MINUTES OF FIFTH MEETING OF "TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"

Venue : CERC, New Delhi

Date : 15-07-2016

List of Participants : At **Annexure - I (Enclosed)**

1. The fifth meeting of Technical Committee on Implementation of Framework for Renewable sat the State level was held under chairmanship of Mr. A. S Bakshi, Member, CERC on 15thJuly 2016.Mr.Bakshi welcomed all the members and commended the works of the sub-committee with their report on SCHEDULING, ACCOUNTING, METERING AND SETTLEMENT OF TRANSACTIONS IN ELECTRICITY ("SAMAST").

Discussion

2. Mr. S.K.Soonee, (CEO, POSOCO) presented the summary of the SAMAST Report with an emphasis on its key findings among various States, operating procedures and recommendations (report attached as Annexure – II). He further shared the results of the survey of SLDC activities in energy metering, scheduling, accounting and settlement at the intra State and inter-State level conducted by the sub-committee.

3. Mr. Soonee shared the recommendations and procedure based on the extensive discussions with stakeholders. The main recommendations were: Demarcation of Interface Boundary, Adequate Interface Energy Meters, Unified Energy Accounting System, Administration of Transmission Losses, STOA Registry and Clearing Agency, Transparency, Archival and Utilization of Energy Meter Data, Logistics and IT Infrastructure, Adequacy of Human Resource and Governing Structure. He stated that suggested time lines for each activity had been given in the report, the idea being that regulators and other involved agencies could ensure that the whole work is completed in a time bound manner.

4. Mr. Soonee laid emphasis on the similarity between the principles of energy accounting and financial accounting and its vitality for an error-free

settlement system. He expressed his concern on the requirement of an agency like Centre for Railway Information Systems (CRIS) which shall cater to the customized requirements of the Load Despatch Centres and provide the IT solutions to stakeholders in the power sector. He also touched upon the need to have a clearing company for clearing and settlement of deviation accounts. He cited the example of Clearing Corporation of India in this regard.

5. It was discussed that the recommendations of the Pradhan Committee would be incorporated in the Human Resource requirements for SAMAST, to ensure demarcation between team requirements just for market operations vis-à-vis the entire SLDC.

6. Thereafter, Mr. Ajit Pandit (Consultant) presented the Implementation Aspects of DSM and Forecasting & Scheduling framework at State level (attached as Annexure – III).

7. The institutional structure of Qualified Coordinating Agency (QCA) was discussed at length among all the members. It was agreed that role of the QCA as an entity shall be defined in the detailed procedures to be prepared by POSOCO/SLDCs and their registration will be done by respective SLDCs.

8. The operationalization of virtual pool and de-pooling was also discussed with comments from all the members. It was agreed that the mechanism of transaction between the generators and QCA shall depend on their contractual agreements.

9. Recommendations related to Funding, Metering Arrangement and Mechanism for Deviation Settlement were showcased through use case illustrations by the Consultant and were discussed amongst the members.

Decisions

1. The Technical Committee adopted the "Report on SAMAST" and endorsed it to the Forum of Regulators for acceptance.
2. The Consultant shall review the Detailed Project Report (DPR) for Tamil Nadu and prepare a Model DPR for implementation of SAMAST with necessary modifications for adoption by Category B & C States.
3. It was agreed that there is an urgent need for finalization of Forecasting, Scheduling and Deviation Settlement Regulations at the State Level.

4. The next meeting of the Committee is proposed to be held in **2nd week of August 2016 at CERC.** It was suggested that SLDCs and STUs may be invited to the next meeting through video conferencing at POSOCO Office with a view to elicit their views on implementation of Scheduling, Accounting, Metering and Settlement of transactions in electricity.

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

ANNEXURE - I

LIST OF PARTICIPANTS ATTENDED THEFIFTH MEETING OF THE TECHNICAL COMMITTEE FOR "IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"HELD ON 15.07.2016 AT THE CERC OFFICE, NEW DELHI

1	Mr. A. S.Bakshi, Member	CERC
2	Mr. S. K.Soonee, CEO	POSOCO
3	Mr. S Akshay Kumar, Chairman	TNERC
4	Mr. A. B.Bajpai, Member	MPERC
5	Mr. Deepak Lad, Member	MERC
6	Mr. D. B.Manival Raju, Member	KERC
7	Mr. P. Rama Mohan, Member	APERC
8	Mr. Raghuvendra S. Rathore, Member	RERC
9	Mr. P. J. Thakkar, Member	GERC
10	Mr. S.C. Shrivastava, Chief (Engg.)	CERC
11	Dr.Sushanta K. Chatterjee, JC(RA)	CERC
12	Ms. Shruti Deorah, Advisor (RE)	CERC
13	Mr. K.Ramanathan	TERI
14	Mr. Ajit Pandit	IDAM INFRA
15	Mr. Shirish Garud	TERI
16	Ms. Shilpa Agarwal, DC(Engg.)	CERC
17	Mr. Vivek Pandey	POSOCO
18	Mr. Jyotish K. Pal	IDAM INFRA
19	Mr. Ankit Gupta, RA	CERC

REPORT

ON

SCHEDULING, ACCOUNTING, METERING

AND

SETTLEMENT

OF

TRANSACTIONS IN ELECTRCITY

(SAMAST)

