MINUTES OF SIXTH MEETING OF "STANDING TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEOWORK ON RENEWABLE AT STATE LEVEL-GROUP-I & II
(Through Video Conference)

Day and Date: Monday, 17th May 2021

List of Participants: Annexure-1(Enclosed)

The Sixth meeting of the FOR Standing Technical Committee was held on 17th May 2021 under the Chairmanship of Shri I. S. Jha, Member CERC. At the outset, the Chairperson welcomed all the participants and special invitees. He gave a brief update on the current state of electricity sector and also emphasized that digitalization of the grid will encourage more consumer participation and enhance stability of the system. He gave brief background of the agenda items to be deliberated in the meeting. Thereafter agenda items were taken up for consideration.

Agenda Item No.1: Confirmation of minutes of the 5th meeting of the Standing Technical Committee held on 16th April, 2021

2. The members of the Standing Technical Committee considered and endorsed the minutes of the 5th meeting of the Standing Technical Committee held on 16th April, 2021.

Agenda Item No. 2: Status Update on Smart Grid/Smart Meter

3. Representative from the Central Transmission Utility (CTU) presented an update on the Smart Meter roll out programme (**Annexure-II**). It was informed that around 24 lakhs smart meters have already been installed in the distribution network till date and around 75 lakhs smart meters are under implementation stage. The smart metering arrangement adopted in the distribution network have bidirectional communication, data transfer, remote operation, automated meter reading and outage detection features. According to him adoption of smart meters will empower the consumers to actively participate in the energy management process. However, the limited financial resources with Discoms, consumer awareness are the challenges in roll out of smart meters. It was proposed that simple tariff structure with regulatory enforcement would facilitate smooth and effective implementation of prepaid metering.

4. Representative of Energy Efficiency Services Limited (EESL) presented on the subject matter sharing their experience in implementing smart metering projects across various States **(Annexure-III)**. It was informed that 10 lakh smart meters have been installed in India in the last 15 months and out of which 6 lakh meters have been installed during Covid times. In order to reach the target installation of 3 crore smart meters, nearly 80 lakh smart meters would have to be installed every year with an investment of about Rs 1.5 lakh crore. According to him, the smart metering and solarisation of agriculture feeders would be help reduce unmetered supply of electricity and the burden of agriculture subsidy. It was informed that EESL has adopted an OPEX model wherein they act as Meter Asset Providers (MAPs) which owns the smart meters and give Metering as a Service (MAAS) to the distribution utilities. It was also updated that the company has more than 78 lakhs operational smart meters and has targeted to achieve a collection efficiency of more than 98% with advanced data analytics in place. According to him, the monthly gain to Discoms is around Rs 225 per meter whereas smart meter charges are in the range of Rs 75-110 per month per meter for Discoms which are expected to come down with economy of scale. It is also claimed that the billing and collection efficiency have significantly improved after the installation of smart meters in the State of Uttar Pradesh, Haryana, Bihar and Delhi (NDMC). It is recommended that metering regulations and policies may be revisited and State Regulators may consider to set up smart meter implementation targets.

5. Members of the Committee appreciated both the presentations and deliberated on technical and operational aspects of implementation of smart meters. Some members enquired about possibility of tampering of smart meters, reliability of communication system in low network signal areas. It was clarified that smart meters have facility to record all tampered events which can be identified on real time basis. On the issue of reliability of network signal, it was informed that low network areas have been upgraded after consultation with telecom companies in the respective areas.

6. Some members also sought information regarding compatibility of smart meters after network upgradation by telecom industry. It was also pointed out that meter rent of Rs 70 per month per meter for eight years may increase burden on small consumers and need to

be evaluated carefully for small consumers. Based on the discussions following suggestions were made:

- The cost of smart integrated meter data management system is on higher side as of now and needs to be ensured that burden of smart meter on the consumers is minimal.
- The cost benefit analysis and feasibility study need be carried out before rolling out the smart meters for small consumers.
- Phased implementation would be advisable. Consumers with higher consumption may be targeted in the initial phases.
- A strong backend IT infrastructure along with data security measures need to be in place for roll out of small meters. Narrow Band -Internet of Things (NB-IoT) technology may also be explored being cheaper than GPRS for data transmission.
- Compatibility of smart meter with the existing provision of the Act in terms of disconnection of supply in default of payment need to be studied in detail.
- Meter testing certification is important to build confidence in the consumers and should be in line with CEA standards of meter testing.
- Discoms and consumers need to be taken on board while replacing the existing meters by smart meters.

Action Point (s) / Decision(s):

The Committee noted the presentations made by representatives of CTU and EESL on Smart Grid / Smart Meters.

Agenda Item No.3: Reference from FOR on Impact of Renewable Energy Integration on Tariff

7. Representative of the consultant made a presentation on the impact of renewable energy integration on States (**Annexure-IV**). He briefed about the methodology adopted in the CEA report in estimating balancing cost of renewable integration into the system along with the approach proposed by the Chairperson UPERC in the 69th FOR meeting dated 20.09.2019. It was informed that analysis for the State of Chhattisgarh has been done with a production cost estimation with PLEXO model for different demand scenarios for 2030 i.e., without RE addition, with RE addition and shifting agricultural load to solar hours to better absorb RE.

8. Representative of KERC presented the operational challenges of RE integration in the State of Karnataka (**Annexure-V**). It was highlighted that to incorporate increased RE generation in the State, most of the thermal generations are being backed down. It was informed that with high penetration of must run RE projects, surplus generation in the State is being sold through various avenues but this is not enough and the State is left with a lot of stranded assets and costs. It was proposed to develop a mechanism to share the burden of fixed charges of thermal capacity in the State to reduce burden on consumers. It was clarified that the report on 'Analysis of Factors impacting Retail Tariff and Measures to Address Them' which was recently endorsed by the FOR has analyzed the cost of stranded assets in some States and has recommended some measures in this regard.

9. Some Members pointed out the difficulties in projecting long term demand and suggested to analyze a scenario with lower demand realization than expected in EPS Projections. Some members pointed out that the transmission cost considered in the study is on the higher side and the RE balancing cost for the RE rich state and non-RE rich state would be different and need to be analyzed separately.

Action Point (s) / Decision(s):

The Committee appreciated the presentation made by the Consultant and emphasized that the cost of balancing RE power will vary depending on State's load projection. Therefore, there is a need to expand the analysis on the impact of RE integration study for RE rich and non-RE rich States separately along with pan India level analysis. The Consultant may present their analysis with findings in subsequent meetings.

10. The meeting ended with a vote of thanks to the Chair.

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ANNEXURE – I

LIST OF PARTICIPANTS ATTENDED THE SIXTH MEETING OF RECONSTITUTED TECHNICAL COMMITTEE (COMBINED GROUP- I & II) HELD ON 17.05.2021.

Members

S. NO.	NAME & DESIGNATON	ORGANIZATION
01.	Shri I.S. Jha, Member	CERC
02.	Shri M. Chandrasekar, Chairperson	TNERC
03.	Shri D.K. Sharma, Chairperson	HPERC
04.	Shri R.K. Choudhary, Member	BERC
05.	Ms. Anjuli Chandra, Member	PSERC
06.	Shri Durgadas Goswami, Member	WBERC
07.	Shri K.K.Sharma, Member	UPERC
08.	Shri H.M. Manjunatha, Member	KERC
09.	Shri Thakur Rama Singh, Member	APERC
10.	Shri KVS Baba, Chairman	POSOCO
11.	Dr. S.K. Chatterjee, Chief (RA)	CERC
Special Invitee		
12.	Shri Vijay Menghani, Chief (Engg.)	CERC
13.	Shri S.K.Soonee, Advisor	POSOCO
14.	Shri Sameer Saxena, Chief General Manager	POSOCO
Guest Speakers		
15.	Shri Subir Sen, COO	PGCIL

16.	Shri Saurabh Kumar, Executive Vice Chairperson	EESL
Other Participants		
17.	Ms. Rashmi Nair, Dy. Chief (RA)	CERC
18.	Shri Ravindra Kadam, Advisor (RE)	CERC
19.	Shri N Pradeep Kumar, Dy Director	KERC
20.	Shri Siddhant Raj Singh, RA	CERC
21.	Shri Anish Mandal	Deloitte/GTG-RISE
22.	Ms Rashmi Gupta	Deloitte
23.	Shri Nirmal Shaju	Deloitte

Annexure-II

SMART METER ROLLOUT

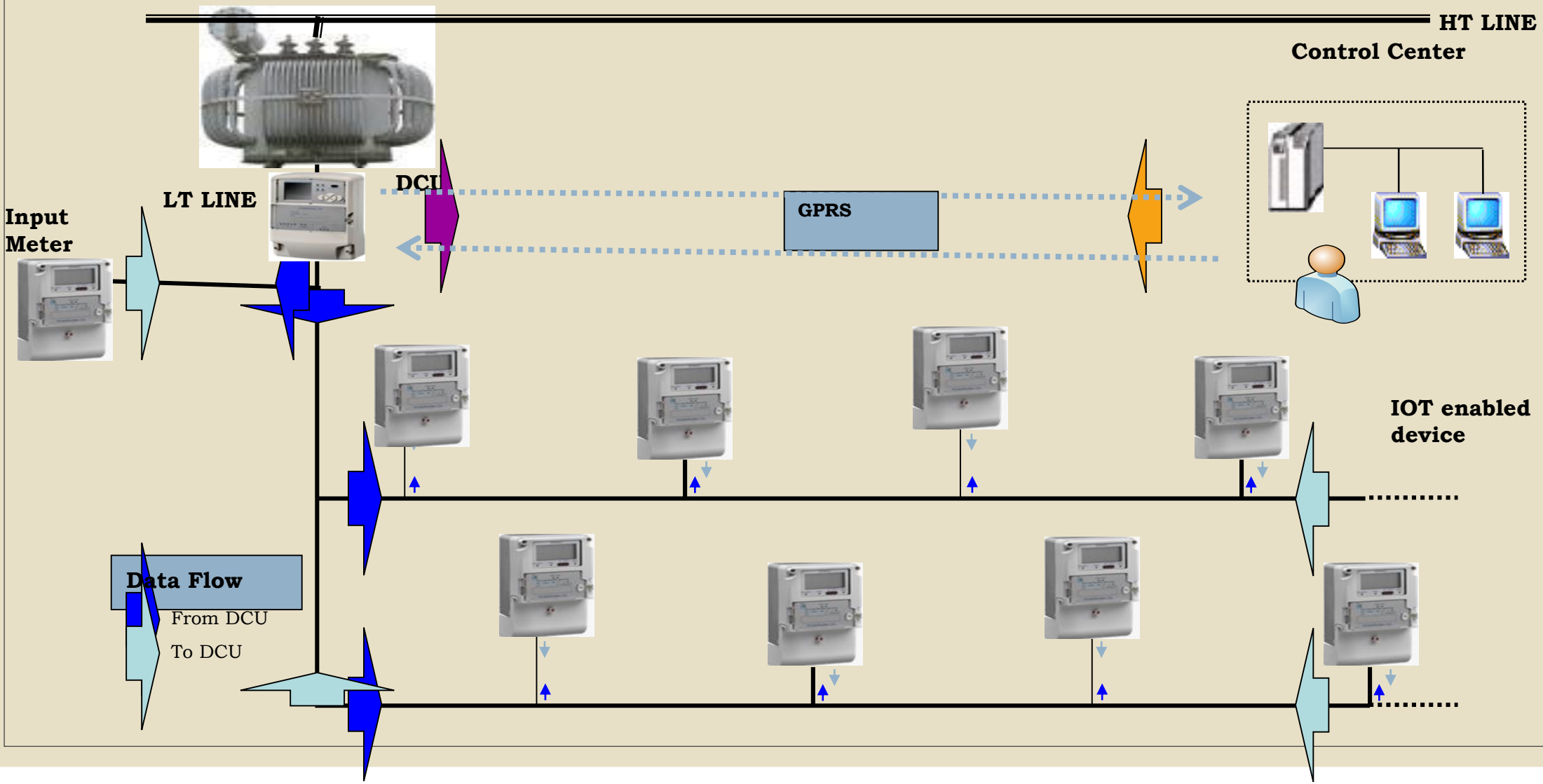
Forum of Regulators

May 17th 2021

Implementation Status

Deployment Completed	24,20,126 smart meters
	List of Projects
Ongoing Deployment	75,24,565 smart meters
	List of Projects

Typical Smart Metering Arrangement



Smart Meter Features

- Consumer connect/disconnect through Remote operation for overdue payment
- Real time energy audit up to DT level & feeder level
- 100% Automated meter reading for bill generation
- Easy customer category identification
- Outage detection and consumers affected
- Consumer Engagement & empowerment with greater control over their energy use and bill
- Improved quality & reliability of power supply
- Renewable generation with facility to feed excess power into the grid – Net Metering

Policies

- **Consumer Rules, 2020**
  - No connection shall be given without a meter and such meter shall be the smart prepayment meter or pre-payment meter.

- **MoP has requested all the states to submit plans for rollout of smart metering by end of April 2021, which should include following provisions:**
  - No connection shall be given without a meter and such meter shall be the smart prepayment meter or prepayment meter
  - Any faulty meter shall be replaced only by smart prepayment meter or prepayment meter.
  - The existing post-paid meters should be replaced within 3 years.

Issues for slow pace of implementation

- Limited financial resources with discoms
- Lack of related knowledge and skill in discom manpower
- Consumer resistance and lack of consumer awareness
- More emphasis required from Govt/ Regulatory bodies

Enabling Framework

- Meter Standardization: IS 16444
- Communication Standards: IS 15959, Part 2, Part 3
- Model Standard Bid Document (SBD) by NSGM for TOTEX based AMI projects

- Simplicity in tariff structure suitable for prepaid metering
- TOD Metering to all consumers not possible without Smart Metering

Test Laboratories

- Central Power Research Institute, Bhopal
- Central Power Research Institute, Bengaluru
- Electrical Research & Development Association, Vadodara
- Yadav Measurements Private Limited, Udaipur
- Bharat Test House Pvt Ltd , Sonepat

Suggestions

- Making it regulatory compliance for all discoms
- Consumer outreach programs
- Promotion of TOTEX / OPEX implementation models
- Payment Security for potential investors
- Standardization / Interoperability / module based meters, DCUs, etc.
- Manpower training and skill development
- Development of Regulatory Framework like ToU tariff, Demand Response programs for all consumers

Thank You

- **Completed Deployment**

Sl.	State	Total Meters
1	Andaman & Nicobar	50390
2	Assam	97350
3	Bihar	147055
4	Chandigarh	7681
5	Delhi	255206
6	Gujarat	23760
7	Haryana	275232
8	Himanchal Pradesh	1335
9	Karnataka	20916
10	Kerala	780
11	Madhya Pradesh	153163
12	Odisha	4000
13	Puducherry	30568
14	Punjab	563
15	Rajasthan	126703
16	Tamil Nadu	10359
17	Telangana	8882
18	Tripura	43081
19	Uttar Pradesh	1147938
20	West Bengal	15164
	Total	**2420126**

Source: Smart Meter Statistics, NSGM website

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- **Ongoing Deployment**

Sl.	State	Total Meters
1	Andaman & Nicobar	25610
2	Assam	268000
3	Bihar	2202988
4	Chandigarh	21752
5	Delhi	4583
6	Haryana	736319
7	J&K	200000
8	Madhya Pradesh	315673
10	Punjab	95581
11	Rajasthan	669101
12	Tamil Nadu	130641
13	Uttar Pradesh	2854317
	Total	**7524565**

Source: Smart Meter Statistics, NSGM website

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Annexure-III

ROLL OUT OF SMART METER NATIONAL PROGRAMME

Presentation for FOR 17th May 2021

DISTRIBUTION SECTOR- CHALLENGES AND OPPORTUNITIES

- Two biggest **Challenges** of Distribution sector – Unbilled revenues and agriculture subsidy
- **Unbilled Revenue**: National average billing efficiency – 83% → 200 b units unbilled every year → unbilled revenue (at Rs. 5 per unit) – Rs. 1 lakh crore per year
- **Agriculture subsidy**: Over Rs. 1 lakh crore per annum (Economic Survey, 2021) – reckoned at Rs. 4.25 per unit as against an average cost of supply between Rs. 6.5-7.5 per unit – cross subsidy and losses to DISCOMs
- The two big **Opportunities - Smart Meters** and **Solarisation** of agriculture power.
- Business models exists to avoid public expenditure in both with loss reduction of DISCOMs – solar – **Convergence**
- **Government of India, MoP recently launched the Result linked Revamped program, where Govt offers 15% Opex cost contribution to the utilities under the BOOT model.**

