Design of Time of Use (ToU) Electricity Tariff in the state of Gujarat And Energy Storage Roadmap for Gujarat

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Project Scope

Design of Time of Use (ToU) Tariff for Electricity in the State of Gujarat

- Detailed feasibility analysis and recommendations for ToU tariff options
- Implementation methodology and possible impact of the ToU tariff options
- Development of implementation roadmap for the DISCOMs to implement ToU tariff including the infrastructure upgrades required
- Development of an Analytical Tool to assess different ToU options

Project Partners

Funded by**: Shakti Sustainable Energy Foundation**

Project Lead: **India Smart Grid Forum**

Supporting Partner: **Florence School of Regulation** (FSR), Italy

Subject Matter Expert: **Mr BP Singh** (Former Member, DERC)

Objectives of ToU Implementation

- Shifting of loads to reduce peak demand
- Avoidance of Peaking Power plants
- Renewable energy (RE) resources integration
- Deferral of distribution infrastructure upgrades
- Reduction in AT&C losses
- New market opportunities
- Enhanced revenue from higher tariff during peak hours

Technical Requirements

AMI: Ideally smart metering or Advanced Metering Infrastructure (AMI) is required for proper implementation of ToU

Software: Energy Management Software (EMS) is another prerequisite

Reliable Communication System: Reliable two-way communication system between the DISCOM and the customers on standard data/metering communication protocol is required

Smart Switches and Smart Appliances: Remotely controllable smart switches and smart appliances at customer premises to take advantage of the price signals

Policy and Regulatory Requirements

- Regulatory framework needs to be realigned for putting in place an effective ToU tariff regime
- Standardised methodology for computing dynamic tariffs is needed
- Roles and responsibilities of all the stakeholders (DISCOMs, Aggregators and Customers, etc.) needs to be defined in the tariff policy
- Incentive mechanism to be formulated for consumers adopting ToU tariff model
- Cost Benefit Analysis Framework to be prepared for assessing the RoI for the enabling infrastructure

ToU Consumer Survey

Consumer survey was carried out in UGVCL area to understand the awareness of consumers on electricity tariff matters and their willingness to participate in ToU

Geographical Area Covered: UGVCL Service Area
Number of Data Sources Received : 932
Number of Consumer Surveyed : 932
Number of Consumer Responded positively: 162
Limitations of the survey: The consumer survey was done in UGVCL area only, survey across Gujarat DISCOMs will fetch better results

Category	Responses
Agriculture LT	16
HT WW	1
Industries LTMD	43
Large Commercial HT	43
LT	1
LT WW	26
Residential LT	23
School Colleges LT	9
Total	**162**

Consumer Survey Response

- Consumers agreed on receiving subsidized smart switches (programmable thermostat) for heavy appliances
- People are willing to buy smart appliances provided sufficient incentives are offered
- Electricity bill should show the customers what they would have paid for the same electricity usage under a different rate structure based on time of electricity consumed and the money that the customer would have saved (shadow billing) before actual implementation of the Electricity Consumption Management Program

ToU Analytical Model Overview

Objective: Shifting the peak load to regular/off-peak hours to flatten the load curve with added incentives to consumer and no extra burden (preferably savings) to DISCOMS
The model focuses on reallocation of load from peak time of the day to comparatively non-peak period in order to reduce burden on the system and reduce cost. It has been designed for two categories of customers (a) LTMD (b) NRGP

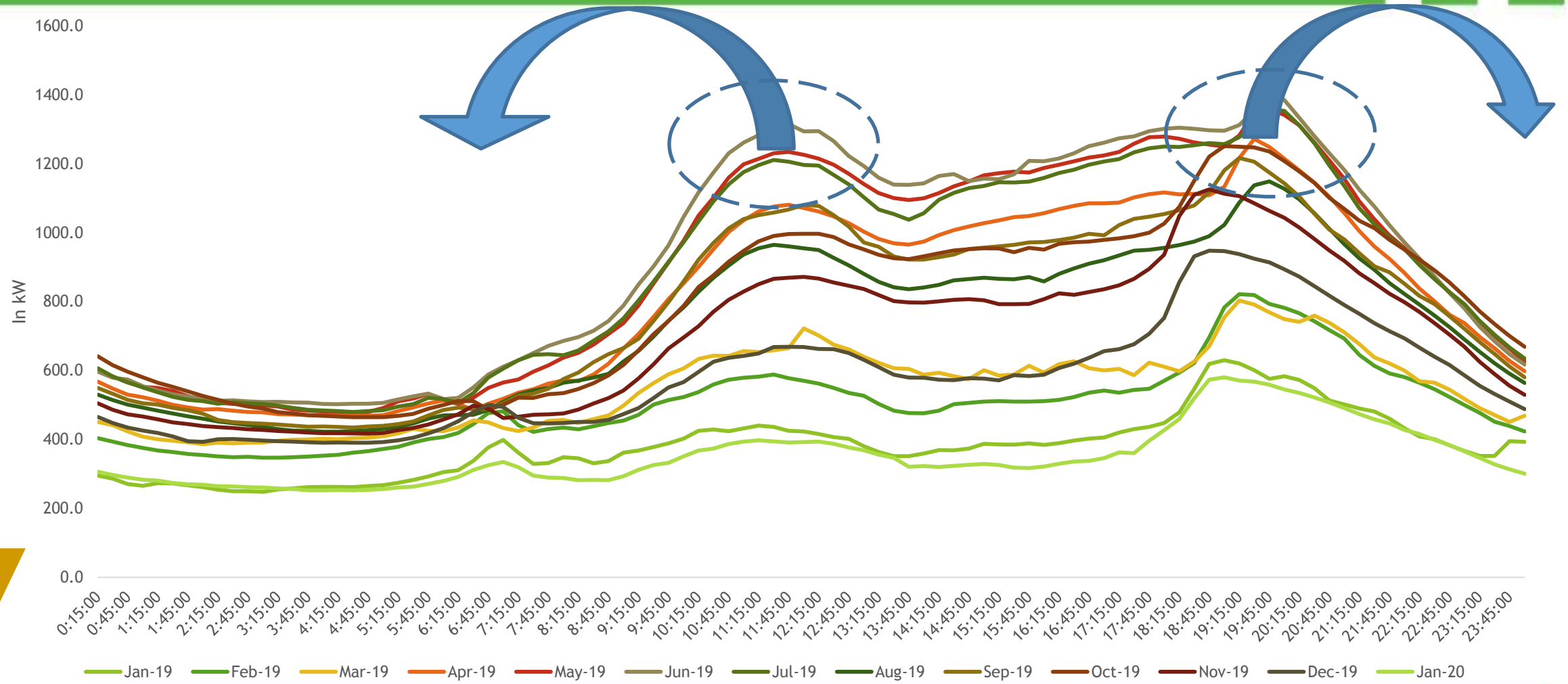
Geographical Area covered: Smart Grid Project Area in Naroda under UGVCL Service Area

Data Source and Type: Customer-wise consumption data across 96 slots in a day for the period Jan 2019 – Jan 2020