July 2016

Table of Contents

List of Tables

List of Figures

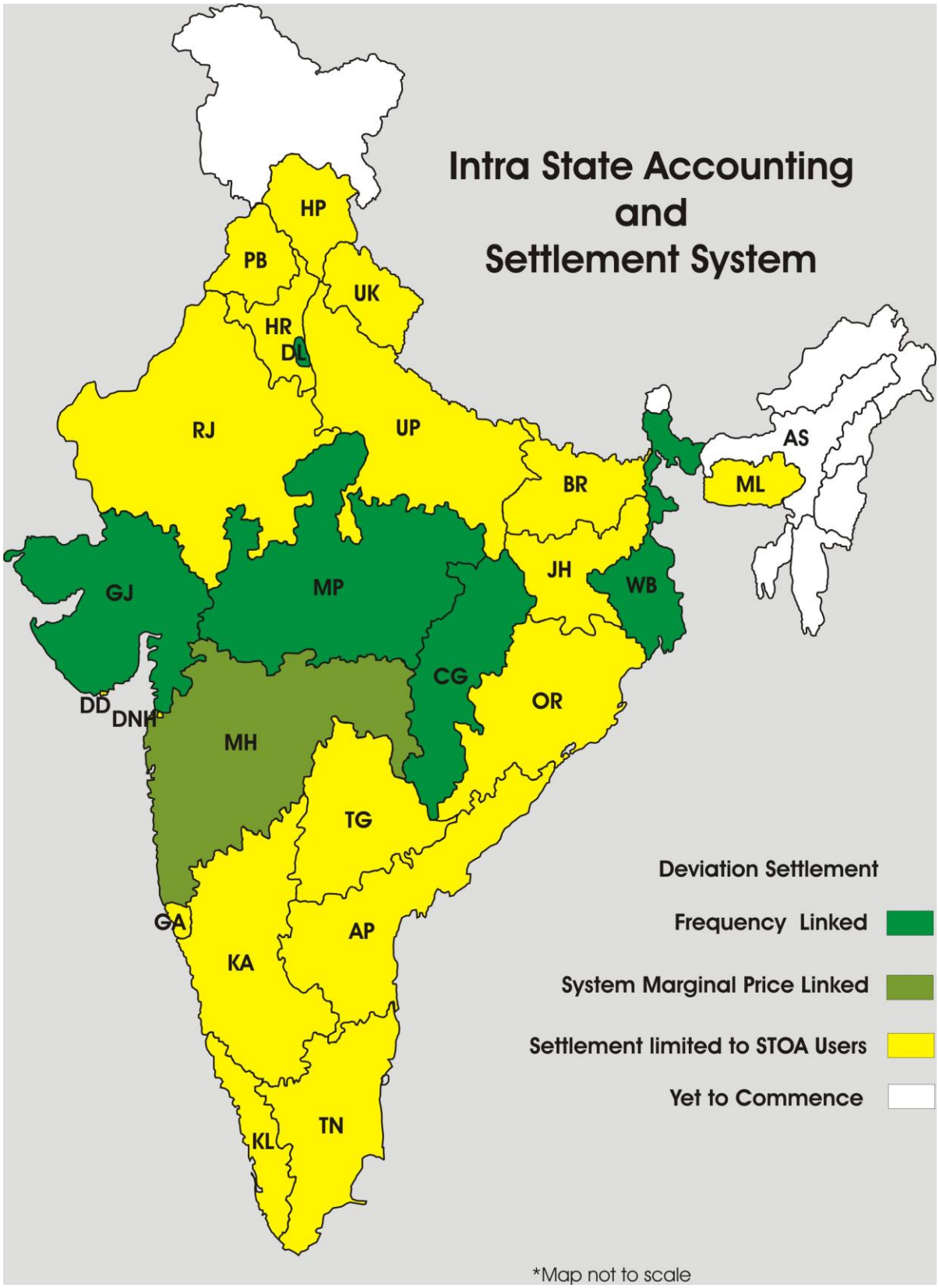

Figure 1: Intra State Accounting and Settlement System - as on 31.03.2016

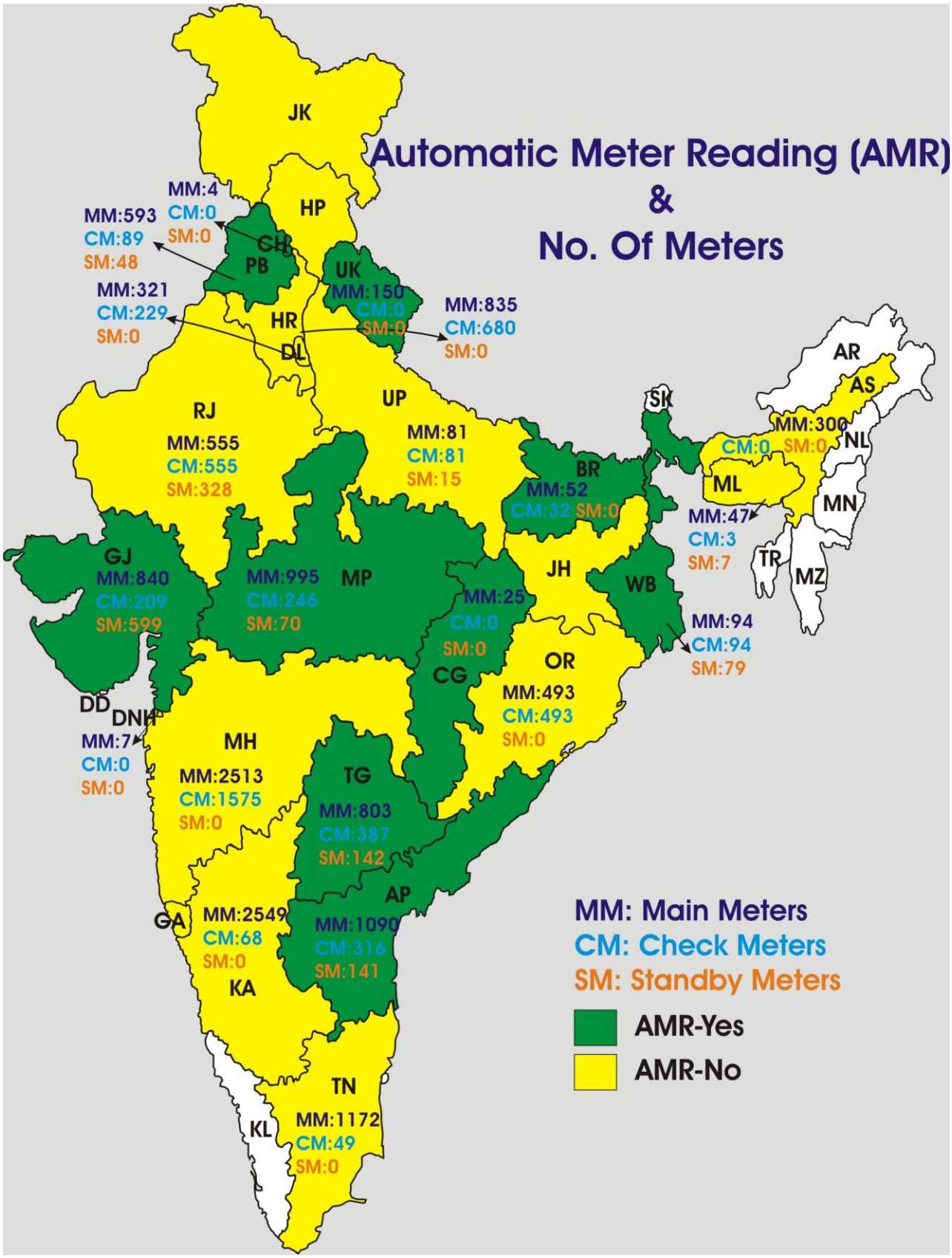

Figure 2: Interface Energy Metering Infrastructure- as on 31.03.2016

EXECUTIVE SUMMARY

Electricity is a fungible commodity and does not carry the owner's tag. Section 28 and 32 of the Electricity Act 2003 mandate that the Load Despatch Centre shall schedule in accordance with the contracts and keep account of electricity transmitted through the transmission grid. This implies that a 'ledger' of energy transactions have to be maintained, the physical flow of electricity across various notional seams in the electricity grid have to be measured and 'energy balance sheets' have to be prepared at the transmission level. The measurements have to be at the remote substations and collected at a centralized location for preparation of 'energy statements' that indicate the scheduled and actual interchange of entities with the grid as well as account for the transmission losses incurred in the grid. Thus, Scheduling, Accounting, Metering and Settlement of Transactions in electricity (SAMAST) is indispensable as it solves the puzzle -"Who" pays to "Whom" and for "What?"

Merging of electricity markets is a natural corollary to the integration of physical power grids. In the near future, the penetration of the renewable energy sources and distributed resources would increase manifold. 'Carriage-Content' separation, formation of Distribution System Operators and Energy Service Companies are being envisaged. Innovative and advanced products may be introduced in the electricity market. Consequently, the complexity of energy transactions is likely to increase manifold. The success of the electricity market

relies on the available systems, procedures, logistics and human resources for book keeping of energy scheduled and actual energy exchanges between the market players through the common network. The synchronous National Grid in India coupled with Open Access and other enabling regulatory provisions have provided opportunities for economic exchanges of energy from conventional as well as the Renewable Energy Generators to the load serving entities. For instance, an RE generator embedded within the distribution system in a State located in a Region-A may enter into a contract to sell green energy to an obligated entity located in another State located in Region-B. The transaction would have to be scheduled, physical delivery would have to be measured, accounted for and finally settled across multiple seams. It is envisaged that the formation of SAARC grid would further enlarge the scope for trade in electricity. The financial settlement of all the energy transactions whether from conventional or renewable; whether intra state or interstate or transnational; would ultimately require scheduling and book keeping besides a tamper-proof, robust, scalable, flexible and dispute-free energy metering, accounting and settlement system.

The energy statements are the bedrock for the financial settlements in the power sector. The invoice for the charges related to capacity, active energy, incentive, reactive energy, transmission usage, deviation from schedule, market operation, trading margin that have to be raised by power sector utilities rely on

the energy account statements. The integrity, probity and timeliness of the energy accounting and settlement system is indispensable for the viability, financial stability and sustainability of the sector. Thus, it is essential that the adequate priority and importance is assigned to this critical statutory function in the Indian power sector.