Rs.10 Lakh Crore — **Loss reduction by 2030 through Smart Meters**

Rs. 1.5 Lakh Crore — **Investment required for Smart Meters**

Rs. 60,000 Crore additional revenue/ year — **Private investment could be leveraged**

SMART METERS – GLOBAL PRESPECTIVE

- US and Canada – Started 2008 – 94.8 m in USA and 6.2 m in Canada
- EU- started 2010 – 140 m installed – Cost per smart meter € 200 and overall benefit € 309 (source: DG ENER and JRC, as COM(2014)356)
- UK – Started 2010 – 12 m installed
- South Korea – Started 2010 - 10 m installed
- India completed first million in about 15 months and 0.6 million additional during Covid times. Need to do about 8 million a year to achieve the desired target, would need about 1.5 lac crs of investment.
- Most places – OPEX model used – **Meter Asset Providers (MAPs)** own meters and give **Metering As A Service (MAAS)** to Utilities
- Malaysia, Thailand have begun recently – CAPEX model in both as on date
- **EESL/ IntelliSmart following OPEX model**

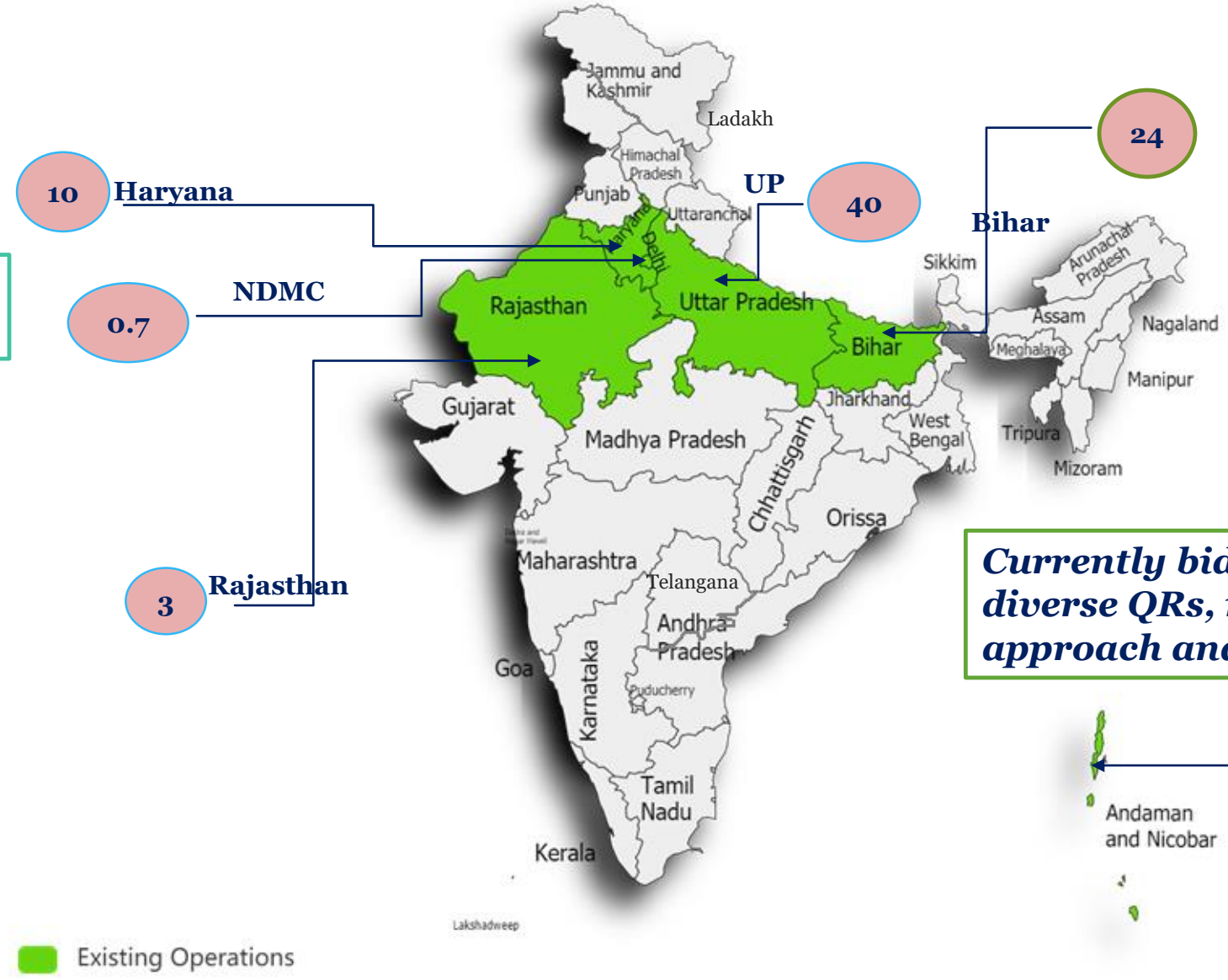
CURRENT OPERATIONS

78 Lakhs **Existing Projects**

10 **Haryana**

0.7 **NDMC**

3 **Rajasthan**



24 **Bihar**

40 **UP**

Andaman and Nicobar

A&N 0.8

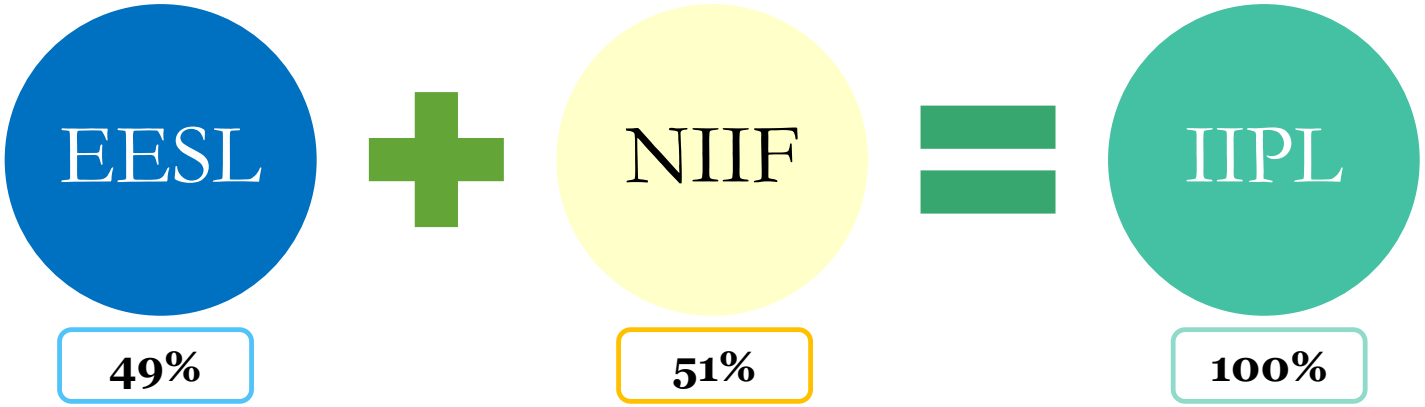
Installed ~ 17 lakh Smart Meters till date

Raj. competitively won, Rest under Nomination

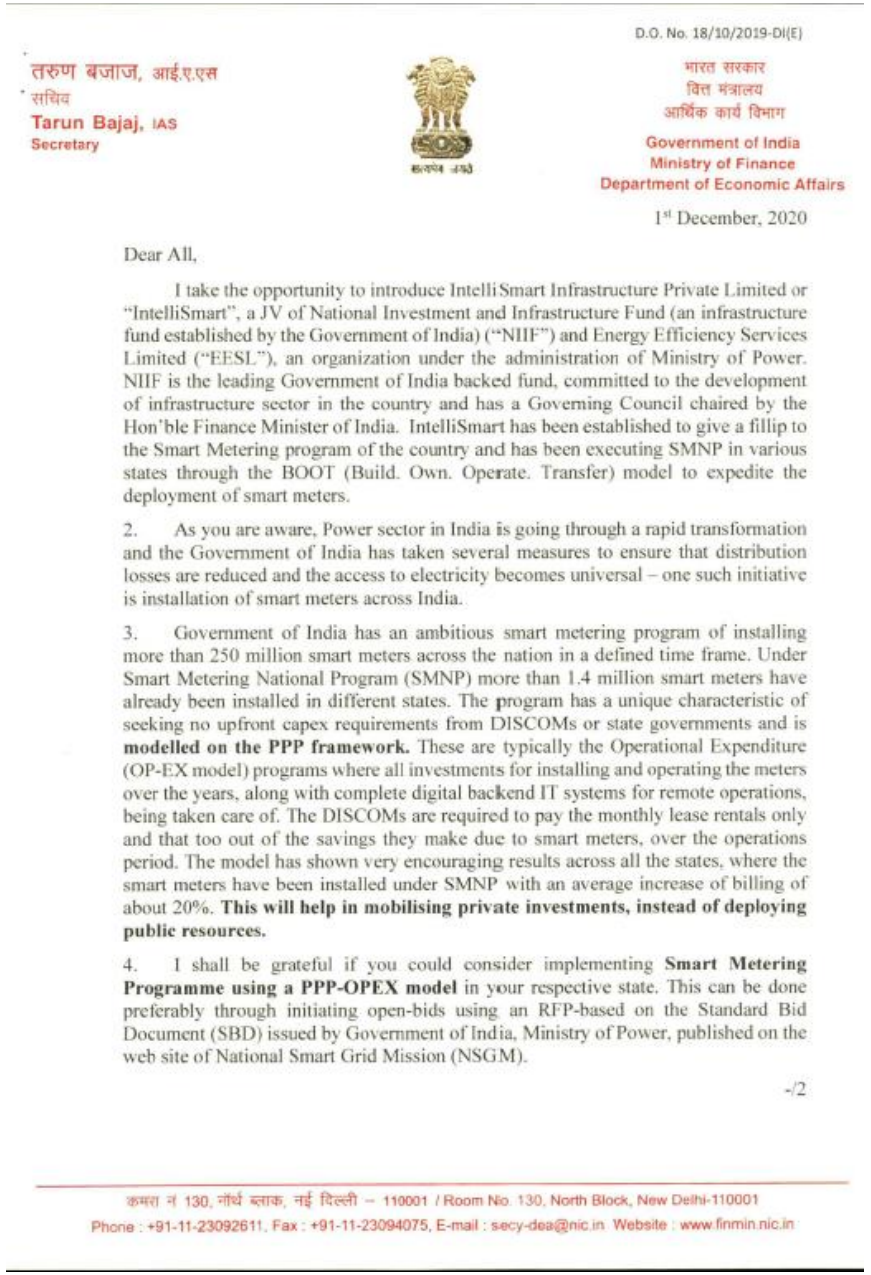
Participating in upcoming bids across states

Currently bidding on in 4 states, very diverse QRs, need coherence of approach and alignment with SBDs

ABOUT INTELLISMART



- **EESL:** promoted by Ministry of Power, Government of India (GoI) as a JV of four reputed PSUs viz. NTPC, PFC, REC and PGCIL.
- **NIIF (National Investment & Infrastructure Fund):** a GoI Backed Fund directed by Governing Council chaired by Finance Minister, GoI and Secy – DEA, Secy as other member.
- IIPL enabling implementation of Smart meters through BOOT (Build, Own, Operate & Transfer) model under competitive bidding or nomination route.
- Secretary, DEA has recently sent a communication to all Chief Secretaries introducing IntelliSmart with following inputs:
  - Unique characteristics of OPEX Model that seeks no upfront capex from DISCOMs;
  - Urging states to implement same model.



D.O. No. 18/10/2019-DI(E)

तरुण बजाज, आई.ए.एस
सचिव
Tarun Bajaj, IAS
Secretary

भारत सरकार
वित्त मंत्रालय
आर्थिक कार्य विभाग
Government of India
Ministry of Finance
Department of Economic Affairs

1st December, 2020

Dear All,

I take the opportunity to introduce IntelliSmart Infrastructure Private Limited or "IntelliSmart", a JV of National Investment and Infrastructure Fund (an infrastructure fund established by the Government of India) ("NIIF") and Energy Efficiency Services Limited ("EESL"), an organization under the administration of Ministry of Power. NIIF is the leading Government of India backed fund, committed to the development of infrastructure sector in the country and has a Governing Council chaired by the Hon'ble Finance Minister of India. IntelliSmart has been established to give a fillip to the Smart Metering program of the country and has been executing SMNP in various states through the BOOT (Build. Own. Operate. Transfer) model to expedite the deployment of smart meters.

2. As you are aware, Power sector in India is going through a rapid transformation and the Government of India has taken several measures to ensure that distribution losses are reduced and the access to electricity becomes universal – one such initiative is installation of smart meters across India.

3. Government of India has an ambitious smart metering program of installing more than 250 million smart meters across the nation in a defined time frame. Under Smart Metering National Program (SMNP) more than 1.4 million smart meters have already been installed in different states. The program has a unique characteristic of seeking no upfront capex requirements from DISCOMs or state governments and is **modelled on the PPP framework.** These are typically the Operational Expenditure (OP-EX model) programs where all investments for installing and operating the meters over the years, along with complete digital backend IT systems for remote operations, being taken care of. The DISCOMs are required to pay the monthly lease rentals only and that too out of the savings they make due to smart meters, over the operations period. The model has shown very encouraging results across all the states, where the smart meters have been installed under SMNP with an average increase of billing of about 20%. **This will help in mobilising private investments, instead of deploying public resources.**

4. I shall be grateful if you could consider implementing **Smart Metering Programme using a PPP-OPEX model** in your respective state. This can be done preferably through initiating open-bids using an RFP-based on the Standard Bid Document (SBD) issued by Government of India, Ministry of Power, published on the web site of National Smart Grid Mission (NSGM).

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कमरा नं 130, नॉर्थ ब्लाक, नई दिल्ली – 110001 / Room No. 130, North Block, New Delhi-110001
Phone : +91-11-23092611, Fax : +91-11-23094075, E-mail : secy-dea@nic.in Website : www.finmin.nic.in

SMART METER IMPACT- BILLING & COLLECTION EFFICIENCY

State	No of Smart Meters	Billing Efficiency Before Smart Meters	Billing Read Efficiency Post Smart Meters	Collection Efficiency Before SM	Collection Efficiency After SM
UP	10,38,699	78%*	**98%**	79%	**112%**
Haryana	2,52,475	78.5%*	**94.2%**	100%	**100%**
Bihar	1,28,280	69.3%*	**96.25%**	92%	**100%**
NDMC	59,494	89.7%**	**96%**	99%	**99%**

* *Source - PFC report on performance of state power utilities 2018-19* | ***Source for NDMC:* Tariff Order on ARR for FY 2017-18 dated 31st Aug., 2017.

Along with improved billing and collection efficiency, Discoms have benefitted from following improved operational and financial parameters:

- Improved and readily available working capital.
- Increased on-time payment by consumers.
- Reduction in disputes w.r.t. billing errors and provisional bills.

SMNP IMPACT – INDIAN EXPERIENCE

DISCOM	City	No. of consumers	Consumer Type#	Average Monthly revenue (INR per Consumer)			
				Before	After	Net Inc.**	Net Inc. (%)
NDMC	New Delhi	59,494	D & ND	2,735	3,050	315	11.52%
UP	All Discoms except KESCO	10,38,699	D & ND	1,175	1,420	245	20.86%
KESCO	Kanpur	1,05,194	D & ND	1,574	1,672	98	6.22%
BIHAR	All DISCOMs	1,28,280	D & ND	502	708	206*	41.03%
Charges by EESL (INR per Meter per Month)							**75-110$**

Average monthly gain per meter to the DISCOMs is ~INR 225, whereas EESL/ IntelliSmart charges only in the range of INR 75-110/ month/ meter resulting in huge benefits to the DISCOMs

- During Covid induced lockdown,
  - Smart meter billing was **95% against 71% provisional billing** in non-smart areas.
  - Daily revenue collection of Bihar DISCOMs during lockdown @ **INR ~ 5 lakh** through Smart pre-paid meters.
  - In March – April 2021, Revenue collection in Bihar DISCOMs **increased 12%** in **smart meter areas** whereas it **came down by 30%** in non-smart meter areas.