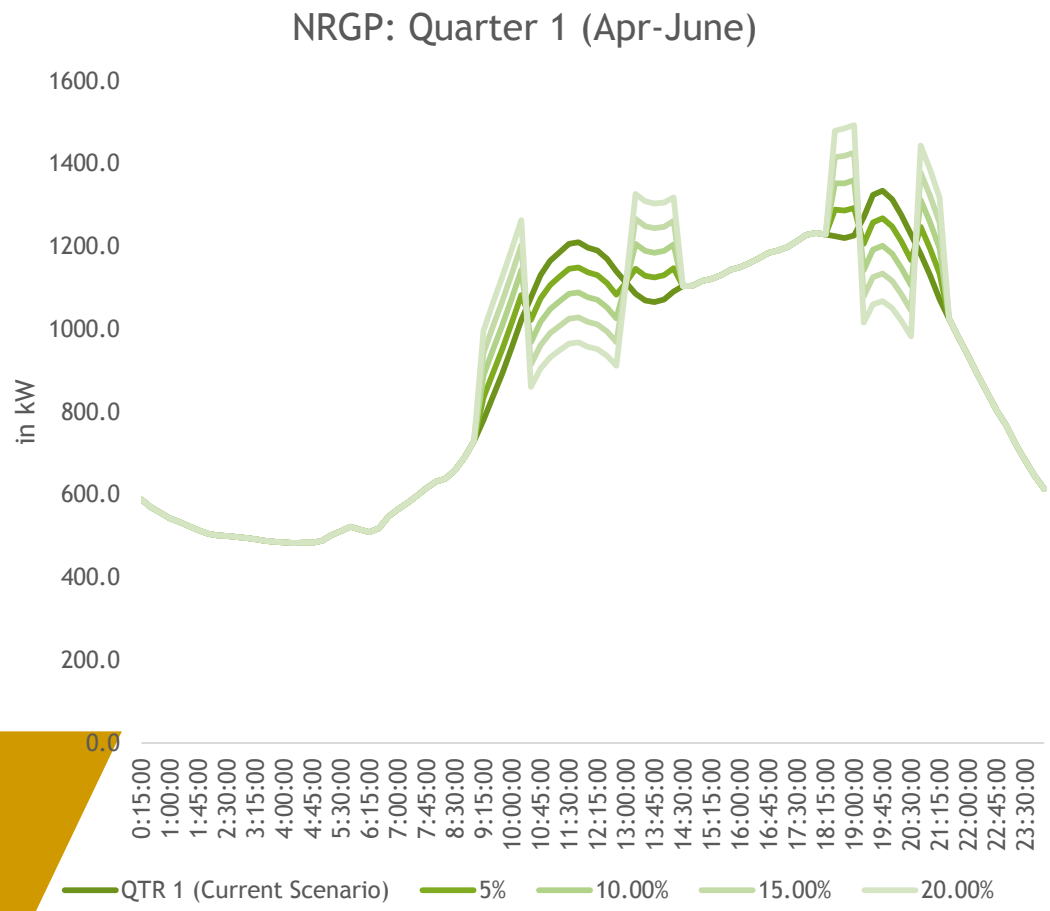
Limitations of the model: The model has been designed on the basis of one-on-one reallocation. This leads to a sudden spike in the curve due to shift in load. Upon application, however, the spike will comparatively gradual and will provide the system time to cope to the new usage trend

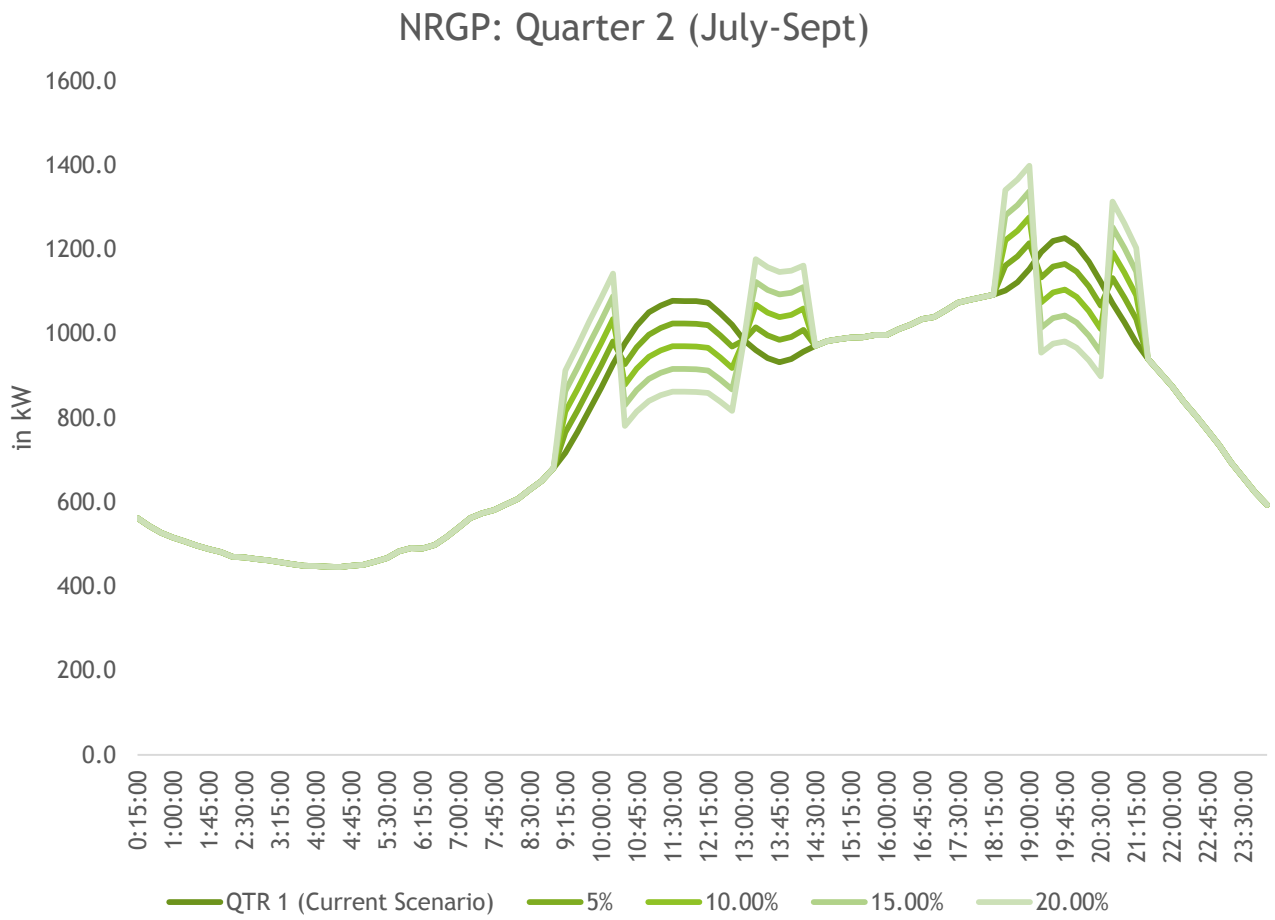
Experimental Night level shift: On an experimental basis, we have undertaken a case where load has been completely shifted from peak hour to late night off-peak hours. This will help to closely understand the potential success of this approach in case of proper implementation