The objective of this endeavor was to assimilate the available experience at the interstate/intrastate level and suggest a uniform procedure for SAMAST across all the States and Regions in India whether renewable – rich or otherwise. One to one interactions were held with thirteen (13) SLDCs including Maharashtra, Tamil Nadu, Karnataka, Delhi, Gujarat, Madhya Pradesh, Andhra Pradesh, Telangana, West Bengal, Rajasthan, Meghalaya, Assam and BBMB. An electronic survey on the prevailing infrastructure and procedures was conducted. The finding of the survey and the recommendations were discussed and with all the SLDCs, RLDCs and NLDC in the 16th and 17th meeting of the Forum of Load Despatchers. It emerged that the SLDCs could be placed in following one of the four groups: Group-A comprising of States where SLDCs has the first-hand experience of all the aspects of intra State accounting and settlement system. Group-B comprising of States where deviation settlement system has been introduced for a few intra-state entities or mock exercises have been undertaken by the SLDC. Group-C comprises of States where draft regulations for deviation settlement have been notified and preparatory

exercises have commenced. Group-D comprises of States/UT where deviation settlement is yet to commence. It was agreed that implementation of the suggested procedure was essential. Few exceptions may be considered to accommodate the local imperatives.

There was a consensus that the electrical energy accounting procedure should comply with the accounting principles of 'economic entity', 'accrual', 'going concern' and 'double entry'. The energy statements should have all the attributes of 'understandability', 'relevance', 'reliability', and 'comparability' as enumerated in the standards for financial accounting. It was also agreed that that the activities in SAMAST are highly data intensive and complex. Deployment of Information Technology applications to automate, streamline and integrate the entire gamut of activities is strongly recommended. Automatic Meter Reading System needs to be in place for cutting down the time taken in meter data collection. Web-based interface is required for activities such as open access request processing, scheduling, reporting and billing. Few LDCs have decent in-house IT solutions, few rely on external vendors while a few have experimented with off-the shelf IT solutions. However, in all cases, serious limitations emerge during scaling up as well as during upward, downward and lateral integration between IT systems. Therefore in an evolving and growing electricity market of India, long-term sustainability of IT logistics

at the LDC, requires long-term collaboration with IT service providers to develop and deliver customized IT solutions.

There was consensus among all the LDCs regarding the need for a Registry and Clearing Agency for Bilateral Short term Open Access transactions as well as for the Regulatory Pool Accounts presently being operated by the respective LDCs. The Clearing Agency could provide guarantee of Pool Account settlements to all Pool members maintaining adequate margin. Such a system would enable mitigation of systemic and credit risk. It is recommended that possibility of engaging the services of existing Clearing Agencies may be explored.

This report has been prepared under the guidance of the Technical Committee of the Forum of Regulators (FOR) chaired by Member (Technical), CERC. The committee comprised of Members from the SERCs of Tamil Nadu, Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh; CEO, POSOCO and Joint Chief (Regulatory Affairs). Deliberations on the subject were held the third and fourth meeting of the Technical Committee held on 10 Feb 2016 and 01 June 2016. The Minutes of the four meetings of the FOR Technical Committee are collectively placed as Appendix-2.

After an exhaustive consultative process with domain experts from all the State, Regional and National Load Despatch Centres the recommendations in this report were endorsed by the Forum of Load Despatchers (FOLD) in its 17th meeting held on 22 June 2016. The brief details of the report are as under.

Chapter-1 provides the context and background of this report. The sub-committee examined the statutory and regulatory provisions as well as recommendations of the various experts committees for energy metering, accounting and settlement in India. The relevant extracts and associated discussion is placed in Chapter-2.

Chapter-3 provides a summary of the survey results while the summary of the discussions with SLDCs is placed as Appendix-3. The various challenges being experienced at the intrastate level in energy metering, accounting and settlement have been summarized in Chapter-4. The international practices on Metering and Accounting as well as on Settlement System are placed as Appendix-4 and 5 respectively.

Chapter-5 discusses the philosophical issues related with the architecture of a typical scheduling, accounting, metering and settlement system. This chapter also discusses the key learning from the principles of financial accounting that could be applied to energy accounting and settlement.

The learning from the interactions with domain experts in India and the views of the international experts in electricity market were used to evolve the proposed uniform procedure for book-keeping and settlement of electrical energy across all States and Regions in India. The recommendations of the sub-committee on Information Technology, Human Resource and the Uniform Procedure are placed in Chapter-6, 7 and 8 respectively. Appendix-6 provides the general guidelines on the Technical Specification of Interface Energy Meters (IEM), while Appendix-7 gives the outline of the Automatic Meter Reading System. Appendix-8 summarizes the rich experience (more than a decade) of accounting and settlement at the interstate level in all the five regions of India. The learning from different States and Regions has been profusely borrowed. Chapter-9 of the report suggests checklist for implementation of the SAMAST in all the States.

ACKNOWLEDGEMENT

The sub-committee would like to thank the Forum of Regulators, Technical Committee of the FOR and the staff of CERC as well as SERCs for supporting and guiding the sub-committee towards accomplishment of this assignment.

The sub-committee is grateful to the SLDCs of Maharashtra, Tamil Nadu, Karnataka, Delhi, Gujarat, Madhya Pradesh, Andhra Pradesh, Telangana, West Bengal, Rajasthan, Meghalaya, Assam and Bhakra Beas Management Board for fruitful interactions with the FOR sub-committee and for participating in the survey. The SLDCs of Jammu and Kashmir, Punjab, Haryana, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Chandigarh, Bihar, Jharkhand, Bihar, Odisha, Goa, UT Dadra Nagar Haveli, Damodar Valley Corporation and Kerala provided their inputs through the electronic survey form. The sub-committee is grateful for overwhelming participation of all SLDCs during the consultations and for being frank and forthright during interactions on the subject in the meeting of the Forum of Load Despatchers.

This report is a culmination of the collaborative effort of professionals working in operation, logistics, energy accounting, commercial and finance functions at various SLDCs, RLDCs and NLDC. The list of contributors is attached at Appendix-9. The sub-committee would like to acknowledge the valuable contribution of each and every member of the Forum of Load Despatchers, Expert Audit Group on Metering and Settlement, Expert Audit Group on Scheduling and Web-group 'eMASS of India'.

Host of technical literature, reports, statutory documents and public blogs on the subject available on the Internet were referred for guidance. The sub-committee would remain indebted to the domain experts and authors for the above.

The sub-committee is also thankful to the Heads of respective RLDCs and NLDC for providing resources, logistics and secretarial support to the sub-committee. The contribution of team-WRLDC led by Shri Vivek Pandey, supported by Smt. Usha S. in coordinating with other contributors, conducting secondary research, back-end data processing, drafting and editing the report is gratefully acknowledged.

The sub-committee expresses sincere gratitude to the Ministry of Power, Govt. of India, Central Electricity Authority and Central Transmission Utility for their motivation and administrative support to this exhaustive exercise that would go a long way in creating a sustainable institutional arrangement in the Load Despatch Centres for handling the grid with high penetration of Renewable Energy Sources.