IntelliSmart A JV of NIIF and EESL

* These are representative numbers based on extrapolation of smaller sample
** The net increase is calculated post neutralising the tariff increase and inherent growth

- D: Domestic / ND: Non-Domestic
$ - dependent upon geography and consumer mix

EESL

ADVANTAGES OF EESL/INTELLISMART IMPLEMENTATION

- Smart Metering is an ecosystem wherein different infra components perform to deliver pre-determined SLAs.
- Under PPP - Opex mode, Developer owns and provides end to end solution with **no upfront financial burden** for cash strapped Discoms.
- **AMISP SBDs launched by Ministry of Power, GoI** provide viable implementation model.

Benefits of Opex Mode over Capex

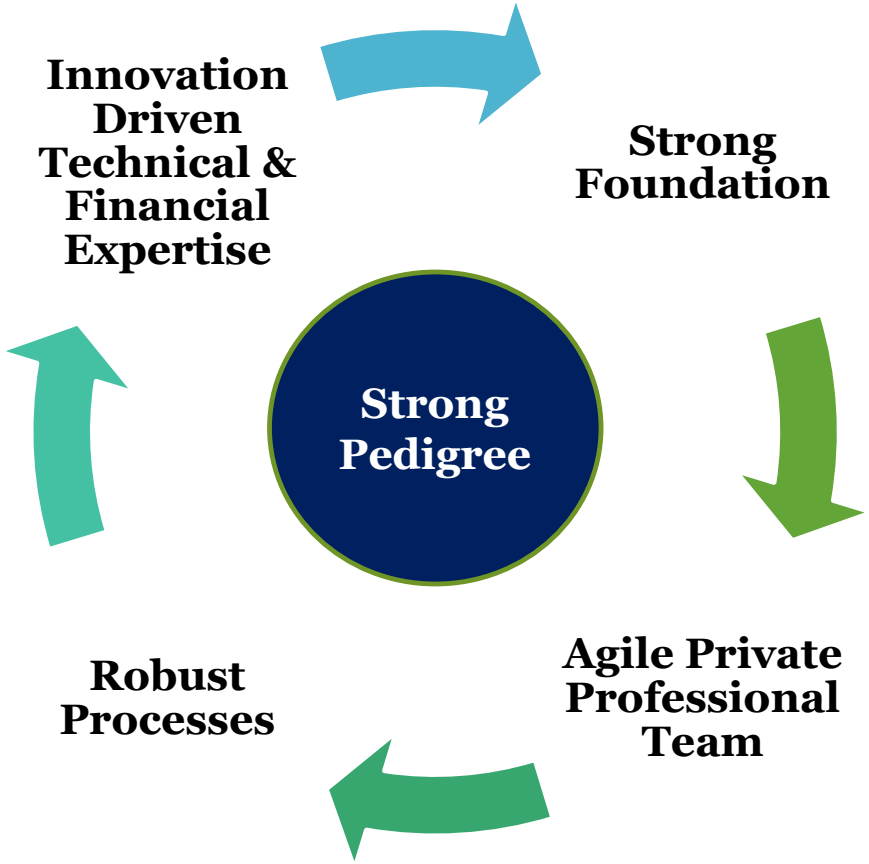
Parameters	Opex	Capex
Upfront financial burden	🔴	🟢
Scalability	🟢	🟡
Flexibility	🟢	🟡
Reliability	🟢	🔴
Accountability	🟢	🟡
Value delivery to Consumer	🟢	🔴

Other Benefits to Discoms

- Potential to reduce consumer tariffs through large scale deployment.
- Optimisation of costs through economies of scale.
- Discoms have better control over performance.
- Leverage for reducing dependence on state finances through systemic efficiencies.

End to End responsibility alongwith freedom to operate under Opex mode provides a viable solution for implementing smart metering solution.

VALUE CREATION BY INTELLISMART



- Clear vision and priorities.
- Cohesive performance driven culture.

- Best in class implementing partners.
- 100+ strong driven private professional team.

- Continuous focus on quality.
- Standardised systems & processes.

- Digital enablement of Utilities.
- Innovating digitised consumer service on real time.

- Financial leverage by strong parents.

78 lakh+

Running largest smart metering program

>98%

Automated Meter Data collection

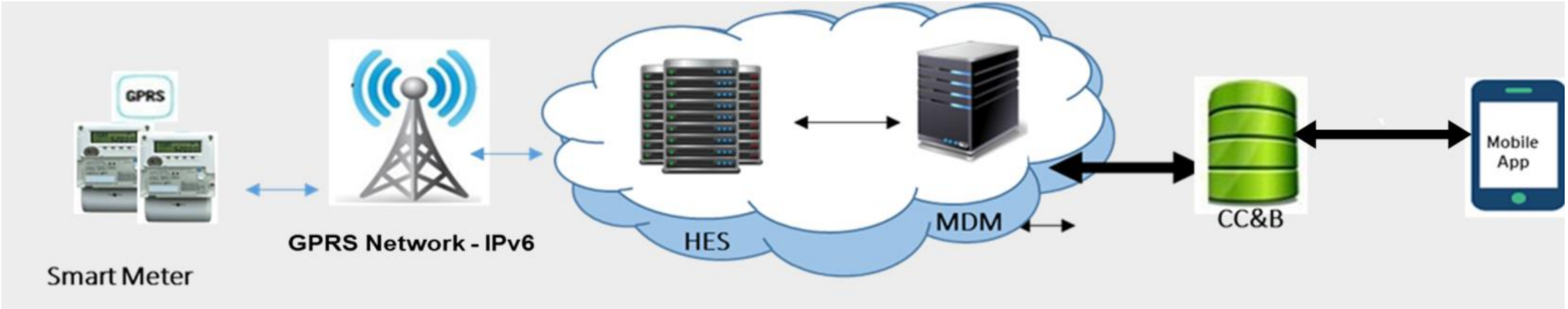
Futuristic Digital Technologies

Unified consumer centric solutions across sectors

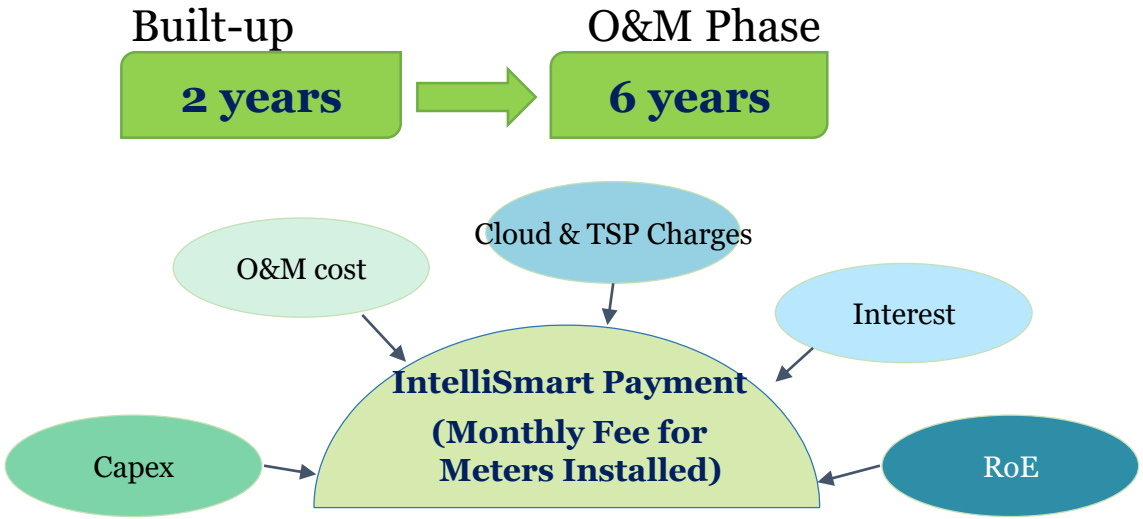
Advanced data analytics

Enabling robust resource planning & informed strategic implementation.

BUSINESS MODEL



- Implementation on BOOT model
- No Upfront CAPEX from Utilities
- Cost discovery for value chain through competitive bidding
- Recovery of actual cost along with nominal RoE.
- Payment based on SLAs met.



BOOT Model relieves Discom from upfront financial burden, ensures performance through well defined SLAs and ensures large scale operations by bringing time & cost efficiencies.

UP INCIDENT – ROOT CAUSE ANALYSIS

Incident

- **Disconnection Pressure:** To handle, disconnection pressure, L & T initiated activity manually through HES user interface by creating small consumer group (25 nos.) after receiving command from billing system on holiday.
- **Plugged cascade effect in time:** Due to Bug in HES software, an activity of group deletion by one operator and disconnection command by another converted into a disconnection command over entire family of 12,22,522 Consumers at 4 pm on 12th Aug.. Immediate action taken to kill the command and activity could be stopped at 1,58,703 Meters.
- **Restoration of supply through immediate reconnection:** Acting swiftly, we could reconnect 96% consumer by 11 PM same day and balance also got connected by next day.

Root Cause Analysis

Operational Glitch	System Bug	Non-adherence to User Access Protocols	Discoms laxity in UAT
• Non compliant operations through multiple access on holiday beyond specified time limit.	• Bug in HES application software.	• User Access protocols and SOPs was not being followed.	• UAT not conducted.

UP INCIDENT – WAY FORWARD

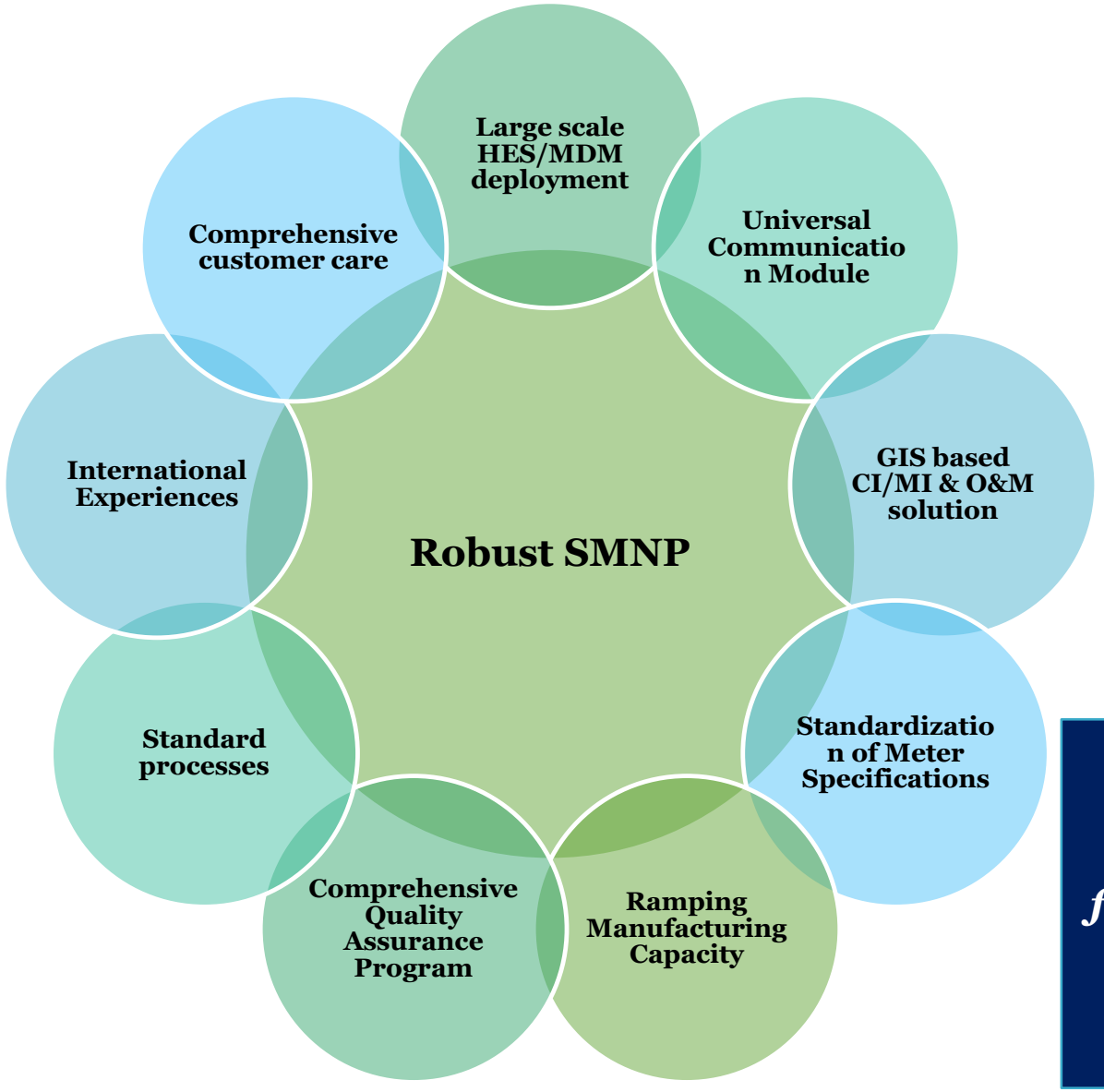
Immediate Corrective Actions

- **User Access Controls:** All the user IDs in operations disabled from immediate effect. New user IDs created based on SOP
- **User Access SOP:** User access SOP for AMI system authorization and authentication has been released to all SIs for compliance.
- **Process Compliance :** Process Compliance ensured across value chain.
- **Commencement of UAT :** Through sustained efforts at management level, UPPCL could be convinced to start the UAT and it is progressing.

Near to Mid-Term Measures

- **Focus on UAT in all States.**
- **Third party Security Audit:** Ongoing third party audit expedited and also initiated independent security audit of by STQC, GoI.
- **Communication Issues:** Initiatives taken to improve signal strengths at field level, NB IoT (as an alternate technology) pilot initiated and initiatives being taken for Hybrid Communication to address geo – physical issues.
- **Robust Quality Control :** Methods and teams put in place to ensure device quality at field and manufacturing level.
- **Process Improvement :** Processes at Field, IT and O&M level are being reviewed and improvised.
- **AMI Gap Analysis :** Initiatives are being taken to identify critical gaps which can trigger major breach across the value chain for redressal.
- **System response Improvement: IT** Processes are being optimised through product OEM interventions and Infra requirement being monitored.

DRIVING DIGITAL INNOVATIONS IN SMART METERING



Key Differentiator provided by IntelliSmart is taking SMNP forward by delivering cost effective solutions to Discoms and taking consumer experience to next level.

ENTERPRISE IT INFRASTRUCTURE

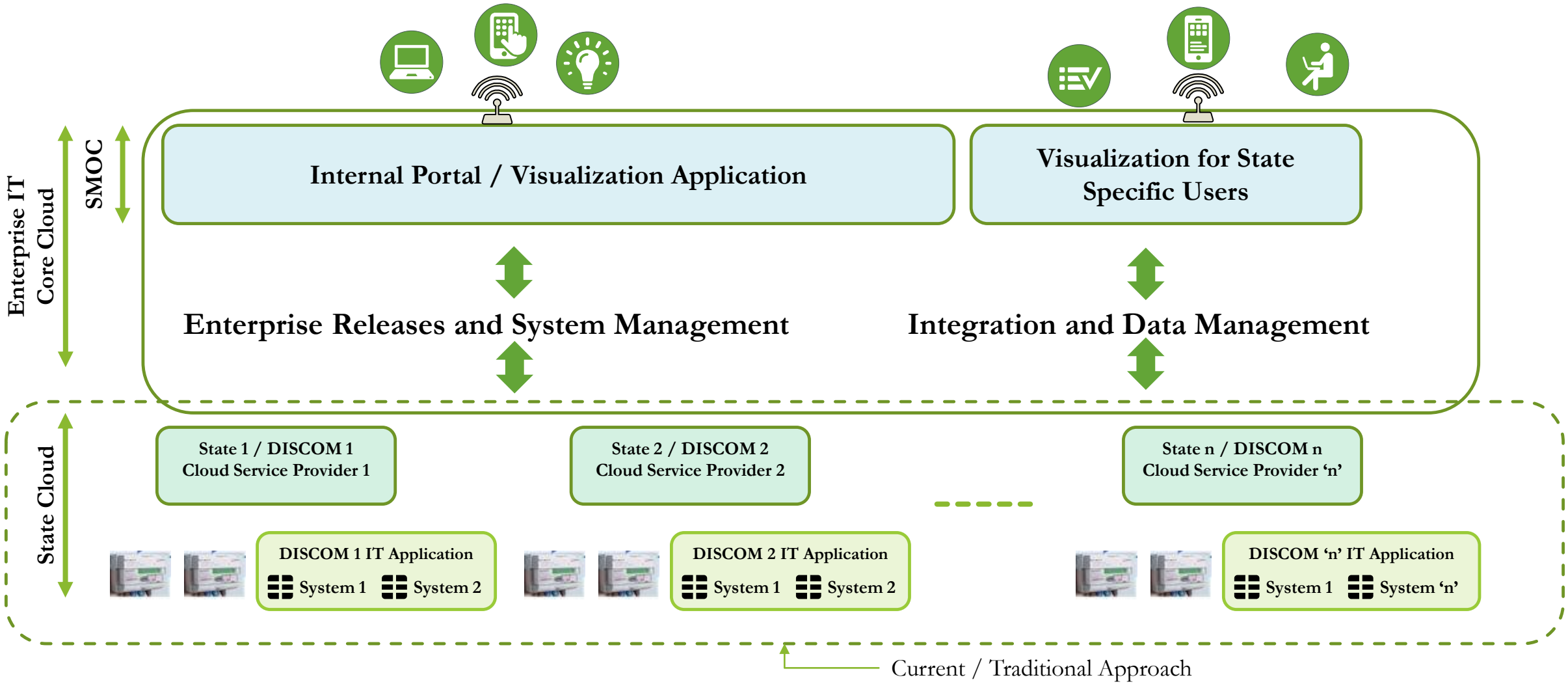
Comprehensive digital backend for smart metering where any Discom can plug and play.