Shifting The Load

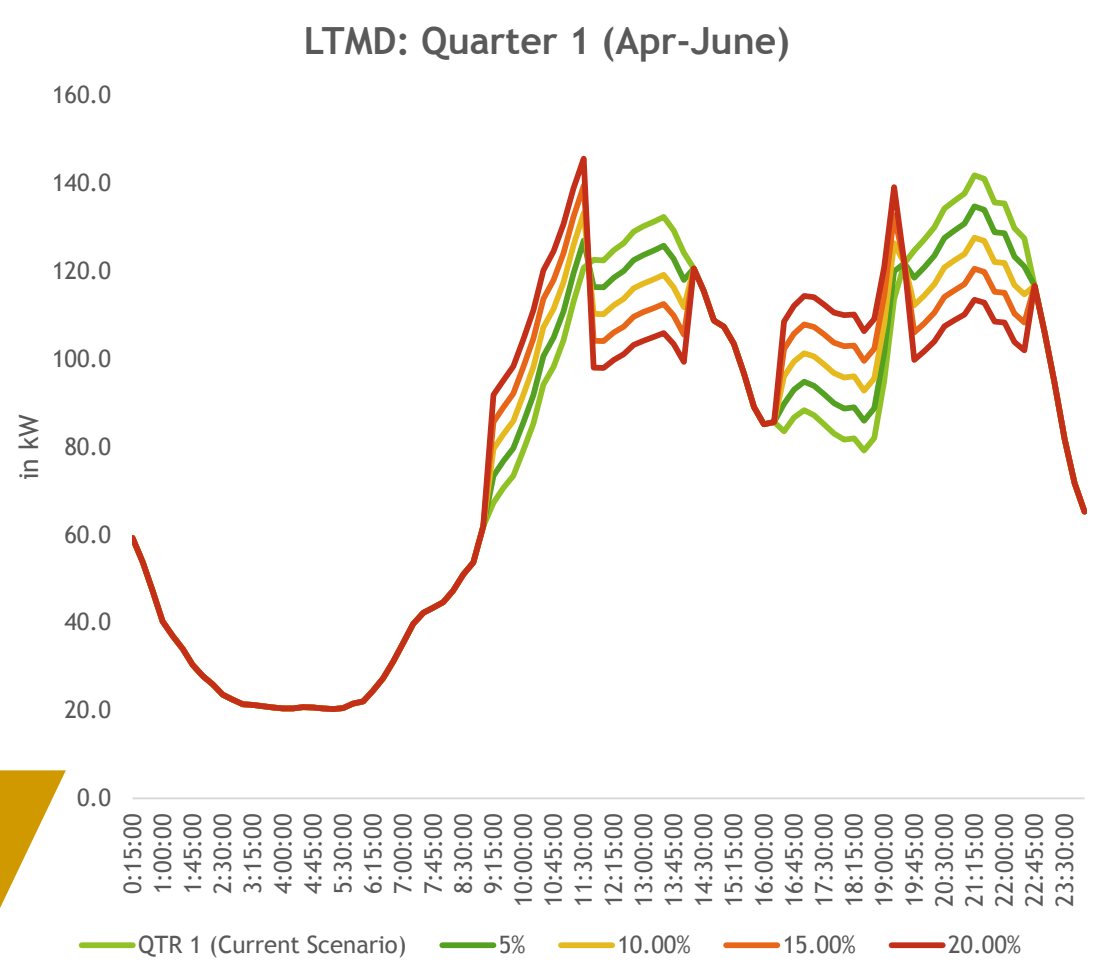


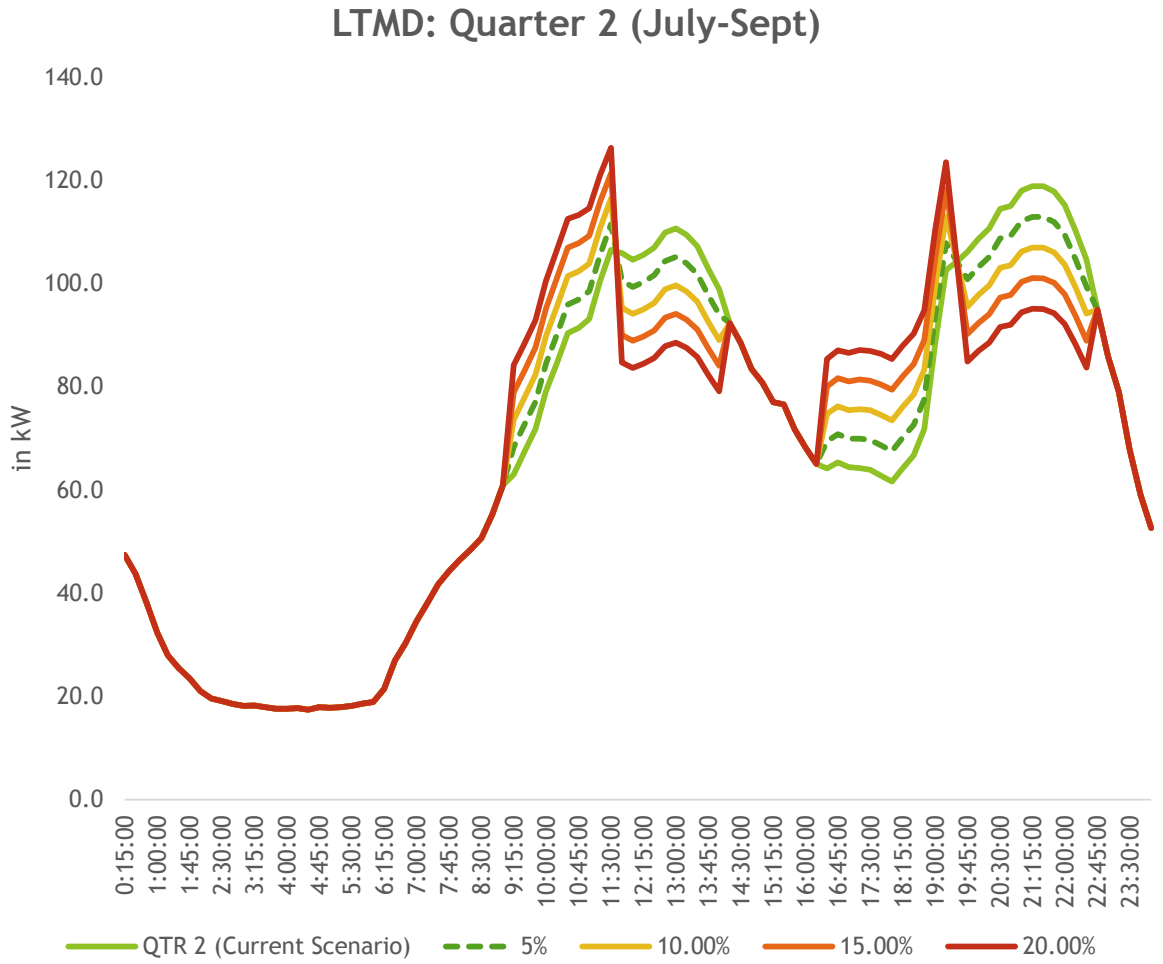
Impact of Load Shifting on NRGP Consumers





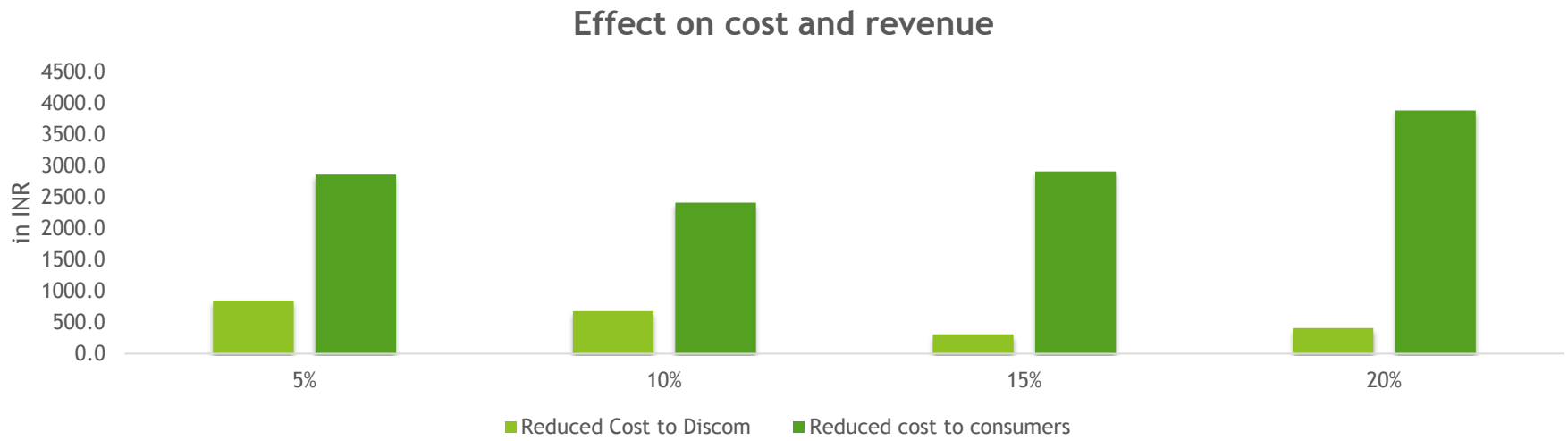
Impact of Load Shifting on LTMD Consumers





Effect of ToU on DISCOM & Consumers - NRGP

	Existing Rates (Assumed)*		ToU Rate per kWh (Assumed)			
Time slots	Buy Rate	Sell Rate	**5%**	**10%**	**15%**	**20%**
Peak	6.00	8.00	9	9.8	9.6	9.6
Regular	4.00	7.00	5	5	5	5
Off-peak	3.00	6.00	3	4	4	4

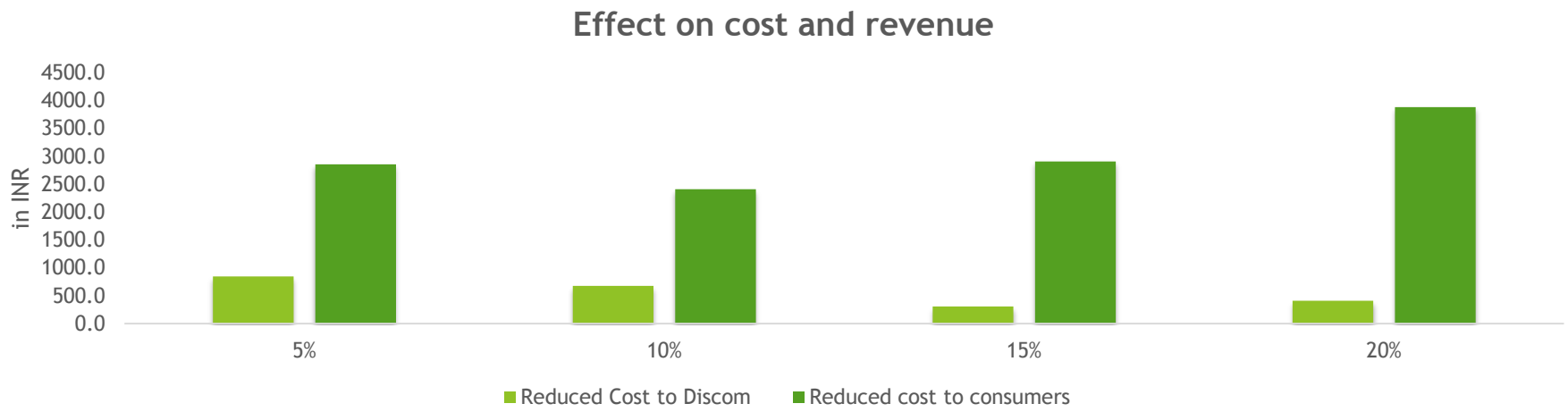


Reduced cost to DISCOMS is the difference between their revenue and cost respectively in both the scenarios
Reduced cost to consumers is the savings in total cost incurred comparing both the scenarios