ACRONYMS

ABT	Availability Based Tariff
AMI	Automatic Metering Infrastructure
BBMB	Bhakra Beas Management Board
CERC	Central Electricity Regulatory Commission
CGS	Central Generating Stations
CPP	Captive Power Plant
CT	Current Transformer
CTU	Central Transmission Utility
DCD	Data Collection Device
DER	Distributed Energy Resources
Discom	Distribution Company
DSO	Distribution System Operator
DSM	Deviation Settlement Mechanism
DVC	Damodar Valley Corporation
E-MASS	Energy Metering Accounting and Settlement System
ESI	Electric Supply Industry
FOLD	Forum of Load Despatchers
FOIR	Forum of Indian Regulators
FOR	Forum of Regulators
Genco	Generating Company
IEM	Interface Energy Meter
InSTS	Intra State Transmission System
IPP	Independent Power Producer
ISO	Independent System Operator
ISTS	Inter State Transmission System
LTA	Long Term Access
KYC	Know Your Customer
MTOA	Medium Term Open Access
NLDC	National Load Despatch Centre
PT	Potential Transformer
QCA	Qualified Coordinating Agency
REA	Regional Energy Account
RES	Renewable Energy Sources
RLDC	Regional Load Despatch Centre
RPC	Regional Power Committee
RRAS	Reserve Regulatory Ancillary Services
RTA	Regional Transmission Account
RTDA	Regional Transmission Deviation Account
SAMAST	Scheduling, Accounting Metering and Settlement of Transactions in electricity
SEA	State Energy Account
SEM	Special Energy Meter
SERC	State Electricity Regulatory Commission
SGS	State Generating Stations
SLDC	State Load Despatch Centre
SPC	State Power Committee
STOA	Short Term Open Access
STU	State Transmission Utility
TOD	Time Of the Day
TSO	Transmission System Operator
UI	Unscheduled Interchange
WASMP	Weighted Average System Marginal Price

1 INTRODUCTION

1.1 Background

The National Grid comprising of Regional and State power systems is operating as a single synchronous system since Dec 2013. The physical interconnection provides access to a vibrant electricity market at the interstate level. More than 32 GW of Renewable Energy Sources (RES) have already been integrated with the grid and there is an ambitious target from the Government of India for ramping up the RES capacity to 175 GW by 2022. Taking cognizance of the variable and uncertain nature of solar and wind sources, the Central Electricity Regulatory Commission notified the 'Framework on Forecasting, Scheduling & Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar) on 07th August 2015. This framework aligned the scheduling and deviation settlement rules for the Wind and Solar RES at the interstate level. The framework was also integrated with the prevailing CERC Regulations on Indian Electricity Grid Code and deviation Settlement Mechanism through an amendment notified on 07 August 2015.

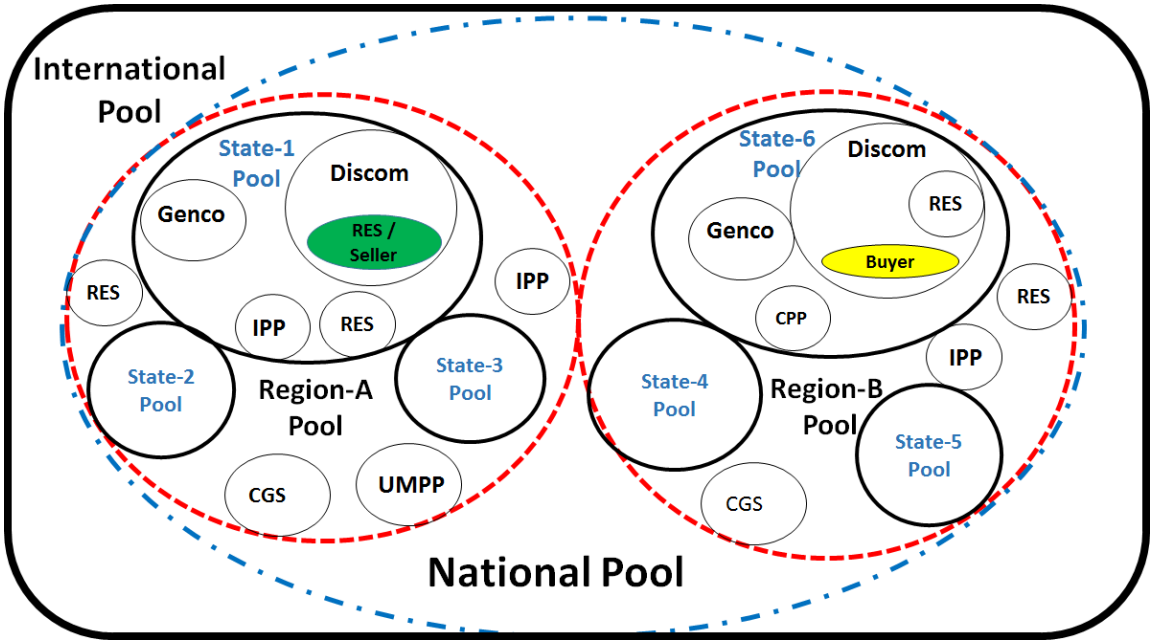

Figure 3: Emerging challenges in energy accounting and settlement in interconnected grid

Presently most of the existing wind and solar generating stations are directly connected to the State Grid and hence they fall under the operational control area of the respective SLDCs. In order to enable States to manage RE generating Stations on the state grid, CERC evolved the State Model regulations that outlines a methodology of forecasting, scheduling and commercial settlement of intra-state RE generators. The Model Regulations (State level) for Forecasting, Scheduling and Imbalance handling for variable

RE Sources (Wind & Solar) were endorsed by the Forum of Regulators during their 50th meeting held on 01st Oct 2015.

Recognizing the challenge for maintaining load-generation in the Indian Grid due to the increase in size of the synchronous interconnection, CERC notified the Regulations on Ancillary Services Operations on 13th August 2015 at the interstate level. Vide its order dated 13-October 2015 in the Suo Motu Petition 11/SM/2015, CERC notified the road map to operationalize reserves in the country. Further The Central Commission in its exercise of powers under Section 79 (2) of the Electricity Act advised the Central Government vide its letter dated 2-Nov 2015 for issuing advisory to the States on the following issues

- Execution of detailed Energy Accounting of all intra State entities
- Creation of Intra State Deviation Mechanism pool at the State level
- Implementation of Availability Based Tariff for intra State generators
- Ring fencing and capacity building of SLDCs
- Adopt Model Regulations on Forecasting, Scheduling and Deviation Settlement for Solar and wind generators
- Evolve Ancillary and Reserves Regulations at State level in line with CERC order on reserves and Ancillary Services

1.2 Constitution of the Technical Committee of Forum of Regulators

Considering the challenges associated with the implementation of the enabling regulations and mechanisms at all the States in a harmonious manner a Technical Committee was constituted on 18 Nov 2015 by the Forum of Regulators (FOR). The Technical Committee was given the responsibility to evolve a roadmap for implementation and ensure timely action on the following:

a. Deployment and implementation of framework on forecasting, scheduling and deviation settlement of wind & solar generating stations at the state level
b. Introduction /implementation of Availability Based Tariff (ABT) framework at the State level as mandated in the National Electricity Policy and Tariff Policy
c. Introduction of Ancillary Services and Reserves at the State level
d. Implementation of Automatic Generation and primary control within States
e. Provide periodic reports to the FOR

The Technical Committee is chaired by Member (Technical), CERC and comprises of Member (Technical), Tamil Nadu ERC, Member (Technical), Gujarat ERC, Member (Technical), Rajasthan ERC, Member (Technical), Maharashtra ERC, Member (Technical), Andhra Pradesh ERC, Member (Technical), Karnataka ERC, Member (Technical), Madhya Pradesh ERC, Chief Executive Officer (CEO), POSOCO and Joint Chief (Regulatory Affairs), CERC.