Discoms get highest level of security standards coupled with economies of scale.

Scalable and Modular through centrally managed services

RFP has received good response from the industry.

PROPOSED SOLUTION



VALUE ADDED SERVICES – ADVANCED DATA ANALYTICS

- Objective is to offer DISCOMs, solutions (dashboards, heat maps & action reports) most relevant to them given their context/ problems.
- These solutions shall be based on data analytics coupled with usage of Machine Learning algorithms.

	Commercial Loss Reduction	Demand Forecasting and PP Cost Optimisation	Home solutions	Network Management
	Real-time detection of outlier customers likely to engage in fraud and defaults	Accurate demand forecast (next day as well as long term) Optimized power mix (next day, long term contract structure changes)	App for consumption at appliance-level and provides customized recommendations for energy savings.	Identifying hotspots for loss/ outages Trigger based alarm systems to schedule maintenance visits.
Value Drivers	Reduction in AT&C losses and increase in revenues	Effective Resource Planning and cost optimisation.	Additional revenue stream from appliance sales and marketing improved customer satisfaction levels.	Higher reliability (SAIDI, SAIFI), Lower technical losses, Reduced O&M spends

Real time data availability shall facilitate informed decisions on deploying futuristic solutions such as dynamic retail tariffs, demand response, cost effective resource planning.

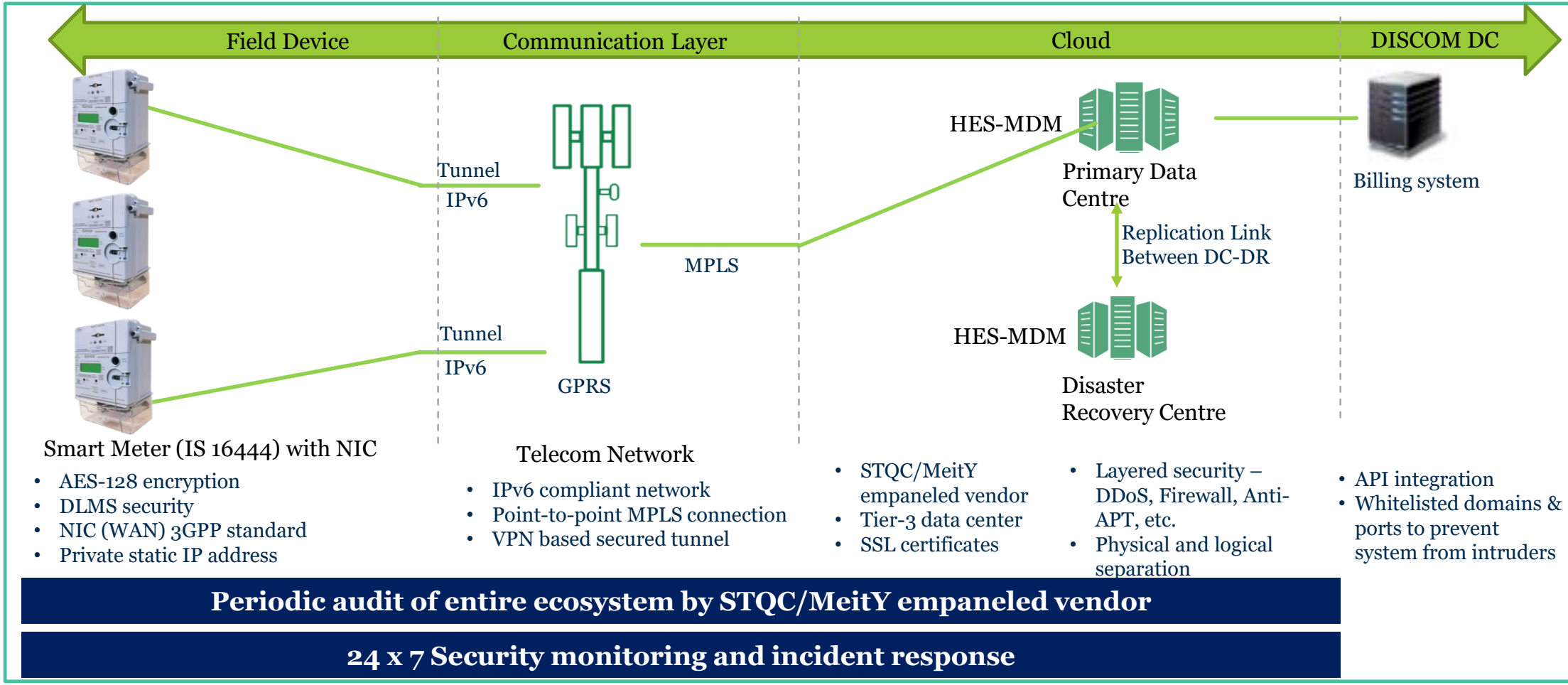
FOCUS ON CYBER SECURITY

Attributes

- **Confidentiality**
- **Integrity**
- **Availability**

Mechanism

- **Authorization**
- **Authentication**
- **Encryption**



REGULATORS' SUPPORT IN WIDENING ROLL OUT OF SMART METERING

1 Smart Meter implementation targets

- Trajectory for installing smart meters should be prescribed by SERCs to the Discoms. This can be clubbed with appropriate incentive linked to incremental revenue generated.

2 Central level regulations for implementing smart metering

- Regulations shall help in guiding Discoms for ensuring implementation of smart meters cost reflective tariffs. Smart Meter Plan should be submitted alongwith MYT/ARR petitions.

3 Standardised decision parameters for implementing smart metering

- This will help state Discoms to identify and structure implementation on ground and ensure reaping intended benefits.

4 Fostering Smart Meter Attractiveness for Consumers

- Tariff Incentives may be introduced for consumers opting for implementation of smart meters. Separate tariffs may also be explored.

5 Delivery of end to end solution

- SERCs should prescribe deployment of end to end solution to prevent digital islanding and deployment of non-uniform solution. This will ensure long term value delivery to the consumers.

6 Regular contractual monitoring

- Performance based monitoring with SERCs taking role of facilitators shall ensure seamless implementation and successful delivery.

THANK YOU

Website

https://intellismartinfra.in/

LinkedIn

https://www.linkedin.com/company/intellismart/

Twitter

@Intelli_Smart

Email

anil.rawal@intellismartinfra.in

REVAMPED REFORMS LINKED RESULTS BASED SCHEME BY GOVT. OF INDIA

Total Outlay – Rs. 3.03 lakh Cr.

Part A: Metering & Distribution Infra Works

- Total Outlay of **Rs. 3.02 lakh Cr.** (**Rs. 1.5 lakh Cr. for smart metering**)
- **Grant for smart metering Rs. 23k Cr.**
- Install smart prepaid meters for all consumers.
- AMI for all DTs and Feeders.
- Unified billing and collection system.
- Feeder Segregation.
- SCADA and DMS in Urban Areas.

Part B: Capacity Building

- Total Outlay of **Rs. 1,430 Cr. with grant of Rs. 1,030 Cr**.
- MoP initiatives consumer awareness, communication plan.
- Training & capacity building.
- Upgradation of Smart Grid knowledge centre.
- Award and recognition.

- Grant for consumer level smart metering shall be **15% limited to max. Rs. 900 per meter**.
- Grant for DT & feeder metering in Totex mode shall be 15%.
- Discom can claim **grant funds for every 5% of meters commissioned.**
- Scheme envisages implementation of **smart metering in Totex mode (capex + opex) under DBFOOT arrangement**.
- **AMISP SBDs to be followed upon**. Any changes to be approved by DRC (Dist. Reforms Committee).
- Action Plan and DPR to be submitted **before Sept., 2021**.

Scheme provides huge financial support for implementation of AMI.

USAID FROM THE AMERICAN PEOPLE

GOVERNMENT OF INDIA
MINISTRY OF POWER

Impact of Renewable Energy Integration on Tariff/ System Cost

Renewable Integration and Sustainable Energy (RISE) Initiative (implemented by Deloitte Consulting)

under

Greening the Grid (GTG) Program

A Joint Initiative by USAID and Ministry of Power

New Delhi, May 17, 2021

Financial Implications of renewable integration

Key determinants

States will face certain additional costs in integrating Renewables

- **Maintenance of standby balancing generation** capability to offset intermittent wind energy generation
- **Higher per unit fixed charg**e due to lower Power Load Factor
- Decrease in generation level **lowers the efficiency** of the power plants
- **Higher transmission charges** due to lower capacity utilization factor of the transmission & distribution system
- Reserve shutdown & cold start causes **wear & tear** and consequently consumes Equivalent Operation Hours of the plant
- **Opportunity cost of mandatorily using renewable energy** despite availability of cheaper alternative power sources
- **High DSM charge** due to higher imbalances between the scheduled and actual generation with respect to the schedule of intermittent renewable generation

CEA – Approach and findings

Financial Implications of RE integration

Analysis of financial implication of RE performed by CEA

Approach and assumptions

Components of total financial impact			
	Cost Component	***Rationale***	***Assumptions***
1	Balancing charges	Fixed Charges - As the share of renewable generation goes up displacing thermal generation, the total fixed cost of the thermal stations would be distributed over lesser number of units due to lower PLF Variable Charges - Operation of thermal stations at a lower PLF reduces the efficiency of these plants resulting in an increase in the station heat rate and auxiliary consumption	Fixed cost - Rs. 1.5/kWh Variable cost – Rs. 2/kWh Decrease in efficiency as per CERC norms
2	DSM Charges	Deviation charges due to deviation of actual generation from scheduled generation for renewable energy plants	Assuming 15% deviation in all the blocks; deviations charged at Rs 4/kWh
3	Variable Charges due to substitution of cheaper stations for costlier ones	Many of the renewable capacity are tied up through feed in or regulated tariff which is much higher than the tariff of several thermal stations	Assuming 25% of RES generation replaces thermal RES – Rs. 4/kWh New RES – Rs. 2.5/kWh Existing Coal Fuel charges – Rs. 2/kWh New Coal charges – Rs 3.5/kWh (Rs 1.5/kWh (FC) + Rs 2/kWh (VC))
4	Stand by Charges	Fixed cost of holding excess capacity for balancing the intermittency of renewable generation	Net Standby capacity of 10% of maximum RES generation
5	Transmission Charges	On account of lesser utilization of the transmission and distribution system due to evacuation of renewable generation which have much lower capacity utilization factors	Based on rates of short term contracts – incremental injection charges of 200% i.e. 26 paise

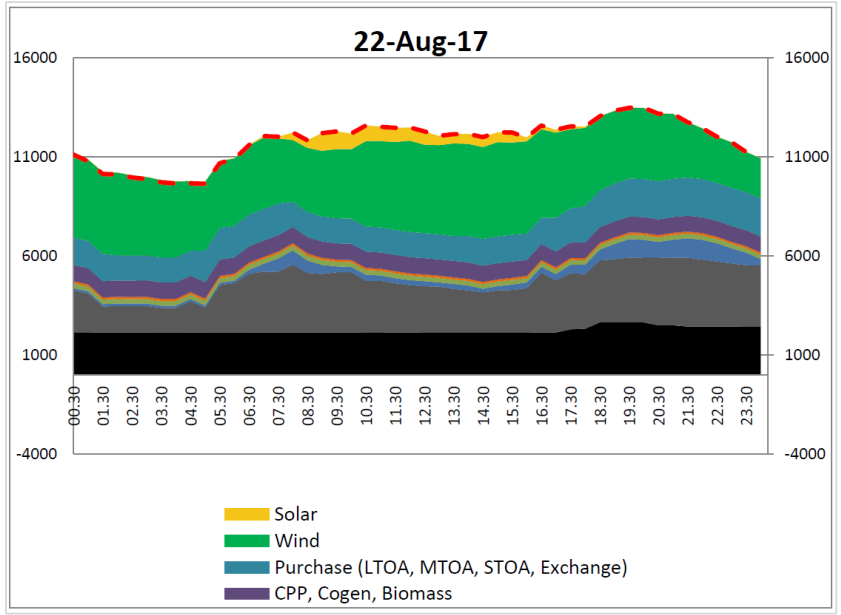
Financial Implications of renewable management

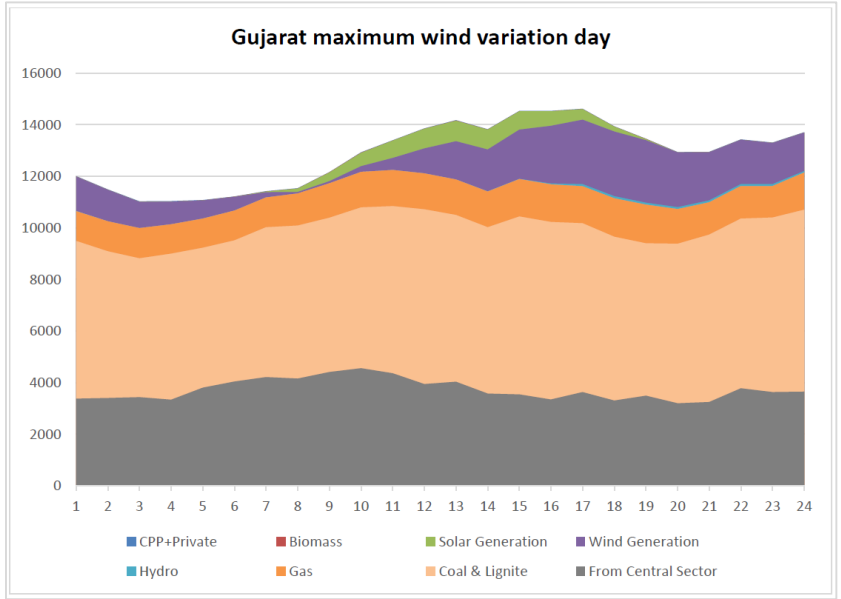
	Tamil Nadu 22 Aug, 2017	
1	Total balancing charge for CGS Coal and gas based station (FC + VC)	**Rs 0.20 /kWh**
2	Total balancing charge for state Coal based station (FC + VC)	**Rs 0.03 /kWh**
3	Impact of DSM	**Rs 0.35 /kWh**
4	Impact on tariff for Tamil Nadu discom for backing down Coal generation (solar and wind - Rs. 4/kWh and coal cost - Rs. 2.0/kWh- (Considering 25% on account of renewables)	**Rs 0.5 /kWh**
5	Stand by charge	**Rs 0.23 /kWh**
6	Extra transmission charge	**Rs 0.26 /kWh**
	Total Impact	**Rs 1.57 /kWh**
	Gujarat 25 May, 2017	
1	Total balancing charge for CGS Coal and gas based station (FC + VC)	Rs 0.24 /kWh
2	Total balancing charge for state Coal based station (FC + VC)	-
3	Impact of DSM	Rs 0.12 /kWh
4	Impact on tariff for Gujarat discom for backing down Coal generation (solar and wind - Rs. 4/kWh and coal cost - Rs. 2.0/kWh- (Considering 25% on account of renewables)	Rs 0.5 /kWh
5	Stand by charge	Rs 0.33 /kWh
6	Extra transmission charge	Rs 0.26 /kWh
	Total Impact	**Rs 1.45 /kWh**

Major part is because of replacement of the cheaper fuel with RE.