*Buy, sell and ToU rates are assumed

Effect of ToU on DISCOM & Consumers: LTMD

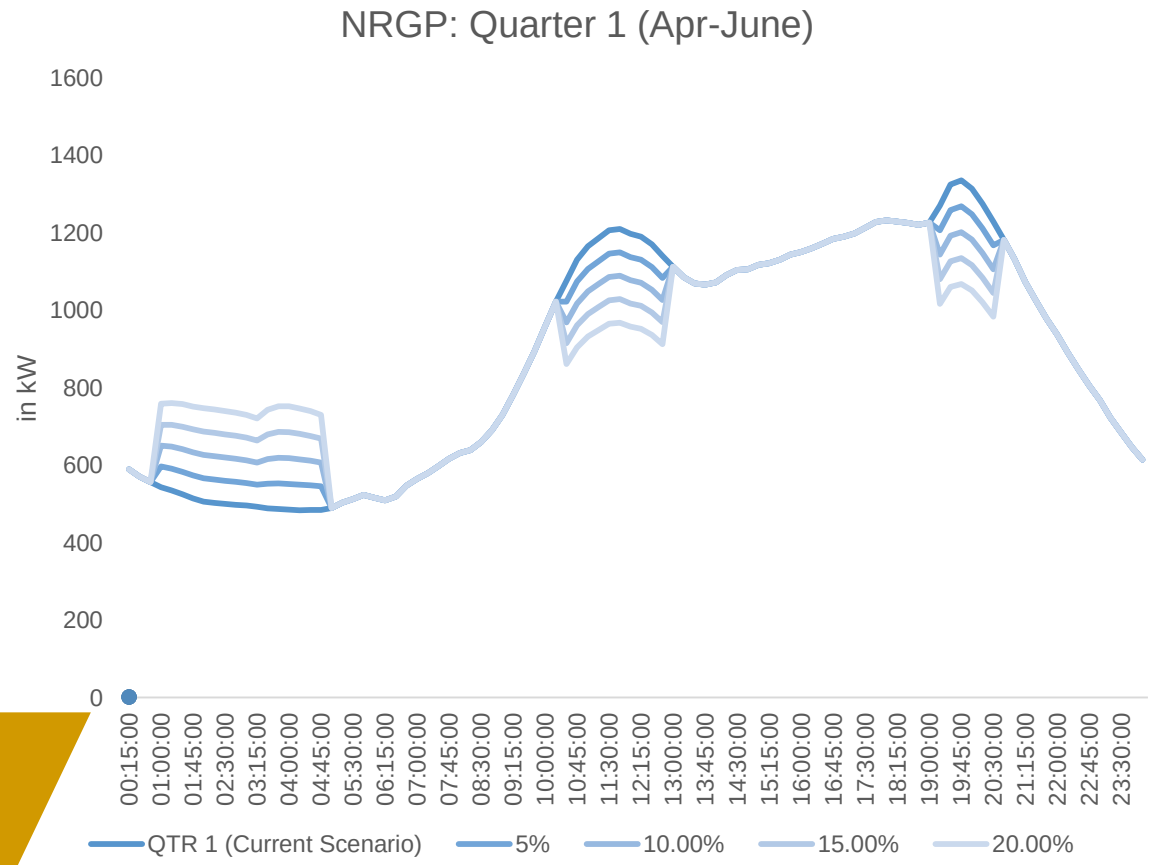
	Existing Rates (Assumed)*		ToU Rate per kWh (Assumed)			
Time slots	Buy Rate	Sell Rate	**5%**	**10%**	**15%**	**20%**
Peak	6.00	8.00	9	9.8	9.6	9.6
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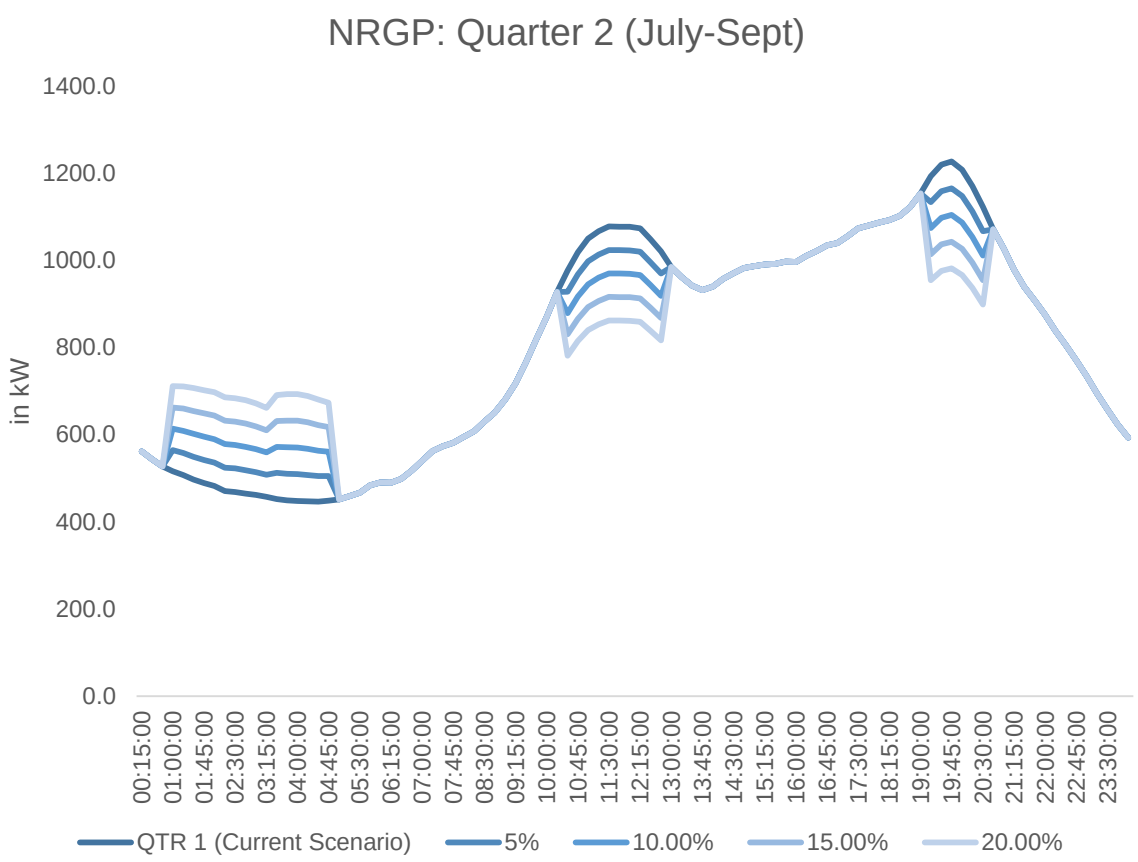