1.3 Constitution of the Sub-committee of the Technical Committee

In line with the decisions taken by the Technical Committee of FOR in its 2nd meeting a Sub-Committee was constituted on 20 Jan 2016 [Appendix-1]. The sub-committee was chaired by CEO, POSOCO and comprised of one representative from concerned SERC, one representative from concerned SLDC, one representative from RLDC and one representative from the FOR secretariat (as Observer). The Terms of Reference (TOR) of Sub-Committee were as under:

a. Evolve detailed action plan with time lines for implementation of ABT/DSM at State level
b. Suggest modification of all technical and accounting procedures as may be necessary for rolling out ABT/DSM framework
c. Assist in drafting of requisite State regulations, or amendments to existing regulations, as the case may be
d. Submit report on the progress of the sub-group to the Technical Committee of States every two months

The progress of the activities of the sub-group were presented to the FOR Technical Committee in its third and fourth meeting held on 10 Feb 2016 and 01 June 2016. The Minutes of the four meetings of the FOR Technical Committee are collectively placed as Appendix-2.

The sub-committee interacted with State/Regional/National Load Despatch Centres and conducted a survey to study the prevailing set-up of energy accounting and settlement system in the States.

The chapters ahead summarize the finding and the recommendations of the sub-committee as endorsed by the Forum of Load Despatchers.

2 Imperatives for Intra State Accounting & Settlement System

2.1 Mandate of the Electricity Act

Section 32 of the Electricity Act 2003 mandates that the State Load Dispatch Centre (SLDC) shall be the apex body to ensure integrated operation ofthe power system in a State. It shall monitor grid operations and exercise supervision and control over the intra-State transmission System. Section 32 (2) of the Electricity Act also entrusts the State Load Despatch Centres with two important responsibilities pertaining to the entities within its jurisdiction. The relevant extracts are quoted below:

Quote

The State Load Despatch Centre shall -

(a) be responsible for optimum scheduling and despatch of electricity within a State, in accordance with the contracts entered into with the licensees or the generating companies operating in that State;

…

(c) keep accounts of the quantity of electricity transmitted through the State grid;

…

Unquote

De-licensing of generation and restructuring of the State Electricity Boards resulted in formation of several new utilities within the State viz. distribution licensees (public and private), generating utilities (public and private) and transmission licensees (public and private) that had to be accountable for the business of electricity purchase/sale/transmission/distribution. Thus, scheduling, dispatching and accounting of electricity transmitted through the State Grid has been recognized as an important statutory responsibility of the State Load Despatch Centre.

2.2 Provisions in the National Electricity Policy

Availability Based Tariff (ABT), with a unique Unscheduled Interchange (UI) component, was recommended for Central Sector generation and private generation by M/s ECC, USA after a nation-wide, World Bank/ADB-sponsored study in 1993-94. Govt. of India then agreed to its early implementation, as a covenant of World Bank/ADB loans to Power Grid Corporation of India. After constitution of the Central Electricity Regulatory Commission (CERC) in 1998, the matter came under the purview of CERC, which after due process in 1999 had issued its orders and regulations on this subject starting from January 2000. ABT has since been implemented at inter-State level (i.e. for Central generating stations), region-by-region during 2002

and 2003.The Central Government recognized the benefits of ABT and the following was stipulated in the National Electricity Policy notified on 12.2.2005.

Quote

"*5.7.1(b) The ABT regime introduced by CERC at the national level has had a positive impact. It has also enabled a credible settlement mechanism for intra-day power transfers from licensees with surpluses to licensees experiencing deficits. SERCs are advised to introduce the ABT regime at the State level within one year.*"

Unquote

2.3 Settlement of Deviations for Short-term Open Access transactions

Electricity Act 2003 mandated Open Access in Transmission and Distribution System. The transmission system was recognized as a common carrier. Consequently, IPPs, Captive Power Plants, HT consumers and other utilities connected to the grid, could pay the usage charges and seek access to the network subject to margins in the system. The regulations for facilitating Short term Open Access Transactions at the interstate level were notified by CERC in 2004. Later STOA regulations for the States were notified by the respective State Electricity Regulatory Commissions gradually in several States. The STOA transactions could be within the intra State system or at the interstate level. These approved short-term open access transactions had to be scheduled along with other long term and medium term transactions by the appropriate Load Despatch Centres. In order to ensure delivery against these transactions, it became imperative to implement a system for energy accounting and settlement system in the intra State level also.

2.4 Provisions of the Tariff Policy

The Tariff Policy notified by the Government of India on 06.01.2006 recommended as under-

Quote

"*6.2 Tariff structuring and associated issues (1) A two-part tariff structure should be adopted for all long term contracts to facilitate Merit Order dispatch. According to National Electricity Policy, the Availability Based Tariff (ABT) is to be introduced at State level by April 2006. This framework would be extended to generating stations (including grid connected captive plants of capacities as determined by the SERC). The Appropriate Commission may also introduce differential rates of fixed charges for peak and off peak hours for better management of load.*"

Unquote

2.5 Recommendations of the Forum of Regulators

Pursuant to the notification of the National Electricity Policy and Tariff Policy several SERCs started working towards implementation of ABT and frequency linked deviation settlement mechanism in their State. MERC took the initiative of implementing the settlement system based on weighted average system marginal price (WASMP).

Forum of Indian Regulators (FOIR) had constituted a Committee in March 2005 to make recommendations to FOIR on implementation of ABT in intra-State systems [http://www.foir-india.org/upload/recomm_abt.pdf]. The FOIR Committee recognized that its recommendations would not be mandatory and the SERCs are fully competent to decide on the subject matter within their respective State jurisdiction. However, it suggested that while introducing ABT mechanism at State level, the SERCs would have to ensure that intra-State ABT mechanism is compatible with the inter-State ABT system. Above recommendations were adopted by the FOIR during its 7th Annual General Meeting held on June 15, 2006.

An Interactive Session was convened on 5 Nov 2007 at New Delhi by the Ministry of Power, Govt of India with the Forum of Regulators and State Governments. It was decided therein to constitute a Task Force to examine various issues relating to scheduling, metering and settlement of intra-State open access transactions. The Task Force submitted its report in 2008. Relevant Extracts from the Report of the Task Force are quoted below:

Quote

"*The Task Force could not come to consensus on the suggestion of adoption by all the States of uniform settlement mechanism on the lines of the mechanism already in place for inter-State scheme. Therefore, the Task Force concludes that it would be preferable that the States adopt the uniform mechanism for settlement. However, the SERC's could adopt alternative mechanisms after fully examining the pros and cons of such options. But such alternative mechanism should definitely be compatible with the inter-State mechanism.*"

Unquote

2.6 Mandate of the Indian Electricity Grid Code

Regulation 6.4.1 of the Indian Electricity Grid Code mandates as under:

Quote

"*The national interconnected grid is demarcated into control areas, like Regional ISTS, States, DVC, etc. where the load dispatch centre or system operator of the respective control area controls its generation and/or load to maintain its interchange schedule with other*

control areas whenever required to do so and contributes to frequency regulation of the synchronously operating system. The Load Despatch Centre of a control area therefore is responsible for coordinating the scheduling of a generating station, within the control area, real-time monitoring of the station's operation, checking that there is no gaming (gaming is an intentional mis-declaration of a parameter related to commercial mechanism in vogue, in order to make an undue commercial gain) in its availability declaration, or in any other way revision of availability declaration and injection schedule, switching instructions, metering and energy accounting, issuance of UI accounts within the control area, collections/disbursement of UI payments, outage planning, etc."

Unquote

It is evident that the IEGC also entrusts the State Load Despatch Centre with the responsibility of scheduling, dispatching, metering, energy accounting, deviation settlement and administration of pool accounts.