This cost is expected to reduce to zero or negative due to competitive bidding for RE & increasing coal prices.

The financial impact of renewable capacity would reduce to about Rs 1 per unit from the current Rs. 1.5

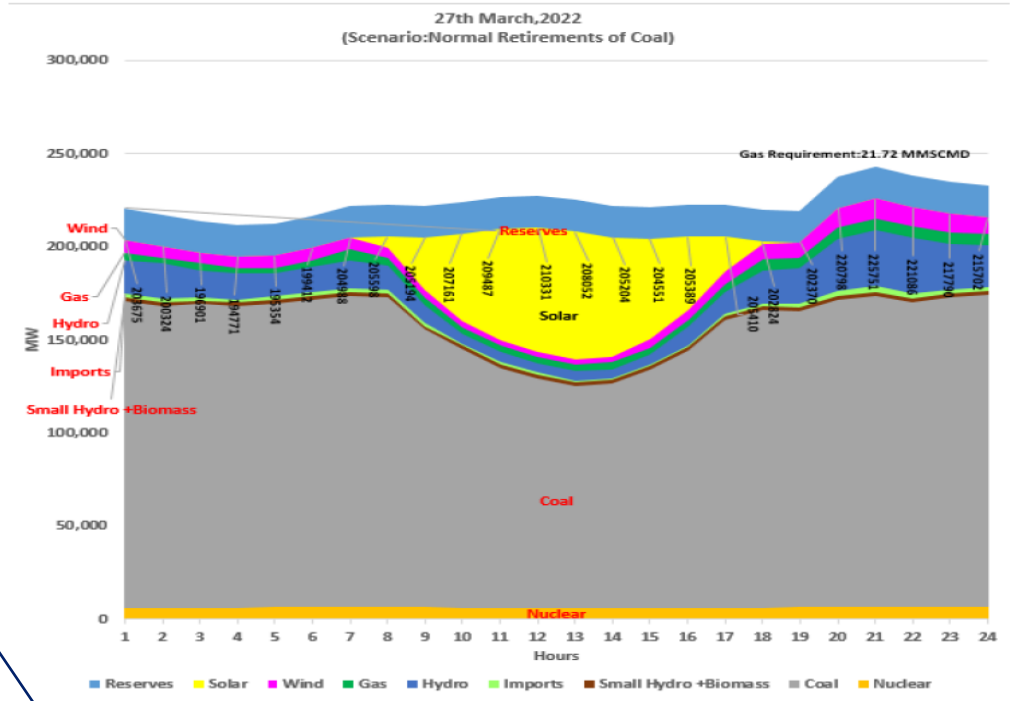




Total financial Implications of renewable management

Calculated for all India, 2022

Item No.	Balancing Cost	Rs./Unit
1	Total balancing charge for Gas based station (fixed +fuel charge)(Rs/kWh)-Spread over renewable generation	0.04
2	Impact of DSM per unit- Spread over renewable generation	0.30
3	Impact on tariff (Rs/kWh) for All India Discom for backing down Coal based generation assuming solar and wind at Rs. 2.50/kWh and tariff of coal based generation at Rs. 3.50/kWh- Spread over renewable generation	0
4	Stand by charge (Rs/kWh)- Spread over renewable generation	0.50
5	Extra transmission charge (Rs/kWh)- Spread over renewable generation	0.26
	Total Impact- Spread over renewable generation (Rs/kWh)	1.11



Increase in the rate of DSM charge and stand-by charge compared to the figure in Tamil Nadu and Gujarat is due to higher mix of renewable energy within the total energy source. This would create more fluctuating energy generation, thus requiring more stand-by generation capability and deviation from the pre-determined limit

Conclusion and recommendations of the study

Though there are financial implications of managing renewable generation capacity, in the future, it will be cheaper to set up renewable generation capacity as compared to coal-based capacity.

- The **financial implications can be shared** between the states in either of the following ways:
    - Using balancing resources from all over the country or expansion of balancing area to the whole country
    - Sharing of deviation charges between the states in the ratio of their RPOs
- **Hydro and gas-based power plants** should preferably be **used for balancing** keeping the constraints with respect to irrigation needs and storage capacity of the gas pipelines in consideration (for modulating gas supply)
- In case of coal-based plants, critical and super critical plants should be operated at higher loads and generation from **sub-critical plants could be fluctuated** for balancing
- Begin **procurement of ancillary services** to ensure capacity on a permanent basis which could include balancing sources as well. These services should be procured competitively and paid on the basis of their performance. Cost of ancillary services could be shared by all the beneficiaries
- Central and State Regulators could **encourage Demand Response** including providing agricultural supply during daytime for substituting frequency based ancillary services in a quick and cost-effective manner
- Intrastate regulations on **Forecasting, Scheduling and Deviation Settlement** for renewable stations need to be notified and implemented

UPERC – Approach and findings

Financial Implications of RE integration

Total financial Implications of renewable management

Results of the analysis

In addition to the balancing cost estimated by CEA, an additional cost component of stranded capacity has been considered due to backing down of conventional sources to accommodate must run RE capacity

S.No.	Parameter	Unit	Value
A	Total RE capacity (all India)	MW	66,000
B	Weighted average plant utilization factor	%	25.5%
C	Equivalent Total Capacity of Conventional (A X B)	MW	16,800
D	Capital cost for conventional	Rs Crs/MW	7
E	Total Cost of Stranded Conventional Capacity (C X D)	Rs Crs	1,17,600
F	Annual Amortized Value of Stranded Capacity (E X 12%)	Rs Crs	14,994
G	Total RE generated	MUs	1,47168
H	**Stranded cost (F / G)**	**Rs/kWh**	**1.02**
I	Balancing cost of RE (as per CEA, for all India)	Rs/kWh	1.11
J	**Total cost implication (H + I)**	**Rs./kWh**	**2.13**

Observations on the CEA and UPERC analysis

Approach and methodology of the analysis undertaken by CEA and UPERC

Limitations of the analysis

Central Electricity Authority

- The analysis is based on a **single sample day** where maximum wind variation was observed. *Generalisation based on a single day analysis may need to revisited*
- CEA has considered a **standby capacity** of 10% of the maximum RE generation **along with DSM penalty** to the extent of 15% of RE for all the blocks. *Both these assumptions appear to be on the higher side considering significant cushion is available in the form of standby capacity and persistent improvement in F&S of RE*
- Balancing cost has been calculated considering reduction in PLF of gas and coal based generating stations due to RE generation. *Reduction in PLF of thermal currently not attributable to RE, but to lower demand*
- Benefit from RE integration in 2022 owing to **lower cost of RE power** vis-à-vis conventional power is **ignored** in the total financial impact

Uttar Pradesh Electricity Regulatory Commission

- The cost of stranded capacity is **akin to balancing charges** (increase in per unit fixed cost) that have been calculated and included by CEA. *Reduction in PLF of thermal currently not solely attributable to RE, but to lower demand*
- *Right resource mix for future load can address this issue. As demand increases, the stranded capacity will get utilized*

The forthcoming analysis has been taken after taking a considered view of the CEA and UPERC studies and their limitations

Calculation of Impact on Tariff – 2022

Key Factors

1

Impact of DSM

To more accurately assess the impact of DSM on the retail tariff due to RE integration, an analysis on the historical deviations by Solar and Wind Generators was undertaken. Based on the analysis, a weighted average deviation percentage was calculated and the total increase in DSM charges was estimated

2

Extra Transmission Charges

At present, due to under utilization of transmission assets (due to lower demand compared to projections), there is an added cost to consumers

The cost of building transmission assets for RE has been estimated on a per unit of demand basis

3

Stranded Costs

Currently, due to lower demand and high costs of Gas, there is significant stranded capacity

As demand increases in the future years, the stranded costs will reduce. The impact of stranded costs per unit of demand has been estimated based on FOR's *Analysis Of Factors Impacting Retail Tariff And Measures To Address Them* report and CEA's calculations

4

Impact of Falling RE Costs

With falling RE costs, replacement of costlier coal generation to meet the demand will reduce the retail tariff

Impact of DSM

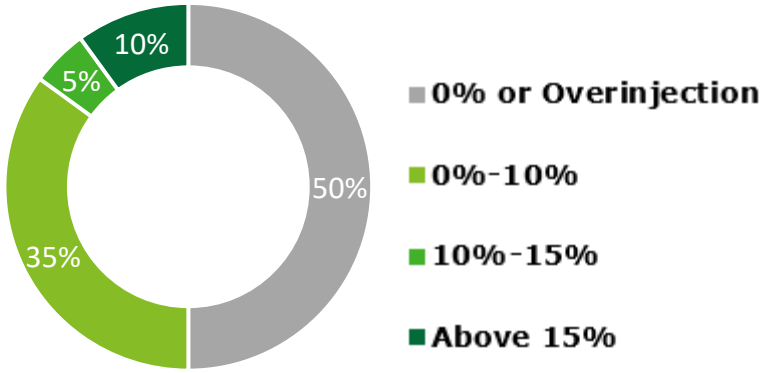
Methodology and Calculation

The pattern of absolute errors of solar and wind stations in the states of Gujarat and Maharashtra were analyzed. The data analyzed included:

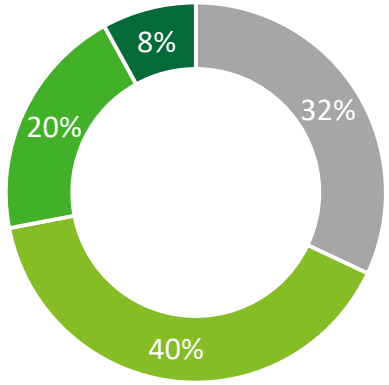
- ***Gujarat:*** 80 wind and 110 solar substations; time block wise data for 5 months – August to December, 2019
- ***Maharashtra:*** 70 wind and 28 solar substations; time block wise data for 8 months – January to August, 2020

The distribution of the deviations for solar and wind are given below:

DEVIATIONS - SOLAR



DEVIATIONS - WIND



Based on the distribution of the deviations, we can estimated a weighted average deviation for solar and wind. Only under injection deviations have been considered, as they will cause the state to overdraw

	SOLAR	WIND
Weighted Average (WA) Deviation	3.96%	5.71%
2022 Capacity	100	60
Capacity Ratio	0.625	0.375
Total WA Deviation	4.62%	

Calculation of Impact of DSM
(RE Generation and DSM charge of ₹ 4 /kWh as per CEA assumption)

Wind + Solar Gen (MWh) *	**Deviation at 4.62%**	**Deviation x DSM Charge** (Rs) *
6874	317	1269369
5968	275	1101975
5724	264	1056968
5895	272	1088545
6718	310	1240425
6929	320	1279392
6262	289	1156313
11519	532	2126991
32519	1501	6004704
50548	2333	9333653
62340	2878	11511149
69281	3198	12792759
71312	3292	13167755
67266	3105	12420639
58856	2717	10867816
44682	2063	8250592
25992	1200	4799419
9661	446	1783994
8008	370	1478694
10475	484	1934174
10425	481	1924888
9871	456	1822760
10025	463	1851098
8617	398	1591050
Total DSM Charges	**11.19 cr**	Total RE Gen **605.8 MU**
		RE Gen/Demand (%) **14%**
Total DSM Impact of RE spread over demand		**₹0.026 pu**

Impact of Transmission Charges

Methodology and Calculation

- The findings of the Report of the **Forum Of Regulators on "Analysis Of Factors Impacting Retail Tariff And Measures To Address Them"** indicate that the per unit higher transmission charge is due to the demand not increasing as per projected.
- To assess the impact of extra transmission charges, due to construction of transmission assets for Solar and Wind plants, the following calculation has been used:

	Parameter	Formulae	Units	Solar + Wind Capacity in 2022
A.	Capacity (MW) in 2022 *(Solar and Wind targets for 2022)*	-	MW	160,000
B.	Cost of setting up transmission asset *(Assumption as per CEA report)*	-	Rs Crs./MW	0.9
C.	Transmission Cost	(A x B)	Rs Crs.	1,44,000
D.	Total Demand in 2022	-	MU	12,82,138
E.	Yearly Transmission Charge	-	%	5.28%
F.	Transmission charges	([C x E x 10]/D)	Rs/kWh	**₹ 0.059**

Impact on Stranded Capacity and Impact on Variable Cost

Methodology and Calculation

The findings of the Report of the **Forum Of Regulators on "Analysis Of Factors Impacting Retail Tariff And Measures To Address Them"** indicate that the generation assets are being stranded due to lower demand and because old gas stations are too expensive.

- The report indicates that the per unit cost is of the range ₹1.35/kWh. The study was undertaken for 12 states and looked at the surplus energy and the fixed costs payable to these assets.
- By calculating the total fixed cost payable to stranded capacity spread over the total demand of the states, an additional ₹ 0.30 per unit of the demand must paid to the stranded capacity.
- If surplus energy was used to the demand originally met by renewable generation, the overall fixed cost payable to the stranded capacity reduces to ₹ 0.19 per unit of demand. This indicates that **the impact of RE is ₹ 0.11 per unit of demand**
- Thus, it can be observed that about 66% of the stranded cost is due to lower demand

With the increase in demand and the right resource mix for the future, the stranded capacity will be utilised

Based on CEA's calculation, the impact of balancing cost spread over the demand for 2022 are calculated as follows:

Total impact of RE on Coal generation - Variable Cost	₹ 0 pu	₹ 0.00 crore	Total Coal Generation	36,57,955 MWh
Total impact of RE on Gas generation - Variable Cost	₹ 0.002 pu	₹ 0.02 crore	Total Gas Generation	1,04,400 MWh
			Total RE Generation	6,05,768 MWh
Total impact on Variable Cost)		**₹ 0.02 crore**	**Total Demand**	**43,68,123 MWh**
Total Balancing Cost (impact on Variable Cost + Stranded Cost) spread over demand: ₹ 0.000 / kWh + ₹ 0.11 / kWh = ₹ 0.11 / kWh				

Per Unit Cost on Stranded Capacity

Analysing the Impact of RE on FY 2020 - 21

State	Year	Surplus Energy (MU)	Fixed Cost for Surplus Energy (Rs Crore)	Fixed Cost for Surplus Energy (Rs/kWh)	Renewable Energy (MU)	Surplus Energy without RE (MU)	Fixed Cost for Surplus Energy without RE (Rs Crore)	Energy Requirement (MU)
		A	B	C	D	E = A-B	F = E * C /10	G
Odisha	FY 2020-21	5,941	₹ 348	₹ 0.59	2327	3,614	₹ 212	29,019
Uttarakhand	FY 2020-21	-536	₹ 0	₹ 0.00	0	0	₹ 0	14,832
Madhya Pradesh	FY 2019-20	28,636	₹ 4,325	₹ 1.51	7644	20,992	₹ 3,170	69,353
Kerala	FY 2020-21	782	₹ 121	₹ 1.55	1,397	0	₹ 0	26,674
Jharkhand	FY 2020-21	5,707	₹ 563	₹ 0.99	1,632	4,075	₹ 402	11,372
Assam	FY 2018-19	864	₹ 294	₹ 3.40	92	772	₹ 263	8,866
Uttar Pradesh	FY 2020-21	22,416	₹ 4,394	₹ 1.96	7,523	14,893	₹ 2,919	1,09,328
Gujarat	FY 2020-21	11,220	₹ 1,528	₹ 1.36	16,533	0	₹ 0	1,05,652
Haryana	FY 2020-21	14,870	₹ 1,719	₹ 1.16	3,588	11,282	₹ 1,304	48,796
Bihar	FY 2020-21	14,301	₹ 1,294	₹ 0.90	3,026	11,275	₹ 1,020	32,384
Andhra Pradesh	FY 2020-21	9,504	₹ 917	₹ 0.96	14,392	0	₹ 0	68,902
Punjab	FY 2019-20	15546	₹ 1,879	₹ 1.21	2,200	13,346	₹ 1,613	56,776
Total		**1,29,251**	**₹ 17,442**			**80,249**	**₹ 10,904**	**5,81,954**
Per unit Fixed Cost of Surplus Energy : ₹ 1.35 / kWh					*Per unit Fixed Cost of Surplus Energy without RE : ₹ 1.36 / kWh*			
Additional Fixed Cost payable per unit of demand (C*10/G) **: ₹ 0.30/kWh**					**Additional Fixed Cost w/o RE payable per unit of demand** (F*10/G) **: ₹ 0.19/kWh**			