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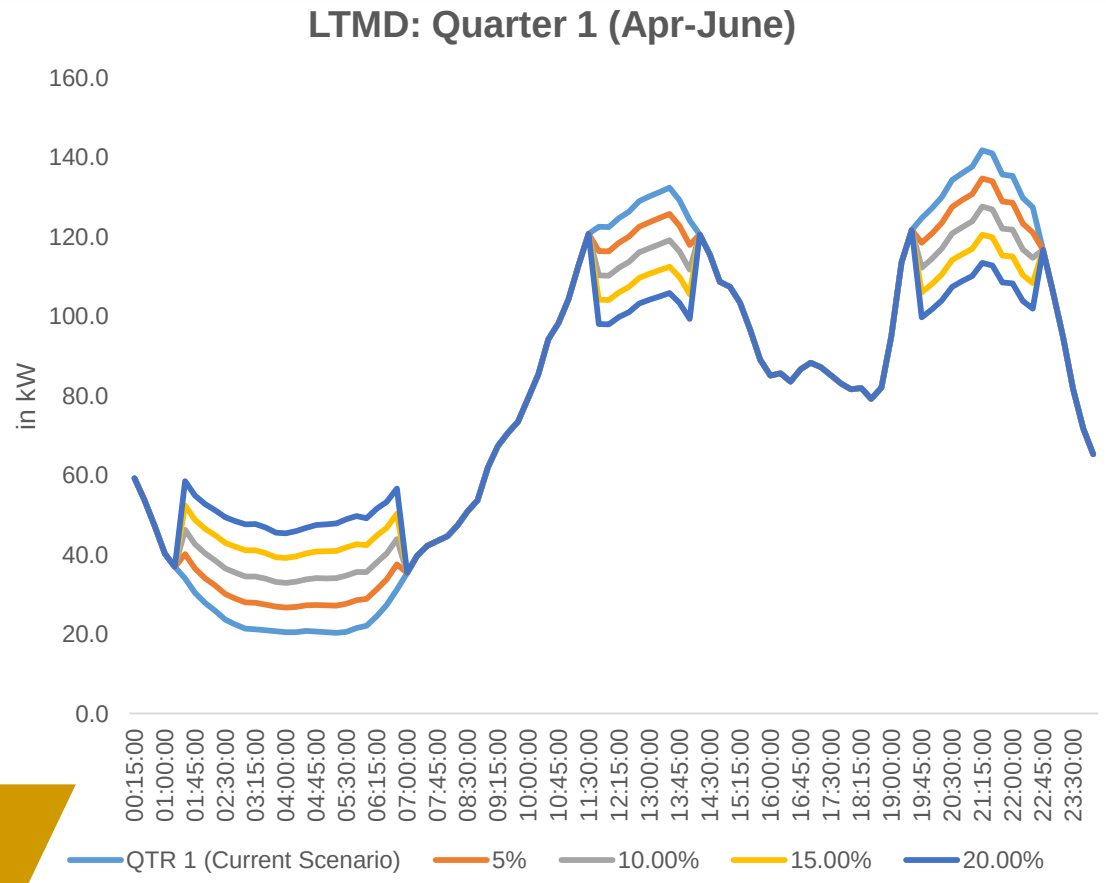
*Buy, sell and ToU rates are assumed

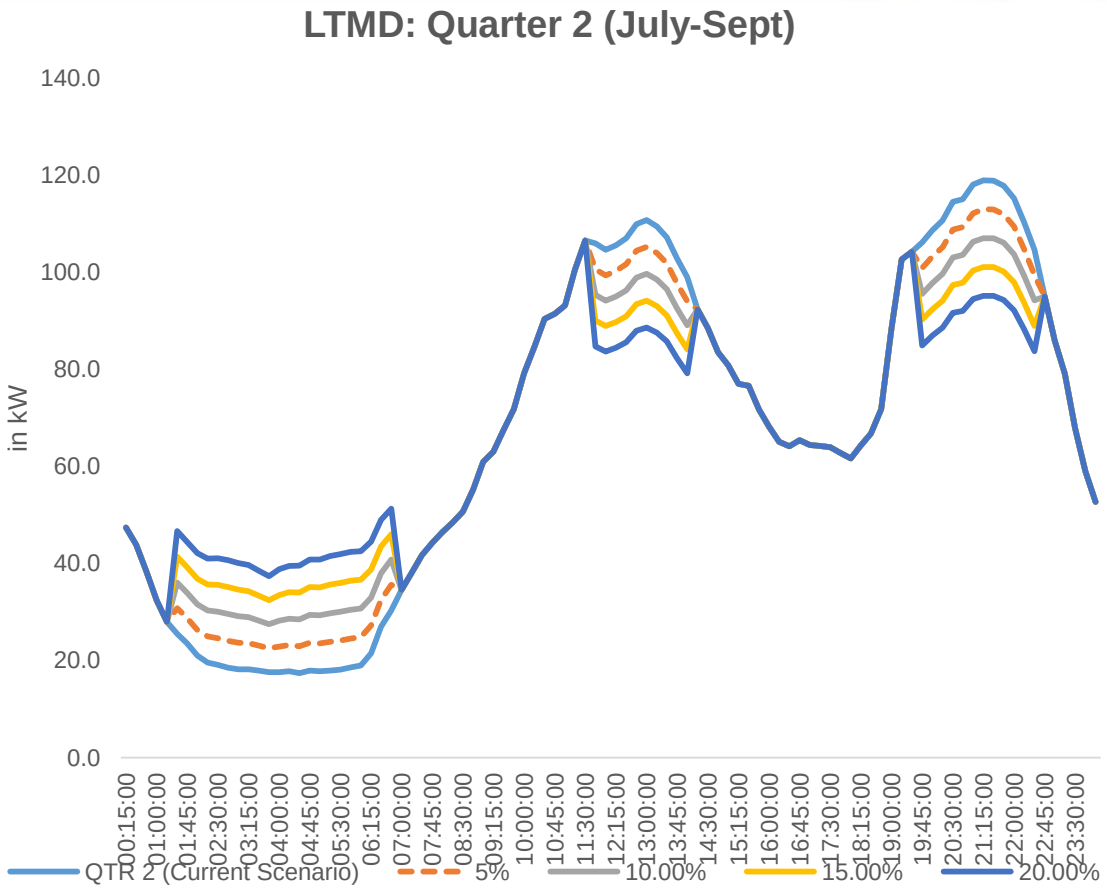
Impact of Load Shifting at Night on NRGP





Impact of Load Shifting at Night on LTMD





Key Findings

- People are open for new technology adoption and new tariff model in Gujarat
- Consumer awareness is one of the biggest concern
- Before going for ToU Model, consumer would want to see how this model is profitable for them
- Individual type of consumer has a different impact on total load curve of utility
- New tariff design should have a different approach for different type of consumer to manage utility scale load curve
- Shadow billing may be introduced to show the benefits to consumers if they adopted ToU before actual enrolment to the ToU program
- AMI rollout is planned nation-wide; hence should not be a constraint

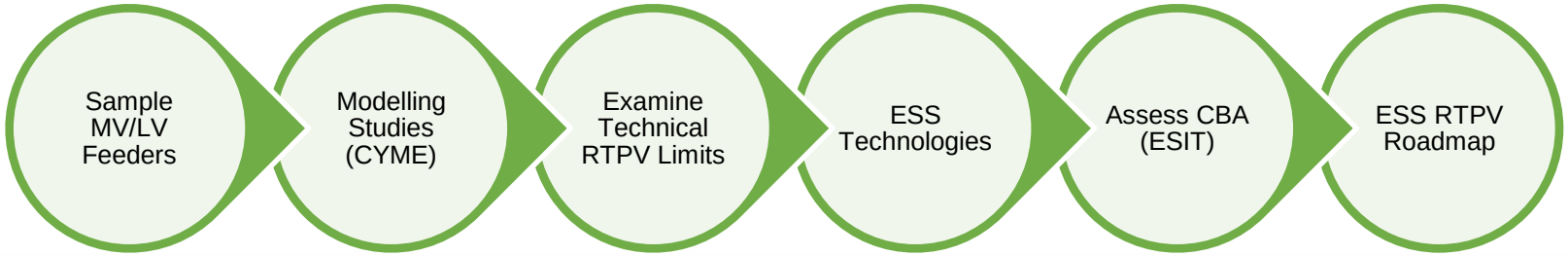
Energy Storage Systems (ESS) Roadmap for India: 2019-2032

https://indiasmartgrid.org/reports/ISGFESSReportFinal10Oct2019.pdf

Scope and Methodology of the Study

- MV and LV grid optimization to facilitate 40 GW RTPV by 2022 and more beyond 2022
- Energy Storage, Demand Response and EV Integration to address Intermittency of RTPV
- Estimation of Grid Connected Energy Storage, its Ideal Locations in each State
- Cost Benefit Analysis (CBA) of different Energy Storage Technologies for different Applications
- Energy Storage System (ESS) Roadmap for India: 2019 to 2032 – consolidated

