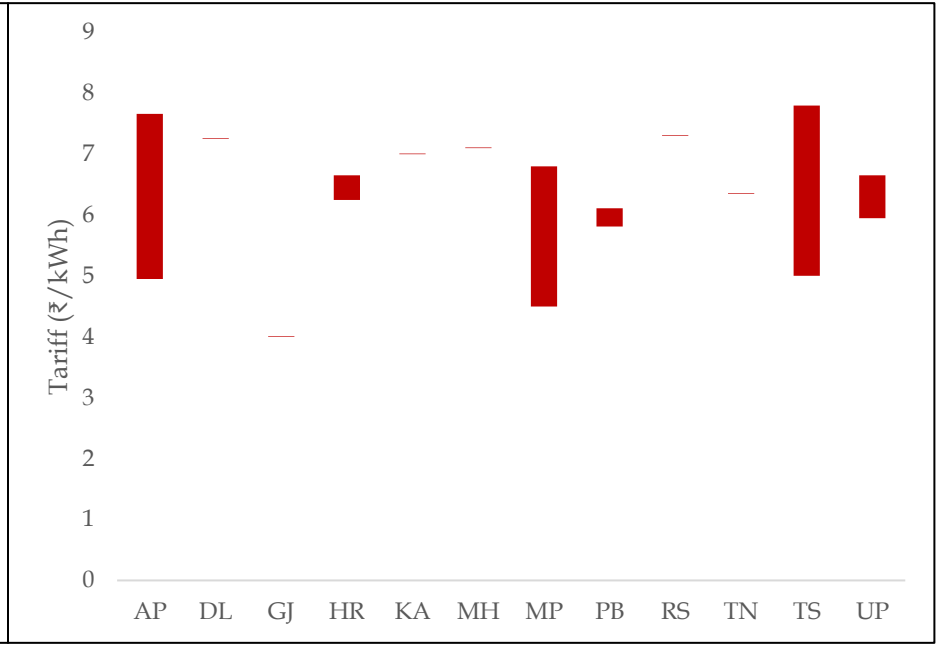




Commercial and Industrial Tariff range

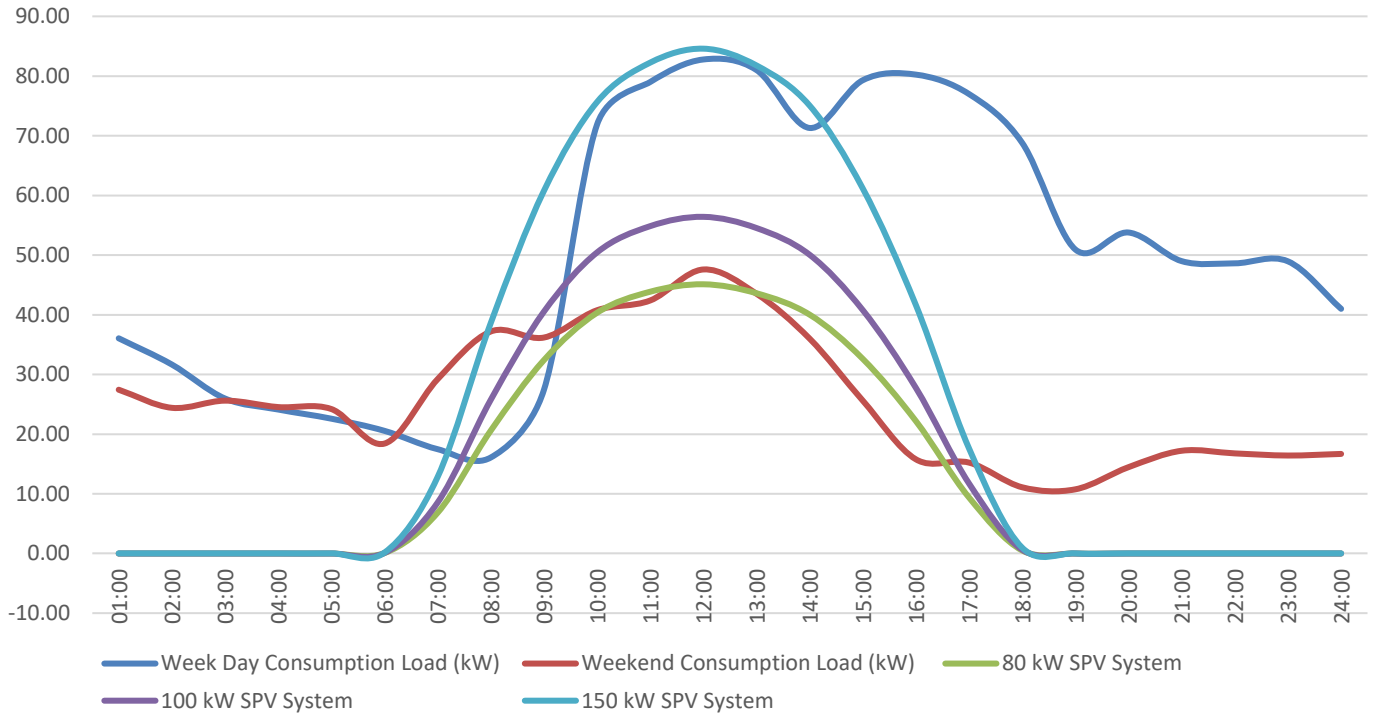


Commercial tariff range in different states



HT Industrial tariff range in different states

BESS at consumer level needs Load Curve Analysis



Comparative Analysis of Business Models

Benefits	Large Generation	Distribution connected	Consumer Projects	Remarks
Lower CoG	✓	✗	✗	Centralised plants are cheaper by 15-20% (only). **Modular nature of technology is making 'economies of scale' argument less relevant.**
Network Investment	✗	✓	✓	Huge investment in transmission required for centralised plants. Decreasing **utilisation of transmission assets with increasing VRE.**
T&D loss reduction	✗	✓	✓	**Distributed sources are deployed near the load centre. This reduces the losses significantly.**
Better Frequency	✓	✓		S + S makes project dispatchable thereby helping better management of frequency
Improves voltage & PF	✗	✓	✓	As generating source and load are nearby, this will improve voltage profile and Power Factor
Reduction in Outages	✗	✓	✓	Smart deployment of decentralised projects could help in reducing outages due to overloading of distribution n/w.
Capex Deferral	✗	✓	✓	Decentralise sources deployed with Battery storage will defer Capital Investment of DISCOMs.
Distr network design	✓	✗	✗	Distributed generation would require change in distribution network planning and operations philosophy.

Thank You

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