Impact of RE on Stranded Costs: ₹ 0.30 - ₹ 0.19 = ₹ 0.11 per unit of demand

Total financial Implications of renewable management

Calculated for all India, 2022

Based on the aforementioned methodologies, the impact of RE in 2022 has been re-estimated:

Additional Cost per unit of Demand due to RE			Calculation / Rationale
1	Total stranded cost impact + impact on VC	Rs 0.11 /kWh	Calculation
2	Impact of DSM	Rs 0.026 /kWh	Calculation
3	Extra transmission charge	Rs 0.059 /kWh	Calculation
	Total Impact on Tariff	**Rs 0.195 /kWh ***	**Spread over total demand**

*** Note:**

- *The impact of reduction of variable charges due to low costs of RE have not been considered. With falling RE costs, procurement of power from new RE capacity will be cheaper than building conventional capacity (VC + FC), bringing the total impact on tariff to zero or even negative*
- *Stand-by is to be provided by Ancillary Services or DSM Charges. Additional charges due to stand-by capacity has not been considered since Impact of DSM is already estimated in point 2*

To assess the long term impact of Renewable Energy on the tariff, an Integrated Resource Planning exercise is necessary

GTG-RISE/ Deloitte – Approach and findings

Financial Implications of RE integration

Estimation of impact of RE Integration on retail tariff - States

GTG-RISE/ Deloitte Approach

- To obtain a more holistic picture of the impact of renewables, a production cost simulation must be undertaken
- A production cost simulation over an entire year can capture:
  - The **effect of Seasonality** on demand and generation
  - Actual Generation from each station and **PLF of each station**
  - **Total System Cost** for a year, which is inclusive of:
    - **Fixed cost payable** to tied up Generators
    - **Variable Charges payable** to Generators (inclusive of compensation)
    - Identify the requirement and quantum of **standby capacity**
- The difference in Total System Cost for a ***"with RE"*** scenario and ***"without RE"*** scenario captures
  - **Balancing charges payable** to each generator due to lower PLFs (increase in energy charges and fixed cost per unit)
  - **Cost of backing down of thermal** generation over the year and **impact of RE tariff**
- The analysis has been conducted for the state of Chhattisgarh

Estimation of impact of RE Integration on retail tariff - States

Approach and Methodology

- The analysis has been undertaken for the following demand scenarios:
  - *Scenario 1 a): Current demand patterns remain – without RE Addition*
  - *Scenario 1 b): Current demand patterns remain – RE Addition*
  - *Scenario 1 c): Shifting Agricultural load to solar hours to better absorb RE*

Step-I

Determination of Demand

- Demand for each time block for each representative day of the month has been estimated
- Keeping the load contours the same, demand is escalated according to load growth projections
- Renewable generation profile (as per actuals used), Nuclear and Hydro generation dispatched as must run and Net Demand established

Step-II

Production Cost Dispatch to meet Demand (Scenario 1 & 2)

- Cost function is formulated by taking slot wise demand of the representative days and taking slot wise generation from generators, solar and wind generation, battery charge/discharge as decision variables
- Generators parameters such as technical minimum, DC and ramp rated were added to the optimization problems as equality and non equality constrains
- Battery parameters are also added as constrains
- Total Installed Capacity of each resource is estimated and System cost for each scenario calculated

Step-III

Estimation of Impact of RE integration on retail tariff

- Total System cost in all scenarios compared to determine impact of meeting RPO targets on the tariff
- Impact on fixed cost and SHR & Auxiliary compensation
- Impact of DSM is calculated based on weighted average deviation by RE generation

Estimation of impact of RE Integration on retail tariff - Chhattisgarh

Data and assumptions

Parameter	Value
Load Profile	2016 – 17
Modelled Year	2029 – 30 (Energy Requirement: 58715 MU – Base corrected EPS 19 figure)
RE Profiles	As per base year
Installed Capacities	Thermal – 5250 MW (as of 2019-20) Hydel – 220 MW (as of 2019-20) SHP – 76 MW (as of 2019-20) Biomass – 228 MW (as of 2019-20)
Constraints	• RE treated as must run • Technical minimum of Thermal Plants 55% and Ramp Rates 1% • Energy charges escalated by CAGR of 3.45% (wt. avg. escalation of VC of central stations 2014-19) • Any unmet demand procured from market at ACP (Flexibility of purchasing from the market to meet any unmet demand (up to 1% of total demand over the year) • Any excess generation sold at ACP • SHR compensation payable calculated as per CERC regulations
Assumptions	• New Thermal Tariff – FC: Rs. 1.5/kWh (at 85% PLF), VC: Rs 3.21/kWh (in 2030) • New Solar Tariff – Rs. 2 /kWh • New Wind Tariff – Rs. 2.2 /kWh • AFC of BESS - Rs 78.5 lakh/MW (Battery Cost Rs 4.11 cr /MW in 2030 – 10 years AFC (8% y o y decline in costs))

Estimation of impact of RE Integration on retail tariff – Chhattisgarh

2030

Estimation of impact of RE Integration on retail tariff - Chhattisgarh

Scenario analysis of the results - 2030

The impact on the tariff for the various scenarios are as follows:

Impact on System Cost - Spread over total demand	Scenario 1 a) 2030 projection with Current LCC*, Without RE	Scenario 1 b) 2030 projection with Current LCC, With RE	Scenario 1 c) 2030 projection with Agri Load Shift, With RE	Calculations / Methodology
Total Demand: 58715 MU				
Additional Installed Capacity	**Thermal:** 2730 MW	**Solar:** 4293 MW **Wind:** 10288 MW **BESS:** 1045 MW (4h)	**Solar:** 5129 MW **Wind:** 10557 MW **BESS:** 496 MW (4h)	
A: Impact on System Cost (Sys Cost$_{Scenario}$ – Sys Cost$_{Scenario\ 1a)}$)	**₹ 25,938 crores**	**₹ 21,808 crores**	**₹ 20,410 crores**	Details
	-	**- ₹ 0.70 /kWh**	**- ₹ 0.94 /kWh**	
B: Impact on DSM	-	₹ 611 crores ₹ 0.104 /kWh	₹ 649 crores ₹ 0.111 /kWh	Details
C: Extra transmission charge	₹ 0.04 /kWh	₹ 0.12 /kWh	₹ 0.13 /kWh	Details
Incremental Impact	**-**	**-₹ 0.516 /kWh decrease in cost**	**-₹ 0.739 /kWh decrease in cost**	

The lowest system cost is obtained when Agricultural Load shift is undertaken and Renewables are used to meet the demand, highlighting the need for shifting of demand to high RE periods to increase RE absorption and reduce system costs.

**LCC – Load Curve Contour*

Annexures

GTG Rise/Deloitte - Analysis for Chhattisgarh

2030

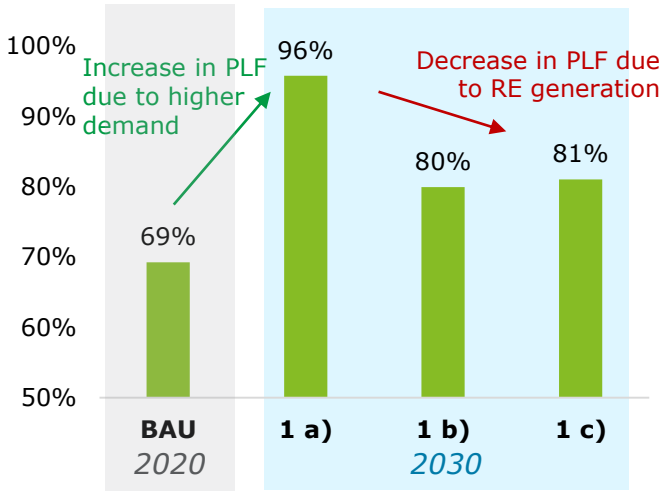
Estimation of impact of RE Integration on retail tariff - Chhattisgarh

Back to results

Component A: Impact on System Cost - 2030

Scenario	Scenario 1 a) Current Demand pattern, Without RE	Scenario 1 b) Current Demand pattern, With RE	Scenario 1 c) With Agri Load Shift, With RE
Total Cost	**₹ 25,938 crores** *₹ 4.418 /kWh*	**₹ 21,808 crores** *₹ 3.714 /kWh*	**₹ 20,410 crores** *₹ 3.478 /kWh*
Change	**-**	**- ₹ 0.70 /kWh**	**- ₹ 0.94 /kWh**
Existing Thermal Generation	40089 MUs	33464 MUs	33905 MUs
Existing Thermal Fuel Costs	**₹ 10,556 crores** *₹ 2.633 /kWh*	**₹ 9,018 crores** *₹ 2.695 /kWh*	**₹ 9,101 crores** *₹ 2.684 /kWh*
Existing Thermal Fixed Costs	**₹ 6,481 crores** *₹ 1.617 /kWh*	**₹ 6,481 crores** *₹ 1.937 /kWh*	**₹ 6,481 crores** *₹ 1.912 /kWh*
New Thermal Generation	19998 MUs	-	-
New Thermal Fuel Costs	**₹ 6,513 crores** *₹ 3.257 /kWh*	-	-
New Thermal Fixed Costs	**₹ 2,775 crores** *₹ 1.39 /kWh*	-	-
RE (Solar + Wind) Generation	-	31875 MUs	34220 MUs
RE (Solar + Wind) Costs	-	**₹ 7,037 crores** *₹ 2.21 /kWh*	**₹ 7,385 crores** *₹ 2.16 /kWh*
Stand by Capacity and Charge	**-**	**740 MW** ₹ 826 crores	**640 MW** ₹ 715 crores
Other gen, market buy/sell, BESS, etc.	-387 crores	-728 crores	-2,557 crores

Weighted Average PLF of Existing Stations



Higher per unit Fuel Costs and Fixed Costs observed with RE due to lower PLFs

Stand by Capacity calculated by taking the maximum of the difference between 10% of total RE generation and the corresponding URS available for all slots

Estimation of impact of RE Integration on retail tariff - Chhattisgarh

Back to results

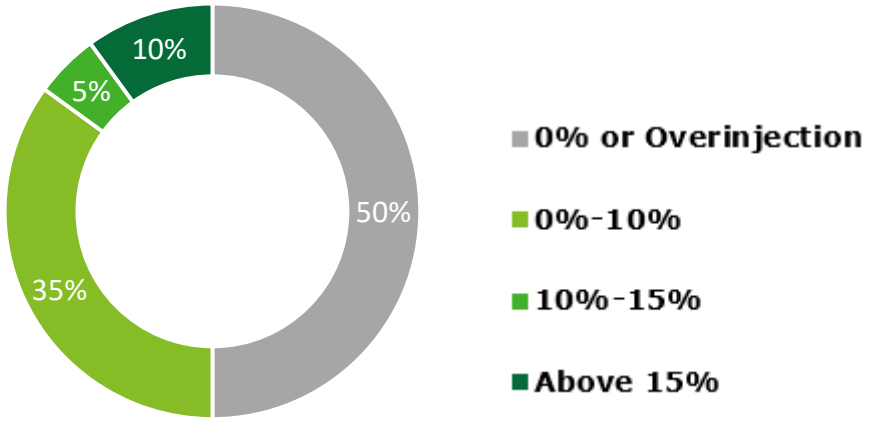
Component B: Impact on Deviation Charges - 2030

The pattern of absolute errors of solar and wind stations in the states of Gujarat and Maharashtra were analyzed. The data analyzed included:

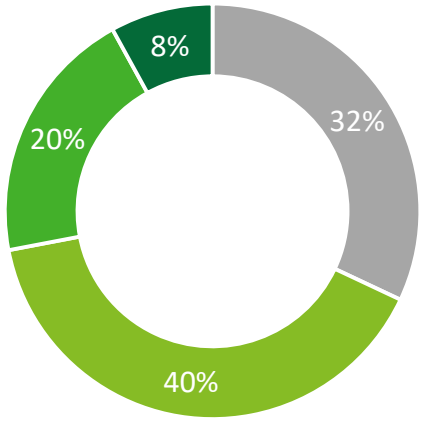
- ***Gujarat:*** 80 wind and 110 solar substations; time block wise data for 5 months – August to December, 2019
- ***Maharashtra:*** 70 wind and 28 solar substations; time block wise data for 8 months – January to August, 2020

The distribution of the deviations for solar and wind are given below:

DEVIATIONS - SOLAR



DEVIATIONS - WIND



Based on the distribution of the deviations, we can estimated a weighted average deviation for solar and wind. Only under injection deviations have been considered, as they will cause the state to overdraw

	SOLAR	WIND
Weighted Average (WA) Deviation	3.96%	5.71%

DSM Charge for a slot is estimated as:
RE Gen * WA Deviation * UI Rate

The total DSM Charge is summed up for the year and distributed over the total demand to get the cost per unit

UI charges from 2020 escalated by 3.45% yoy

Impact on DSM Charges – Scenario 1 b)

COST	SOLAR	WIND	Total
Rs Crore	**132**	**479**	**611**
Rs p.u.	0.022	0.082	0.104

Impact on DSM Charges – Scenario 1 c)

COST	SOLAR	WIND	Total
Rs Crore	158	491	**649**
Rs p.u.	0.027	0.084	**0.111**

Estimation of impact of RE Integration on retail tariff - Chhattisgarh

Component C: Impact on transmission charges – 2030

Back to results

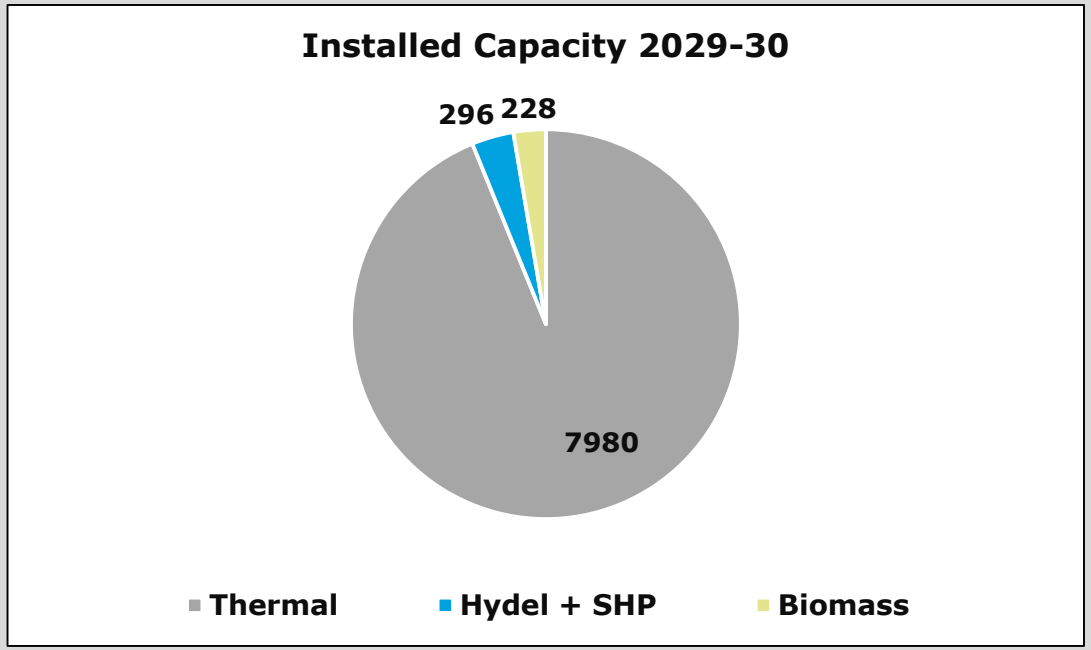
- The cost of setting up additional transmission asset to integrate the additional capacity to meet the demand for FY 30 in each of the scenarios is shown below
- The total cost of additional capacity has been annualised for the year. The Yearly Transmission Charges has been spread over the total demand
- The cost of setting up transmission asset for RE generation and Conventional generation is in line with the costs given in the CEA study

Parameter	Units	Scenario 1 a) Conventional	Scenario 1 b) RE	Scenario 1 c) RE
A. Capacity (MW)	MW	2,730	14,581	15,686
B. Cost of setting up transmission asset *(Assumption as per CEA report)*	Rs Crs./MW	1.75	0.9	0.9
C. Transmission Cost (A x B)	Rs Crs.	4,778	13,123	14,117
D. Total Demand	kWh	58,715,000,000	58,715,000,000	58,715,000,000
E. Yearly Transmission Charge	%	5.28%	5.28%	5.28%
F. Transmission charges ([C x E x 10^7]/D)	Rs/kWh	**0.04**	**0.12**	**0.13**