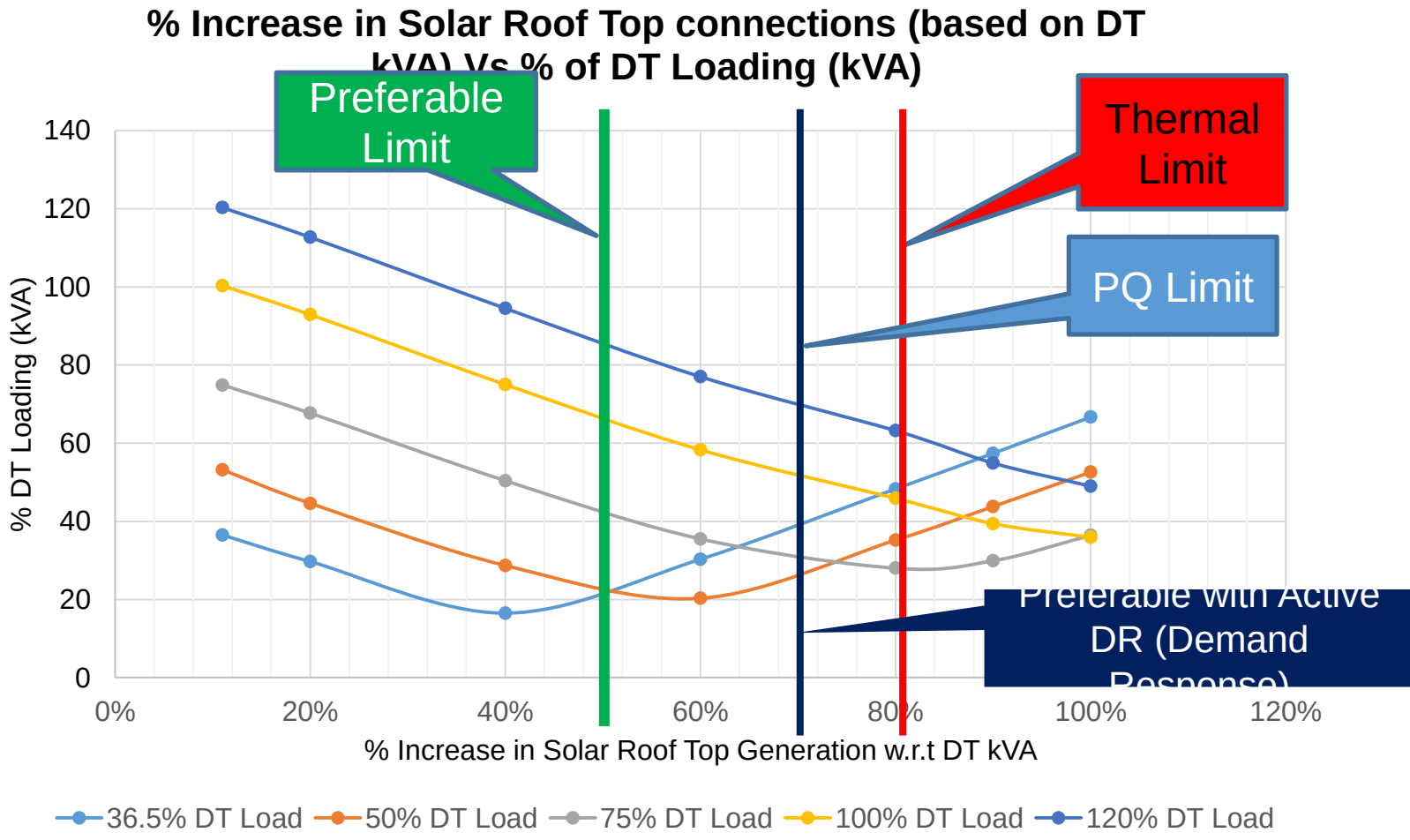
Methodology



Typical Analysis Urban Lightly Loaded Feeder (TPDDL)

Observations

- Thermal Limit: 80% of RTPV connections
- PQ Limit: 75% of RTPV connections
- Considering harmonics and uncertainty of clouds, permissible limit for RTPV connections can be 50% of DT Capacity



Study Findings

RTPV





Battery

1. **50-60% RTPV** possible **with smart inverters** (nodal voltage control using inverter PF control – this will need code changes as well as incentives for ancillary services)
2. In cities, DT LT connections to homes are very short lines (TPDDL study). So, no PQ problems; this will change in city-edge/rural feeders. **Hence 50% is the likely limit**
3. **Study assumes 1.0 pu voltage**; this is rarely the case. In most cases the source voltage could be at 0.98 pu or even lower. **This will lead to more PQ violations**
4. By **adding RTPV decreases the nodal pf at that location** (with unity pf inverters deployed). So residential pf could get worse
5. 11kV PQ problems will come if the feeder has sufficient PVs (say 5-10MVA on 11kV) particularly at the feeder end
6. Study have not looked into harmonic effects (non-linear load interacting with inverters)

Consolidated Energy Storage Roadmap for India

	Consolidated Energy Storage Roadmap					
	Applications		Energy Storage (GWh)			
	2019-2022		2019-2022	2022-2027	2027-2032	Total by 2032
Stationary Storage	Grid Support	MV/LV	10	24	33	67
		EHV	7	38	97	142
	Telecom Towers		25	51	78	154
	Data Centres, UPS and inverters		80	160	234	474
	Miscellaneous Applications (Railways, rural electrification, HVAC application)		16	45	90	151
	DG Usage Minimization		-	4	11	14
	Total Stationary (GWh)		138	322	543	1,002
Electric Vehicles	E2W		4	51	441	496
	E3W		26	43	67	136
	E4W		8	102	615	725
	Electric Bus		2	11	44	57
	Total Electric Vehicles (GWh)		40	207	1,167	1,414
Total Energy Storage Demand (GWh)			178	529	1710	2416

Energy Storage Estimations for MV/LV Grid

Estimations	2019	2022	2027	2032
Generation (GW)				
Thermal	209	NA	NA	NA
Hydro	43	NA	NA	NA
Nuclear	6	NA	NA	NA
Solar	26	107	244	349
Ground Mounted Solar	24	68	148	206
RTPV	1.5	40	98	144
Connected to EHV	14	34	66	94
Connected to MV	11	35	84	112
Connected to LV	2	40	98	144
Wind	35	NA	NA	NA
Small Hydro	4.5	NA	NA	NA
Biomass & Biopower	10	NA	NA	NA
Peak Load (GW)	192	333	479	658
Energy (BUs)				
Annual Energy	1192	1905	2710	3710
Storage Recommended (MWh)				
Battery (LV)	241	5908	14617	21484
Battery (MV)	1054	3482	8393	11191
Total (MWh)	**1295**	**9390**	**23010**	**32675**
Approximate (GWh)	**1 GWh**	**10 GWh**	**24 GWh**	**33 GWh**

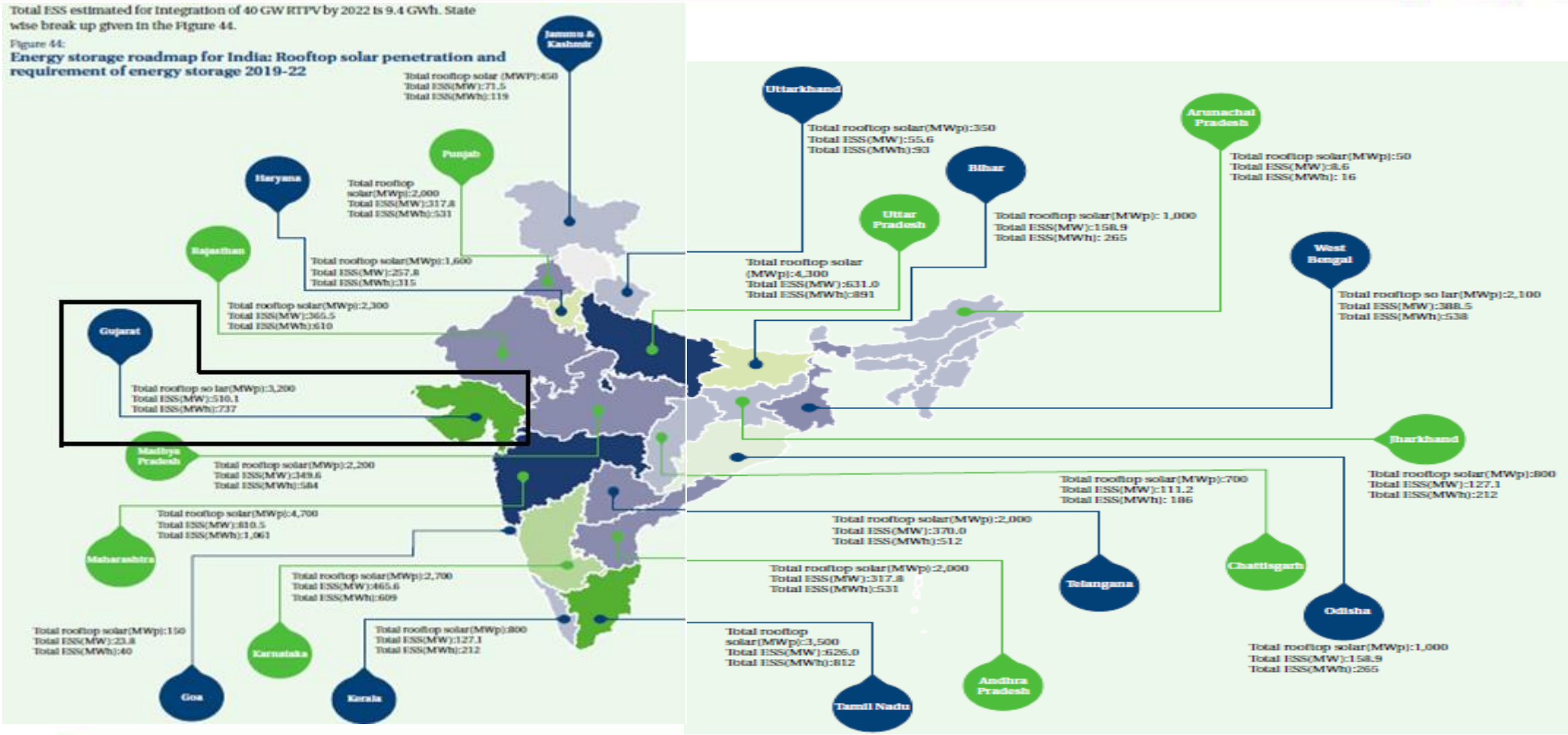
RTPV Penetration and ESS Requirement by 2022