2.7 Large Scale Integration of Renewable Energy

Existing and envisaged capacity of RE (as per MNRE definition) in States is shown in Table-1. With the envisaged large-scale integration of RES in the State as well as interstate level, the number of players, energy transactions, market volume, complexity of pool administration would increase manifold. Relevant extracts from the "Report on India's Renewable Electricity Roadmap 2030: Towards Accelerated Renewable Electricity Deployment" by Niti Ayog in this regard are quoted below:

"*We should not get into the mindset that RE is the intruder and conventional energy is the main player. Why not consider RE to be main occupants of the "house" and then work out the rest of the system around RE, essentially, because RE is the future ?*"

Relevant extracts from the "Report of the Expert Group on 175 GW RE by 2022" by Niti Ayog in this regard are quoted below:

"*Balancing in India is overseen by a state LDC, and is done by each state as a whole. Given that some states are very large indeed – comparable to many countries in scale– this is already a very significant task.*"

"*Placing renewables at the centre of India's power system will require a paradigm shift in planning and governance practices*"

Table 1: Existing and envisaged RES capacity

S No.	State / UT	Existing capacity as on Feb 2016 (as per CEA)	Envisaged Solar by 2022 (as per MNRE)	Envisaged Wind by 2022 (as per MNRE)
1	Tamil Nadu	8864	8884	11900
2	Maharashtra	6400	11926	7600
3	Rajasthan	5266	5762	8600
4	Gujarat	4973	8020	8800
5	Karnataka	4819	5967	6200
6	Andhra Pradesh	2193	9834	8100
7	Madhya Pradesh	1931	5673	6200
8	Uttar Pradesh	1059	10697	
9	Himachal Pradesh	755	776	
10	Punjab	508	4772	
11	Chattisgarh	390	1783	
12	Kerala	246	1870	
13	Uttarakhand	244	900	
14	Jammu & Kashmir	157	1155	
15	Odisha	152	2377	
16	Haryana	139	4142	
17	West Bengal	132	5336	
18	Bihar	114	2493	
19	Arunachal Pradesh	105	39	
20	Telangana	91		2000
21	Sikkim	52	36	
22	Mizoram	36	72	
23	Delhi	35	2762	
24	Assam	34	663	
25	Meghalaya	31	161	
26	Nagaland	30	61	
27	Tripura	21	105	
28	Jharkhand	20	1995	
29	Manipur	5	105	
30	UT Chandigarh	5	153	
31	Goa	0	358	
32	UT Puducherry	0	246	
33	UT DNH	0	449	
34	UT Daman & Diu	0	199	

Source:http://mnre.gov.in/file-manager/UserFiles/Tentative-State-wise-break-up-of-Renewable-Power-by-2022.pdf

As per envisaged RE capacity addition by 2022, it is expected that all the States and UTs would have RES. Efforts are being made to facilitate integration of RES in the mainstream electricity market. The utilities would be obligated to achieve their RPO targets by adding green energy in their energy portfolio. Thus RE transactions would flow across various seams in the intra State, interstate, interregional or even trans-national boundaries. Moreover with the evolution of electricity market new products could be introduced. All these would have to be coordinated by through the respective Load Despatch Centres. Thus NLDC, RLDCs and SLDCs of the RE-rich State or otherwise would have to be equipped to with the framework, logistics and resources to handle large number of transactions.

Energy Accounting and Settlement system would become critical for the reliability of the physical system as well for the credibility of the power sector as a whole. Thus it is evident from the above that enabling mechanisms, infrastructure, resources need to be in place to facilitate the SLDC in discharging the statutory and regulatory provisions.

The report of the Technical Committee on 'Large Scale Integration of Renewable Energy, Need for Balancing, Deviation Settlement Mechanism (DSM) and associated issues' highlights the need for a regulatory framework for intra State deviation, metering, accounting and settlement mechanism amongst the different entities including renewable. Relevant extracts are quoted below:

"*1. Appropriate Regulatory Framework for handling Inter-State Deviations especially for Large and High RE Penetration States*
The deviation limits for inter-state and intra-state entities, especially for Large and High RE Penetration States, stipulated by the Appropriate Commission, may take into account the stakeholder's concerns and international best practices. The regulatory framework for intra-state deviation, metering, accounting and settlement mechanism amongst the different entities including renewables must be in place and implemented at state level in 2016. Subsequently, say by 2017, deviation price may be linked to market linked mechanism with suitable price discovery process."

2.8 Recommendation by international experts on electricity market

Scheduling & Dispatch, Imbalance, Congestion Management and Ancillary Services have been recognized as one of the four pillars for a well-functioning electricity market. Relevant extracts from the book Making Competition Work in Electricity by Sally Hunt are quoted below:

Quote

"*The trading rules that deal with the four features of electricity just mentioned are the four pillars of good electricity market design. All other aspects of market design become quite straightforward once these are in place:*

1. *Imbalances;*
2. *Congestion management;*
3. *Ancillary services; and*
4. *Scheduling and dispatch.*

All of these pieces must work together. Design of trading arrangements really is a technical issue, in which economists and engineers are the experts. If you want to build a bridge, you ask an architect/engineering firm. You can have a covered bridge, a Roman arch, and a suspension bridge or whatever. But don't have half of one and half of another! One of the biggest problems in setting up trading arrangements arises if they are designed through a piecemeal process of litigation or negotiation—processes typical in the United States. Trading arrangements are, after all legal agreements and computer programs, but problems arise if lawyers and programmers design them. The right process is for economists and engineers to set out clearly what is supposed to happen, for the lawyers to write this into detailed documents, and for the programmers to turn this into operational software."

Unquote

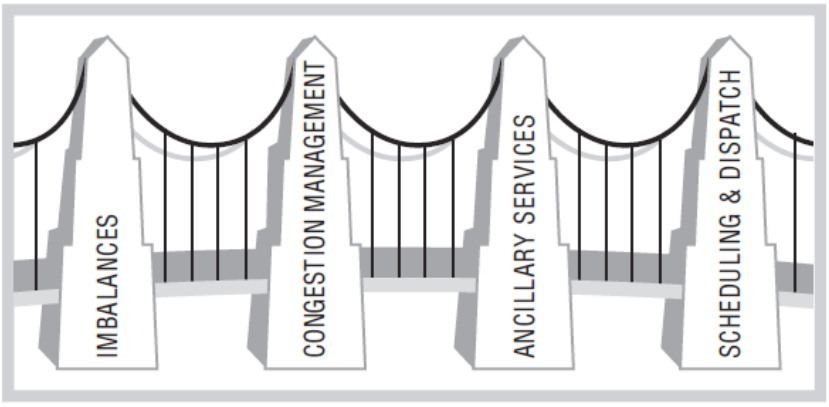

Figure 4: Pillars of Electricity Market Design

The emerging scenario with high penetration of RES in the grid has also triggered discussions on the need for review of the existing institutional mechanism in the power sector. Relevant extracts from the report titled "Clean Restructuring: Moving from Vertically Integrated to Competitive

Wholesale Electricity Market and Beyond- A Report from the 21st Century Power Partnership" are quoted below:

Quote

"*Several market design and system operation practices have also emerged as critical elements of a clean restructured power system. First, the design and implementation of unit commitment and dispatch rules, e.g. faster dispatch, can significantly impact the ability to manage variable renewable generation on the system and has implications for the economic viability of renewables. Second, the structure of imbalance penalties and rules for curtailing generation for balancing are also key considerations for the viability and integration of clean energy sources.*"

"*The band of acceptable schedule deviations and the magnitude of penalties for violation of imbalances are of critical importance for the economic viability of all flexible assets and for effective system operations.*"

"*Market design issues will become more important, the higher the share of renewables becomes.*"

"*Recognizing that power markets have unique local considerations, policy objectives, operational practices, and physical characteristics (e.g., grid infrastructure, generation mix) that play into decisions about clean energy restructuring, international experience can help inform, but not dictate, the path forward.*"

Unquote

It would be inferred from the above that scheduling and settlement system are critical for success of the electricity market.

2.9 Summary

It may be evident from the preceding paragraphs that that the statutory and regulatory provisions, tariff policy as well as the domain experts recommend implementation of a robust energy metering, accounting and settlement system for functioning of the electricity market as well as for integration of RES at a large scale.