Estimation of impact of meeting RPO targets on retail tariff - Chhattisgarh

Scenario 1 – Current Demand Pattern - 2030

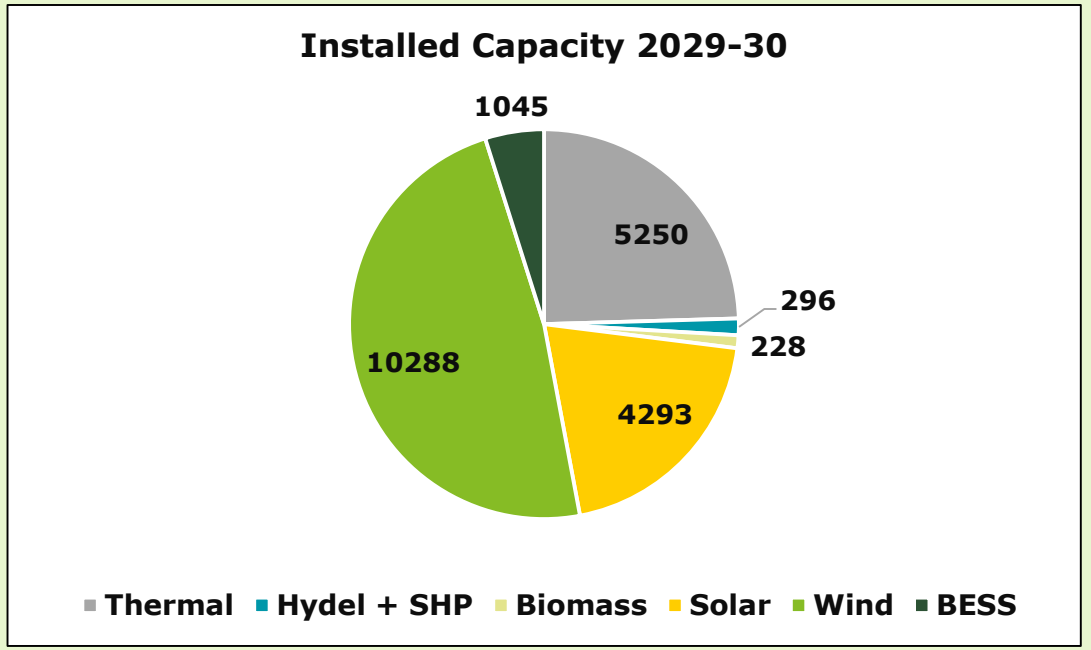
a) Without RE



Additional Thermal Capacity	2730 MW

Total System Cost
(Energy charges (incl. of compensation)+ Fixed Cost)
₹ 26,854 crores

b) With RE



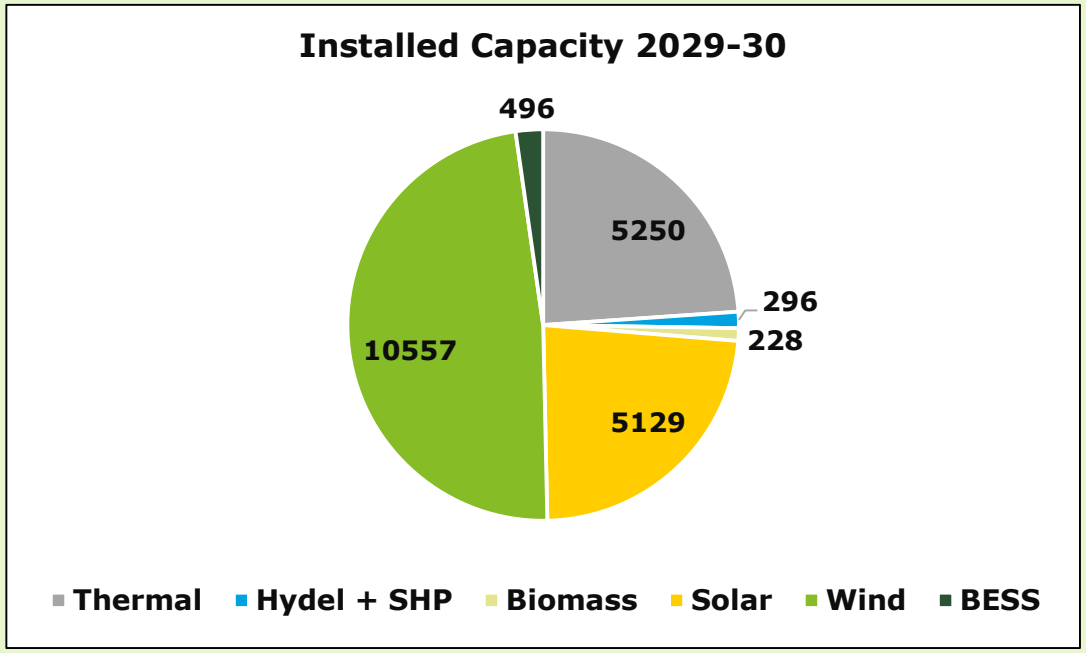
Solar Capacity	4293 MW
Wind Capacity	10288 MW
BESS Capacity	1045 MW / 4180 MWh

Total System Cost
(Energy charges (incl. of compensation)+ Fixed Cost)
₹ 27,301 crores

Estimation of impact of meeting RPO targets on retail tariff - Chhattisgarh

Scenario 1 c) – With Agriculture Load Shift – 2030

c) With RE

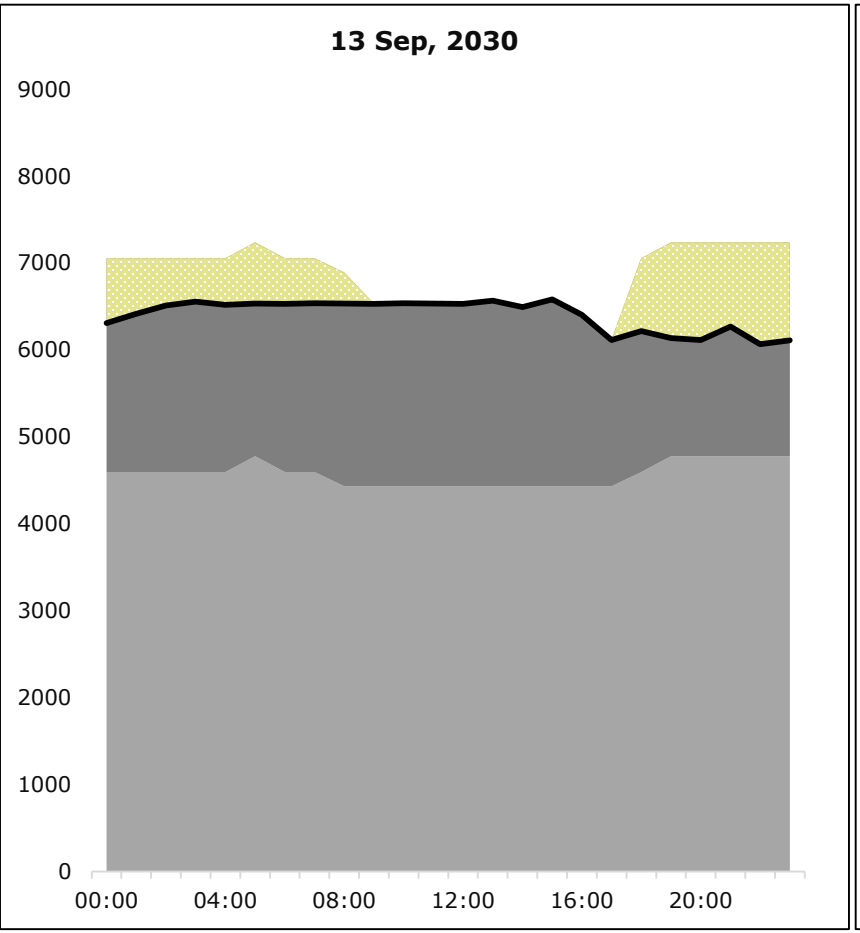


Solar Capacity	5129 MW
Wind Capacity	10557 MW
BESS Capacity	496 MW / 1984 MWh

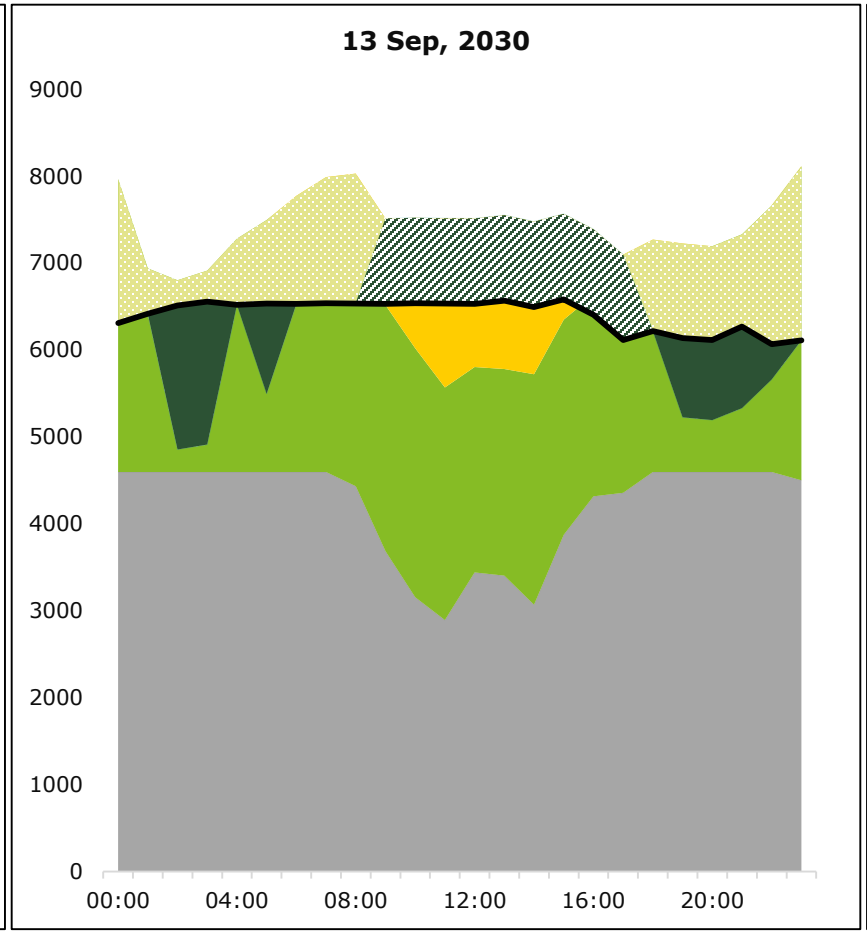
Total System Cost
(Energy charges (incl. of compensation)+ Fixed Cost)
₹ 26,022 crores

Dispatch Profile – select day in different scenarios – 2030

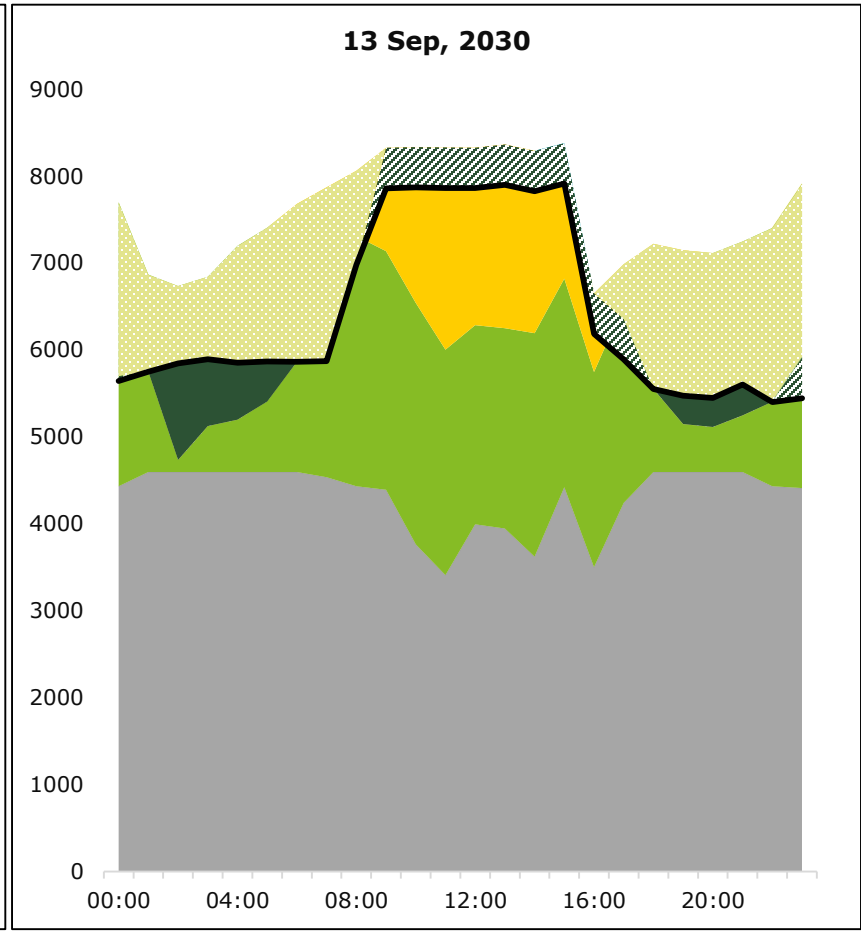
Scenario 1 a): Current Demand Pattern – without RE



Scenario 1 b): Current Demand Pattern – with RE



Scenario 1 c): With Agriculture Load Shift– with RE

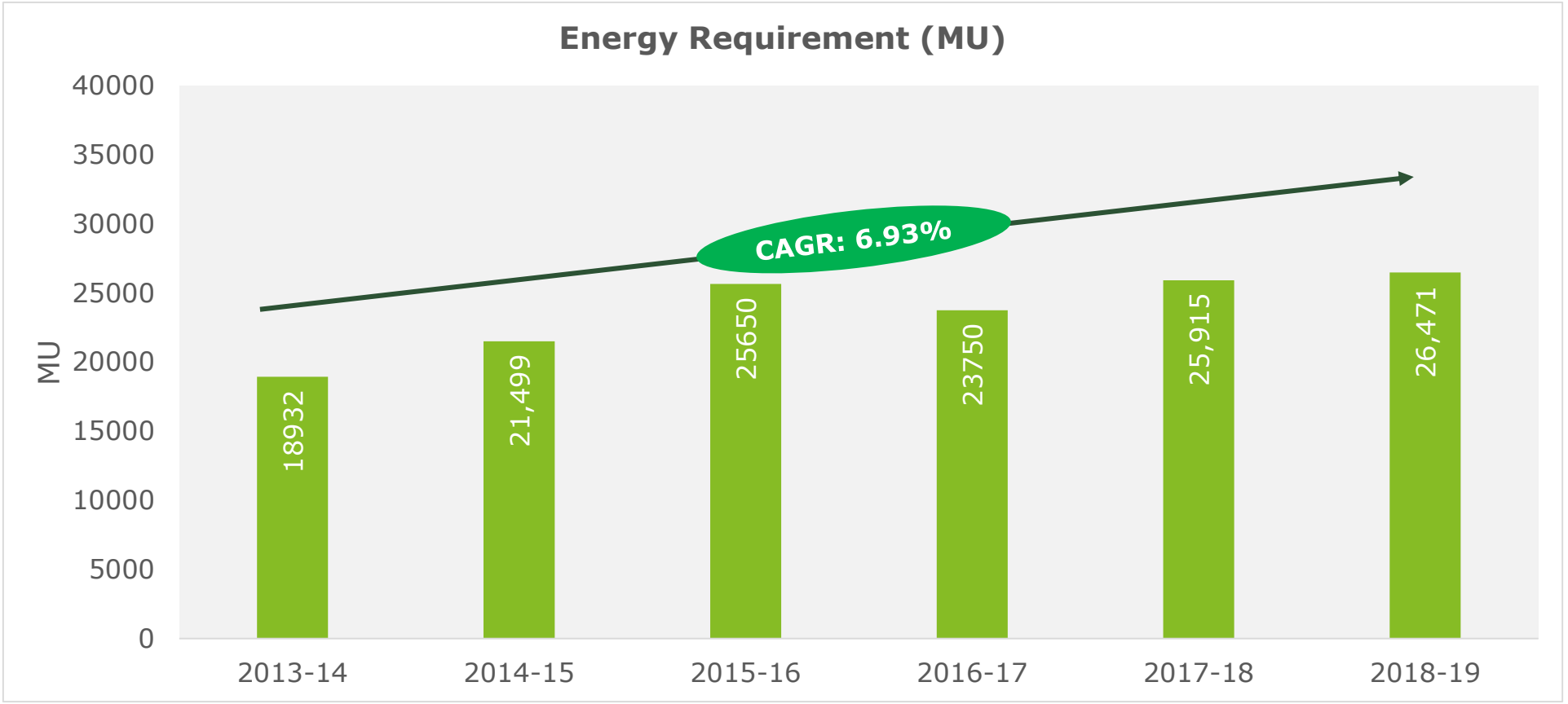


Thermal | New Thermal | Wind | Solar | Export | Import | BESS Discharge | BESS Charge | Net Demand