India Smart Grid Forum

Total ESS estimated for Integration of 40 GW RTPV by 2022 is 9.4 GWh. State wise break up given in the Figure 44.

Figure 44:

Energy storage roadmap for India: Rooftop solar penetration and requirement of energy storage 2019-22



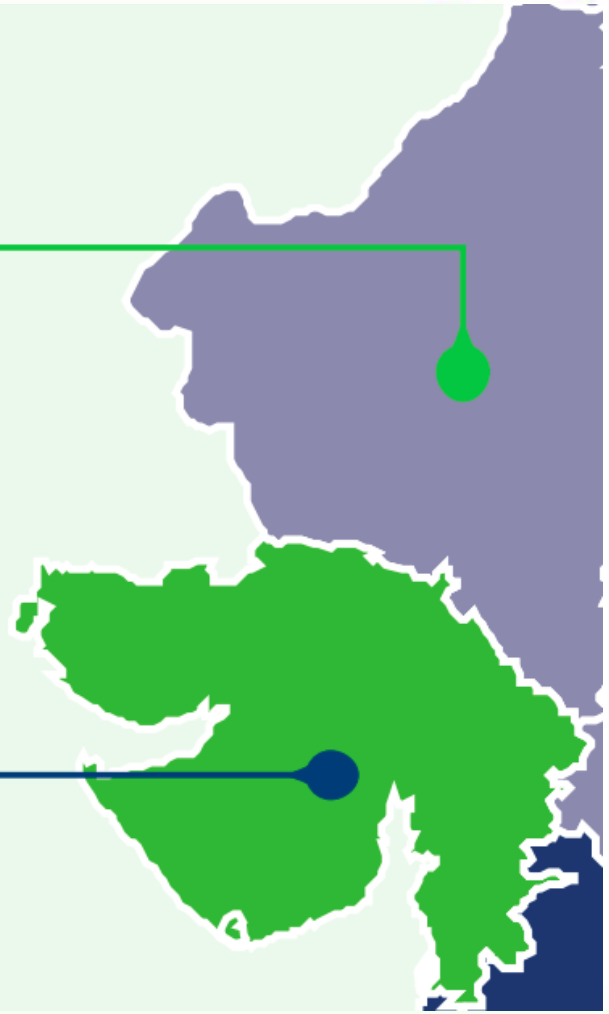
RTPV Penetration and ESS Requirement by 2022

India Smart Grid Forum

Gujarat

Total rooftop solar(MWp):2,300
Total ESS(MW):365.5
Total ESS(MWh):610

Total rooftop so lar(MWp):3,200
Total ESS(MW):510.1
Total ESS(MWh):737



Madhya

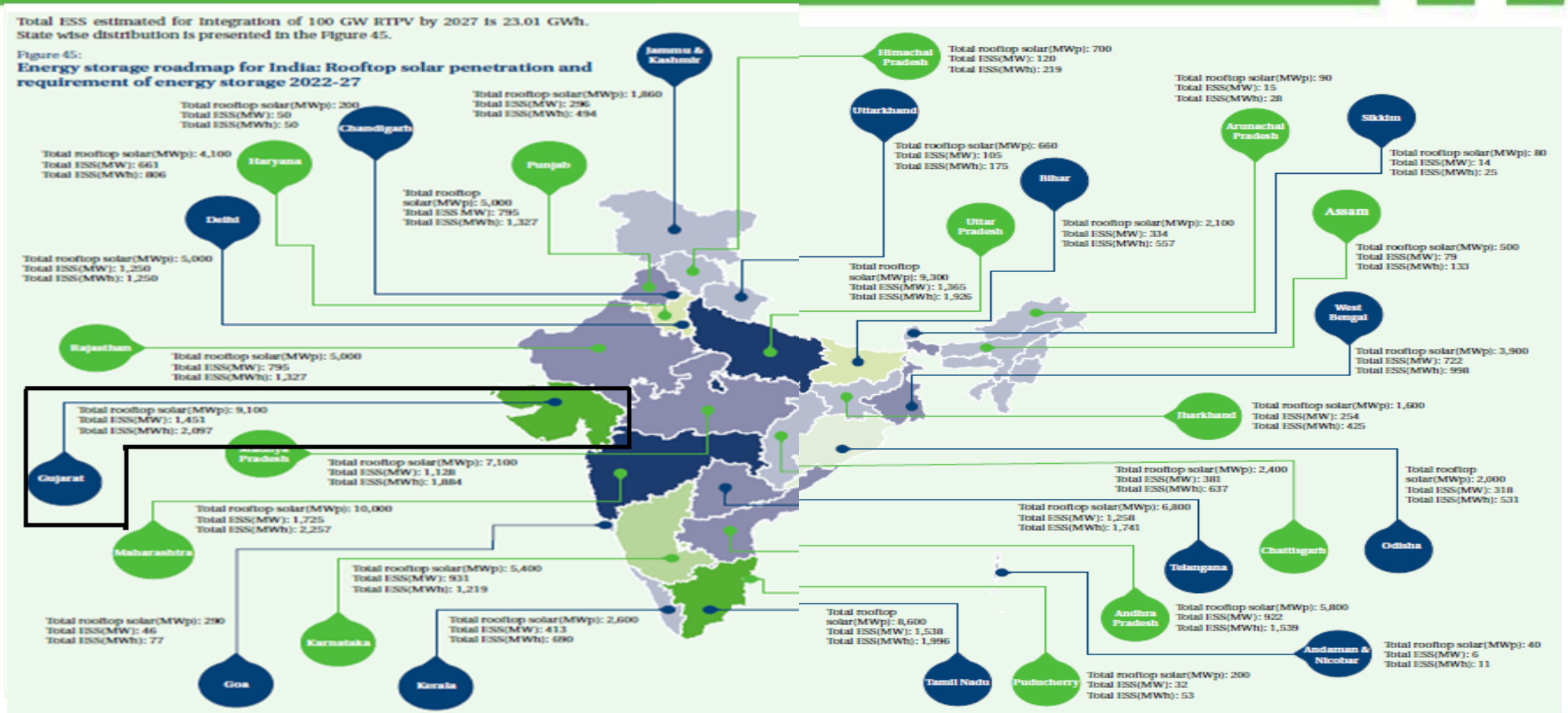
RTPV Penetration and ESS Requirement by 2027

India Smart Grid Forum

Total ESS estimated for Integration of 100 GW RTPV by 2027 is 23.01 GWh. State wise distribution is presented in the Figure 45.