3 Energy Accounting and Settlement-Survey Results

3.1 Background

The sub-committee conducted a survey of SLDC activities in energy metering, scheduling, accounting and settlement at the intra state and interstate level. 28 SLDCs and 5 RLDCs responded to the survey. The summary of the response to the questionnaire as submitted by SLDCs is consolidated in this chapter while the response to the questionnaire as submitted by the RLDCs are enclosed as Appendix-8.

3.2 Number of Intra State Entities

All the intra-State Generating Stations (Thermal, Hydro, RES etc.) Distribution Licensees, HT consumers/Open Access Customers who have been granted connectivity by the respective State Transmission Utility (hereafter referred as intra-State Entities) would fall under the jurisdiction of the respective State Load Despatch Centre. The SLDC is responsible for regulating the generation and/or load within its control area to maintain its interchange schedule with other control areas and ensure that the control area contributes to frequency regulation of the synchronously operating system. Supervision and control over the interchange of the State Grid with the Regional Grid by the SLDC would be possible only when SLDC is able to monitor the interchange of the Intra State Entities with the State Grid.

The present number of intra state entities either whose scheduling is being coordinated by SLDCs is given in Table-2. It may be seen from the table and chart that the number of intra State entities being coordinated by SLDCs is significantly high. It is particularly high in RE rich States (such as Maharashtra, Gujarat, Madhya Pradesh, Rajasthan) as well as in States that have large number of HT consumers/Captive Power Plants connected at the STU level. The number of entities is also very high in States / UT (such as Tamil Nadu, Goa, UT DNH) where there is only one deemed distribution licensee. Considering the envisaged addition of RES in the intra State system and fast evolution of new market mechanisms, there is a need for creating a supportive institutional set up at the SLDC / Distribution level for long-term sustainability.

Table 2: Typical Number of Intra State Entities whose scheduling is coordinated by SLDC

S No	SLDC	No. of Thermal /Hydro Stations	No. of RES	No. of Distribution Licensees	No. of HT Consumers or CPPs directly connected to STU system	No. of interstate STOA customers in State/UT	Total Intra State Entities
1	**Andhra Pradesh**	55	17	3	187	10	272
2	**Assam**	3	1	1	1	11	17
3	**BBMB**	6	0	0	1	0	7
4	**Bihar**	2	21	2	19	0	44
5	**Chandigarh**	0	18	1	0	0	19
6	**Chattisgarh**	4	0	1	13	0	18
7	**UT- DNH**	0	10	1	890	0	901
8	**DVC**	7	3	1	322	0	333
9	**Delhi**	6	2	5	0	7	20
10	**Goa**	0	0	1	884	0	885
11	**Gujarat**	32	132	9	61	155	389
12	**Haryana**	2	0	2	31	349	384
13	**Himachal Pradesh**	6	9	1	0	12	28
14	**Jharkhand**	9	8	1	2	1	21
15	**Jammu and Kashmir**	3	23	0	0	0	26
16	**Karnataka**	21	187	5	147	68	428
17	**Kerala**	41	5	10	2	12	70
18	**Madhya Pradesh**	21	85	5	42	61	214
19	**Maharashtra**	29	190	8	34	162	423
20	**Meghalaya**	4	3	1	6	7	21
21	**Odisha**	8	2	4	30	14	58
22	**Punjab**	2		1	0	248	251
23	**Rajasthan**	15	168	3	80	9	275
24	**Tamil Nadu**	88	207	1	54	440	790
25	**Telangana**	39	3	2	129	15	188
26	**Uttarakhand**	11	10	1	14	79	115
27	**Uttar Pradesh**	21	67	7	80	7	182
28	**West Bengal**	7	1	4	3	0	15

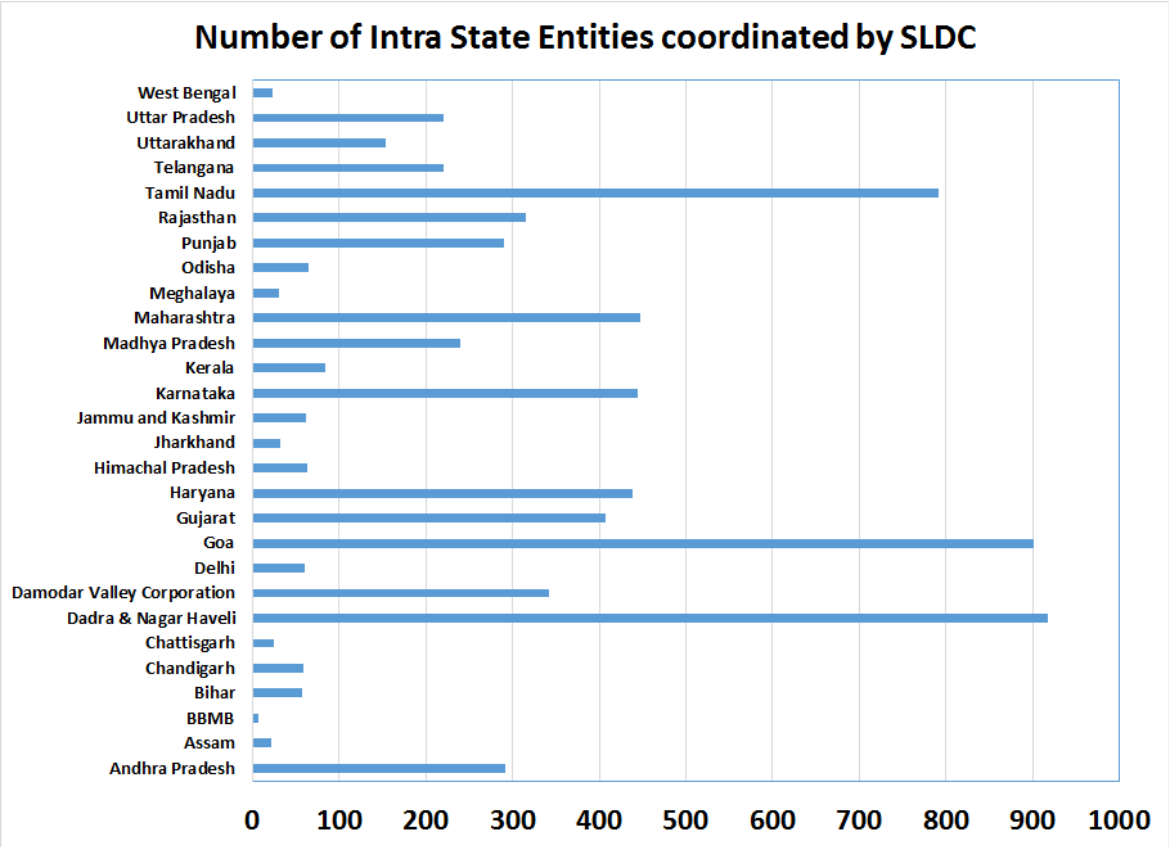

Figure 5: Number of Intra State Entities whose scheduling is coordinated by SLDC

3.3 Interface Energy Meters for Intra State Entities

Interface Energy Meters (IEM) measure and record the exchange of energy at the interface point. Thus in an electricity grid, the interface boundaries are defined by placement of meters. The typical number of interface points (tie lines) in various States is compiled in Table-3 while the number of Interface Meters installed is compiled in Table-4. The total number of Interface Meters vis-à-vis the total number of Interface Points within the State is depicted in Figure-4. Generally the number of Interface Meters should be higher than the Interface points. As per the available survey data, the total number of interface points at the intra State level are 23301 while the number of Interface Energy Meters is 22406. It may be seen that the placement of Interface energy meters in several States is inadequate.