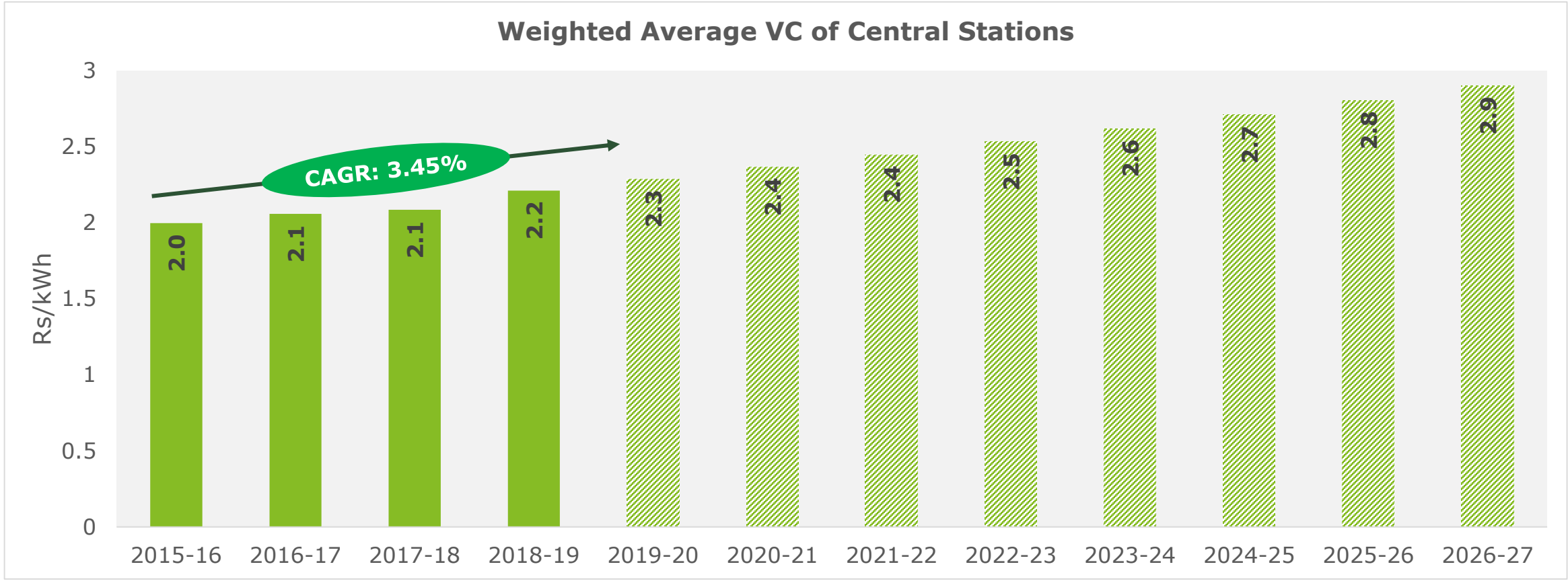
Assumptions Used

Energy Requirement and VC Escalation

Chhattisgarh Demand Growth



Energy Charges of New Coal Block



Projected Short-term Prices for 2030

A production cost modelling exercise was undertaken to estimate the monthly hourly market prices for FY 2029-30

	FY 2029-30																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Apr	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.4	2.5	0	0	0	0	0	0	0	0	0	2.7	5.3	6.0	6.0	6.4	6.4
May	5.8	5.8	5.8	5.8	5.8	5.8	5.8	4.4	2.5	0	0	0	0	0	0	0	0	0	2.8	5.3	6.0	5.9	6.2	6.3
Jun	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.9	0	0	0	0	0	0	0	0	0	2.5	3.3	3.9	3.8	3.7	3.7
Jul	5.8	5.8	4.0	5.8	5.8	5.8	5.8	4.0	2.8	0	0	0	0	0	0	0	0	0	1.6	3.3	3.6	3.5	3.7	3.6
Aug	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.3	2.0	0	0	0	0	0	0	0	0	2.8	3.9	3.7	3.9	3.9	3.8
Sep	5.8	5.8	5.8	5.8	5.8	5.8	5.8	4.0	3.5	2.5	0	0	0	0	0	0	0	2.9	3.5	5.4	4.4	5.3	5.4	5.4
Oct	5.8	5.8	5.8	5.8	5.8	5.8	5.8	4.1	3.5	0	0	0	0	0	0	0	0	3.3	5.7	5.8	5.8	5.9	5.9	5.8
Nov	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.5	0	0	0	0	0	0	2.7	4.0	5.3	5.3	5.3	5.3	5.4	4.0
Dec	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.8	0	0	0	0	0	0	2.5	3.5	4.4	4.4	4.4	3.9	3.7	3.4
Jan	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.8	3.6	2.0	0	0	0	0	0	2.0	3.3	4.4	4.4	4.4	4.3	4.0	3.9
Feb	5.8	5.8	5.8	4.0	4.0	5.8	4.0	5.8	4.0	3.2	0	0	0	0	0	0	0	1.6	3.4	4.4	4.4	4.4	4.4	4.4
Mar	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	4.0	1.8	0	0	0	0	0	0	0	0	3.5	6.2	6.0	6.2	6.4	6.4

Assumptions used are in line with CEA's Optimal Generation mix for 2029-30 report. Escalation of fuel costs (coal) are at 3.45% CAGR

Impact of Transmission waiver for RE

Parameter	Unit	Value
A. Total transmission charge Chhattisgarh (for April)	INR	658,014,597
B. Total LTA/MTOA	MW	2,697
C. STOA charge (A/[B x 7200])	INR/kWh	0.339
D. RE installed capacity in Chhattisgarh	MW	560
E. Revised STOA (A/{[B-D] x 7200})	INR/kWh	0.281
F. Difference in STOA charges (C-E)	INR/kWh	**0.058**

Annexure-V

SIXTH MEETING OF TECHNICAL COMMITTEE RE-CONSTITUTED BY THE FOR - GROUP- I & GROUP-II

MONDAY, 17th MAY, 2021

Agenda Item No. 3: Reference from FOR on Impact of Renewable Purchase Obligation (RPO) and RE Integration on Retail Consumer Tariff : Update

Month wise Details of Solar and Non-Solar RE Generation For FY 2019-20 and its comparison with annual consumption

Sl No	Month	Solar Generation(MU)	Non Solar (MU)(Mini Hydel, Co-gen, Biomass, Wind)	Total RE(MU)
1	Apr-19	1057.705	649.810	1707.515
2	May-19	1105.962	964.610	2070.572
3	Jun-19	926.268	1323.400	2249.668
4	Jul-19	828.743	1985.920	2814.663
5	Aug-19	810.130	2014.050	2824.180
6	Sep-19	820.976	1516.700	2337.676
7	Oct-19	896.687	824.020	1720.707
8	Nov-19	995.844	994.390	1990.234
9	Dec-19	995.769	1239.280	2235.049
10	Jan-20	1221.551	1073.720	2295.271
11	Feb-20	1259.986	974.690	2234.676
12	Mar-20	1347.021	671.690	2018.711
TOTAL(MU)		**12266.642**	**14232.280**	**26498.922**

Financial Year	Total Consumption (in MU)	Total RE Generation (in MU)	Percentage of RE Generation
2019-20	73449	26498	36.08%

Month wise Details of Solar and Non-Solar RE Generation For FY 2020-21 (Till Feb-2021) and its comparison with annual consumption

Sl No	Month	Solar Generation(MU)	Non Solar (Mini Hydel, Co-gen, Biomass, Wind)	Total RE(MU)
1	Apr-20	1226.379	541.260	1767.639
2	May-20	1237.041	885.140	2122.181
3	Jun-20	1014.004	1415.800	2429.804
4	Jul-20	980.619	1335.020	2315.639
5	Aug-20	1008.360	2017.400	3025.760
6	Sep-20	1002.652	1190.510	2193.162
7	Oct-20	1152.076	974.240	2126.316
8	Nov-20	1089.438	1416.180	2505.618
9	Dec-20	1060.677	1467.000	2527.677
10	Jan-21	1018.716	936.400	1955.116
11	Feb-21	1040	895.680	1040.000
TOTAL(MU)		**11829.962**	**13074.63**	**24008.912**

Financial Year	Total Consumption (in MU)	Total RE Generation (in MU)	Percentage of RE Generation
2020-21(till Feb-21)	61114	24008	39.28%

Impact of must run status of RE on other sources of generation:

- Due to must run status of RE generation, most of the thermal generators will backed down during solar period for effective utilization of RE generation.
- During wind season, thermal units are opened out to accommodate RE generation, but due to intermittent nature of RE generation it poses problems to grid operation.
- Hydro generation is under-utilized during the high RE periods.

Month wise Details of back down of energy of various sources to accommodate solar and wind (Must Run Status) and due to low Demand and its Comparison with total consumption :

Financial year	2018-19	2019-20	2020-21 (Till Feb-2021)
Name of the Generating Station	Energy backed down/reserve shutdown (in MU)	Energy backed down/reserve shutdown (in MU)	Energy backed down/reserve shutdown (in MU)
UPCL	3887.89	3779.44	5096.59
RTPS U-1 to 8	4003.67	5074.61	7382.20
BTPS U-1 to 3	5707.48	7161.42	9941.43
CGS	3930.78	3920.39	11505.21
YTPS		23.28	3362.50
Total	17529.82	19959.14	37287.93

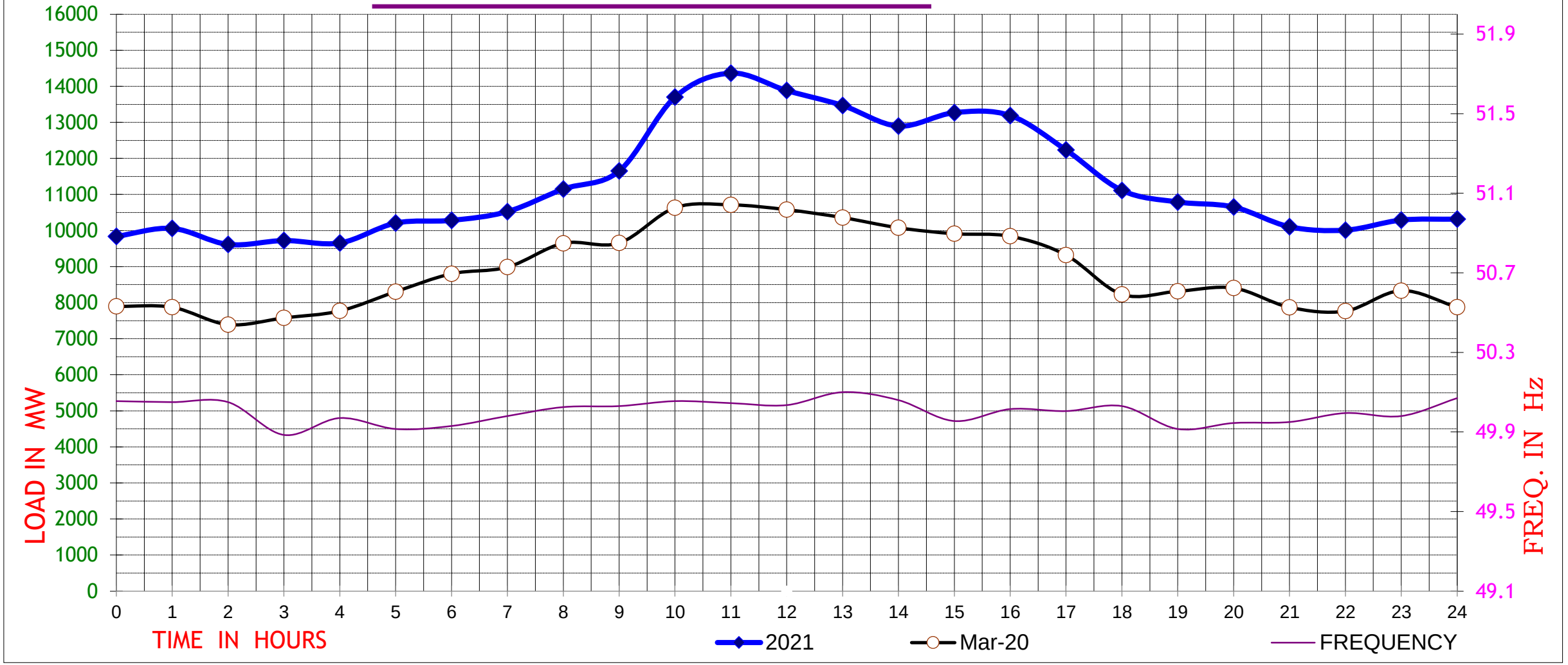
FY	Total Consumption (in MU)	Surplus power backed down/reserve shutdown by State ESCOMs due to low load demand/high RE generation (in MU)	Percentage of Surplus power backed down/reserve shutdown by State ESCOMs due to low load demand/high RE generation
2018-19	73114	17530	23.98%
2019-20	73449	19959	27.17%
2020-21 (Till Feb-2021)	61114	37288	61.01%

Type/ MW capacity of resources available in order to absorb variability for maintaining grid frequency:

Source	Installed Capacity (in MW)
Sharavathi	1035
Nagjari	900
Varahi	460
Gerusoppa	240
Kadra	150
Kodsaalli	120

Maximum Solar and wind variability in MW observed and variability management: The maximum solar generation recorded is 6193MW & wind generation recorded is 3573MW and Maximum Solar variability in MW observed is 300-800MW in a 15 min time block and Maximum wind variability in MW observed is 200-1500MW in a day.

FRIDAY 26 TH MARCH 2021



The maximum Peak Recorded for the Financial year 2020-21 is 14367 MW on 26th March 2021 at 11 a.m. Wherein the total installed capacity is 30523.1MW.

Installed Capacity as on 26th March 2021

GEN STATIONS	Installed Capacity NO.	(MW)	no. of Units	Generation in MW at MAX load	at MIN load
R.T.P.S.	8	1720.00	7	1,345	1,344
B.T.P.S.	3	1700.00	2	1,110	951
Y.T.P.S.	2	1600.00	1	705	674
SHARAVATHY	10	1035.00	10	571	287
N. P. H.	6	900.00	4	440	430
VARAHI	4	460.00	4	205	39
GERUSOPPA	4	240.00	4	-	-
ALMATTI	6	290.00	0	-	-
KADRA	3	150.00	3	-	-
KODASALLY	3	120.00	3	-	-
SUPA	2	100.00	2	99	98
L.D.P.H.	2	55.00	2	35	35
BHADRA	5	39.20	2	-	12
GHATAPRABA	2	32.00	0	-	-
M.D.P.H.	2	9.00	2	5	5
M.G.H.E.	8	139.20	3	31	30
SIVASAMUDRA & SHIMSHA	12	59.20	3	25	4
MUNIRABAD	4	38.00	2	4	4
TB Dam Share	8	14.40	1	5	5
Jurala	6	117.00	0	-	-
SOLAR(KPCL)	4	34.00	0	-	-
Total		**8852.00**		**4580**	**3918**

GEN STATIONS	Installed Capacity NO.	(MW)	no. of Units	Generation in MW at MAX load	at MIN load
NET CGS IMPORT (ISGS +UI+RAILWAYS+Bundled power)		4415.00		5080	4045
STOA+LTA+IEX					
UPCL	2	1200.00	1	505	510
Small Thermal(Conventional)		992.30			
N.C.E Sources 1) Solar		7348.78			
2) Co-Gen		1731.16			
3) Wind		4941.34		3993.0	1120.0
4) Mini Hydel		903.46			
5) Bio mass		139.03			
Total NCE(PROVISIONAL)		15063.77			
Total Energy from IPP'S		**17256.07**		**4498**	**1630**
Other Exchanges					
JINDAL		-1460		209	22
GRAND TOTAL		**30523.1**		**14367**	**9615**

Thank You