Figure 45:

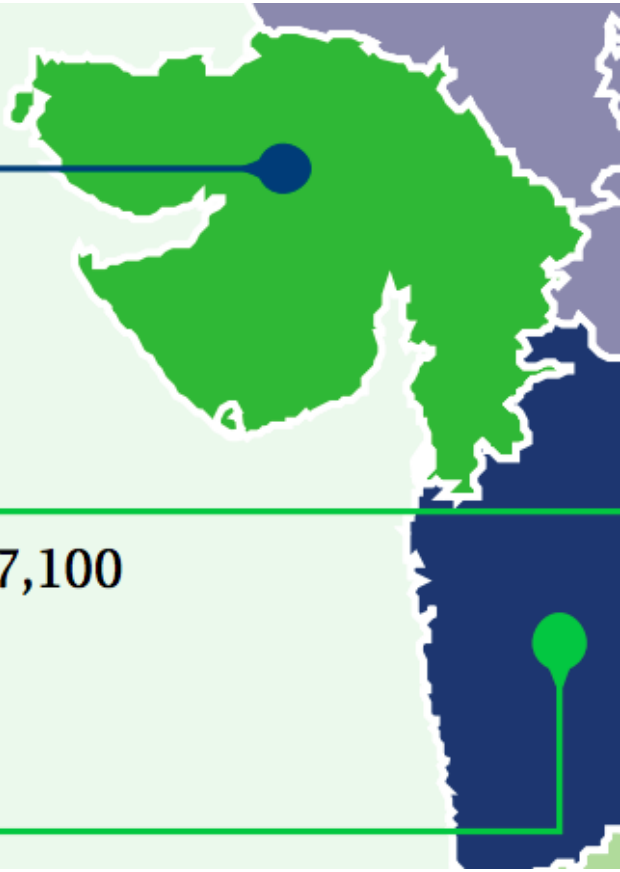
Energy storage roadmap for India: Rooftop solar penetration and requirement of energy storage 2022-27



RTPV Penetration and ESS Requirement by 2027

India Smart Grid Forum

Total ESS(MWh): 1,327



Gujarat

Total rooftop solar(MWp): 9,100
Total ESS(MW): 1,451
Total ESS(MWh): 2,097

Madhya Pradesh

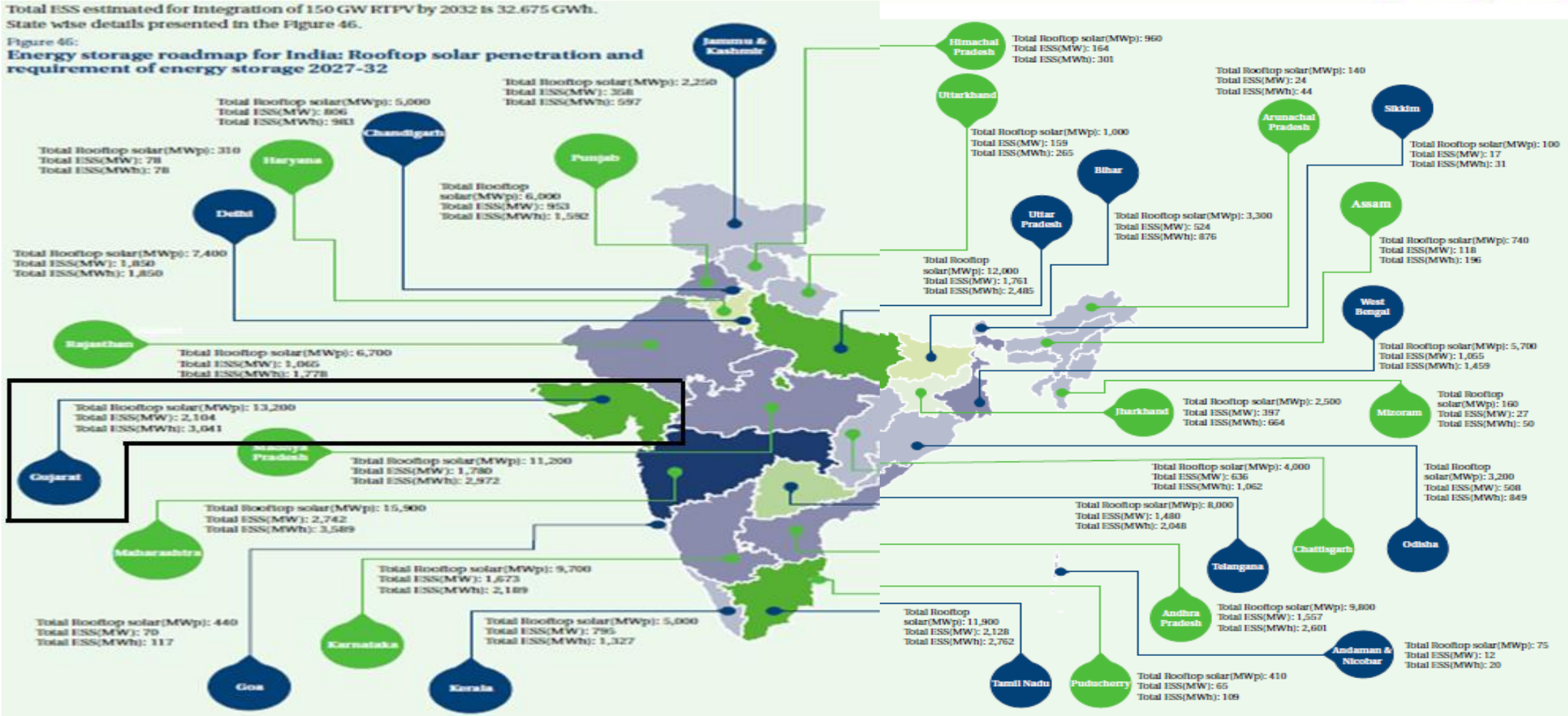
Total rooftop solar(MWp): 7,100
Total ESS(MW): 1,128
Total ESS(MWh): 1,884

RTPV Penetration and ESS Requirement by 2032

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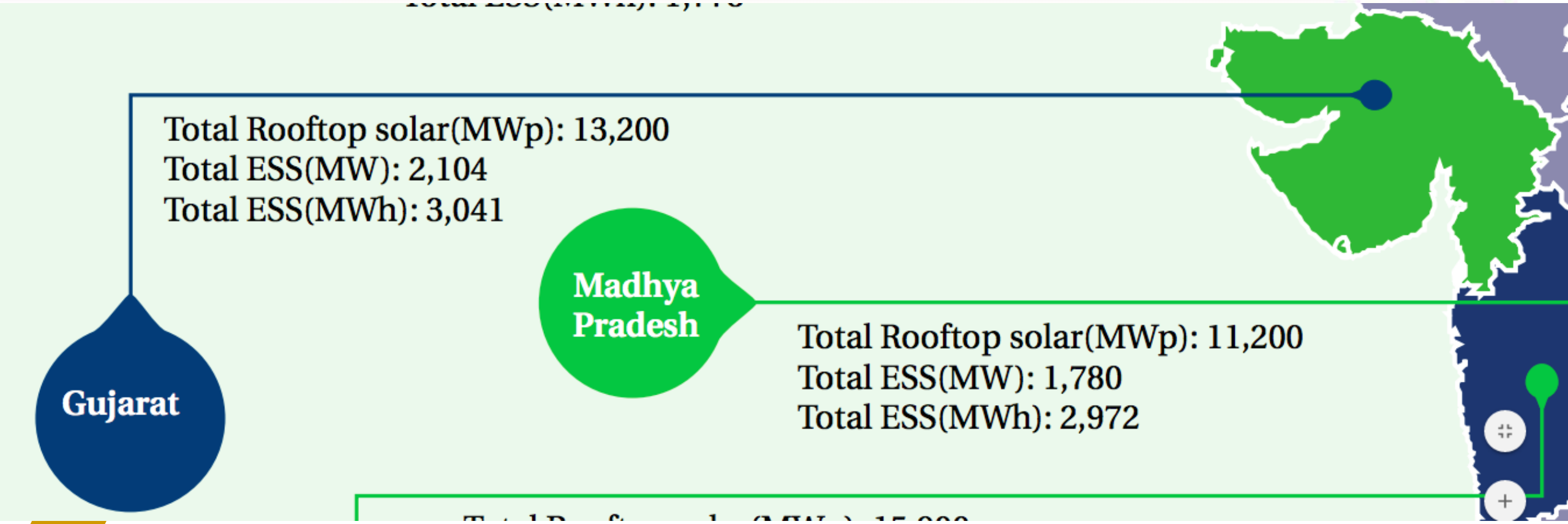
Total ESS estimated for Integration of 150 GW RTPV by 2032 is 32.675 GWh.
State wise details presented in the Figure 46.

Figure 46:
Energy storage roadmap for India: Rooftop solar penetration and requirement of energy storage 2027-32



RTPV Penetration and ESS Requirement by 2032

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