Most of the interface energy meters in place are of 0.2S accuracy class. In few of the States the reactive energy meters are of 0.5S accuracy class. The least count of meters is 15-minutes with exception of Andhra Pradesh, Telangana and Tamil Nadu. In Andhra Pradesh and Telangana the least count in several places is 30-min, while in Tamil Nadu the meters record energy in five (5) time slots in a day. There are several vendors for Interface Energy Meters viz.

L&T, Secure, Elster, ABB, Wallby and Alstom. Due to the proprietary nature of the meter data processing software at SLDCs, often there are compatibility issues when Meter of a particular make is replaced with meters of another make.

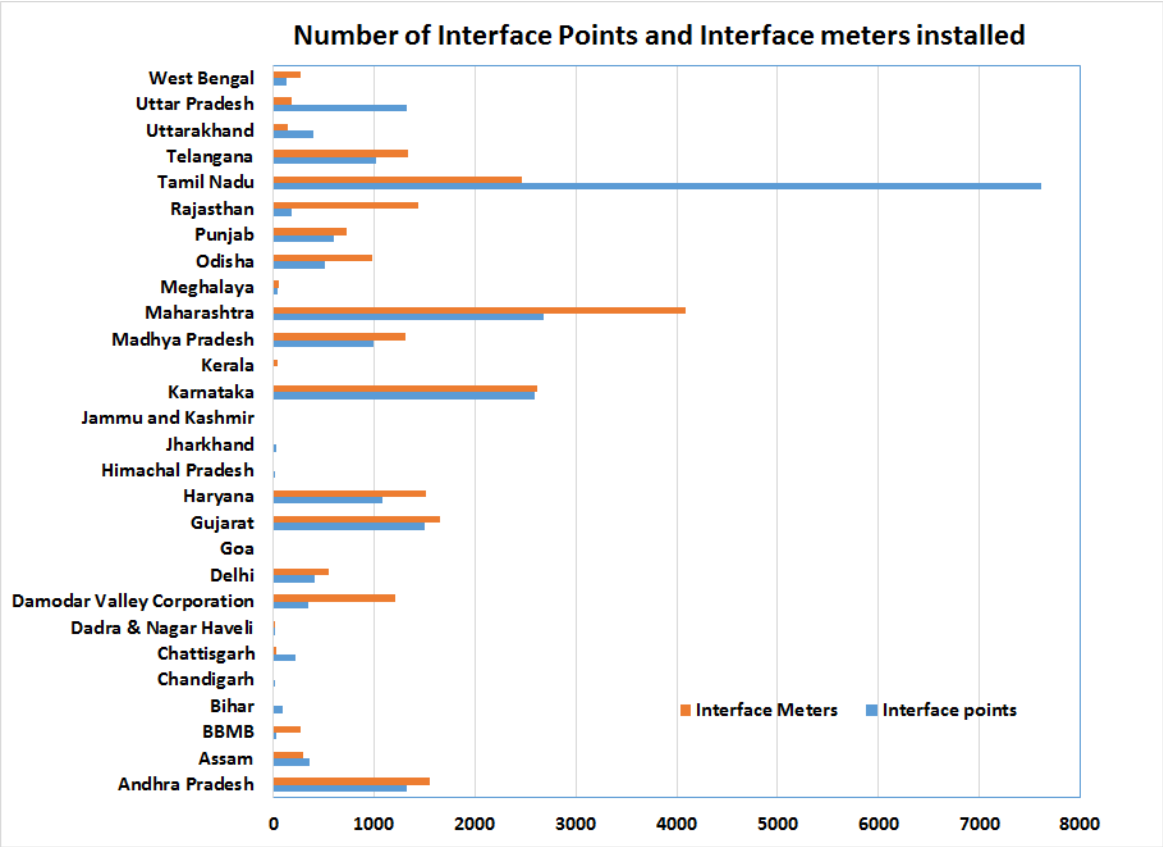

Figure 6: Number of Interface Energy Meters vis-a-vis Interface points

Out of the 25 States/UTs surveyed, 100% data collection through Automatic Meter Reading (AMR) system is deployed only in 8 centres. In 4 cases, AMR is either under implementation or only partially implemented.

Table 3: Typical number of interface points of intra State Entities with intra State Grid

S No.	SLDC	G-T	RES - T	ISTS-InSTS	D-T	HT - T	OA - T	Total
1	Andhra Pradesh	118	21	116	877	187	10	1329
2	Assam	16	1	36	284	11	11	359
3	BBMB	29	0	8	0	0	0	37
4	Bihar	11	21	37	1	19	0	89
5	Chandigarh	0	18	4	NA	NA	0	22
6	Chattisgarh	23	4	19	86	77	9	218
7	DNH	0	0	7	0	0	0	7
8	DVC	7	3	20	0	322	2	354
9	Delhi	45	3	38	321	0	0	407
10	Goa	NA	NA	NA	NA	NA	NA	0
11	Gujarat	881	414	169	0	43	0	1507
12	Haryana	32	6	69	920	34	17	1078
13	Himachal Pradesh	0	0	12	12	0	0	24
14	Jharkhand	9	8	1	2	2	9	31
15	Jammu and Kashmir	NA	NA	NA	NA	NA	NA	NA
16	Karnataka	21	187	27	2136	147	68	2586
17	Kerala	1						0
18	Madhya Pradesh	96	85	69	651	29	65	995
19	Maharashtra	160	416	63	1776	271	NA	2686
20	Meghalaya	4	3	5	16	6	7	41
21	Odisha	50	2	26	402	39	0	519
22	Punjab	121	0	62	398	20	0	601
23	Rajasthan	75	19	65	0	0	21	180
24	Tamil Nadu	245	862	10	4185	2307	0	7609
25	Telangana	85	3	49	714	151	15	1017
26	Uttarakhand	29	9	31	240	16	79	404
27	Uttar Pradesh	81	67	108	996	65	7	1324
28	West Bengal	63	1	38	23	7	0	132

G - T : Tie lines between State Generator & State Transmission System
RES -T : Tie lines between RES & State Transmission Grid (at pooling point)
InSTS – ISTS : Tie lines between Intra State Transmission System & Inter State Transmission System

D-T: Tie lines between Distribution & Transmission Grid
H-T: Tie lines between HT consumer & Transmission Grid
OA – T: Tie lines between Short term Open Access User & Transmission Grid

Roughly only 30% of the Interface Energy Meters in the country are read through AMR system. The data from rest of the meters are collected manually. In the absence of AMR system the practice of Joint Meter Reading is prevalent. This makes the job of data collection extremely tedious and time consuming. There are several locations from where either the data is unavailable or the meter reading is erroneous. These values have to be either estimated, or substituted from SCADA/historical data for preparing the State Energy Account (SEA). This is prone to disputes. Delay in meter data collection, delays the entire energy accounting and settlement.

Table 4: Typical Interface Energy Metering at Intra-State Level

S No.	SLDC	Main Meters	Check Meters	Standby Meters	Total Interface Energy Meters	AMR
1	**Andhra Pradesh**	1090	316	141	1547	Partial
2	**Assam**	300	0	0	300	No
3	**BBMB**	111	48	109	268	Partial
4	**Bihar**	52	32	NA	0	Partial
5	**Chandigarh**	4	0	0	0	Yes
6	**Chattisgarh**	25	0	0	25	Yes
7	**DNH**	7	0	0	7	No
8	**DVC**	517	212	486	1215	Yes
9	**Delhi**	321	229	0	550	No
10	**Goa**	NA	NA	NA	NA	No
11	**Gujarat**	840	209	599	1648	Yes
12	**Haryana**	835	680	0	1515	No
13	**Himachal Pradesh**	NA	NA	NA	NA	No
14	**Jharkhand**	NA	NA	NA	0	No
15	**Jammu and Kashmir**	NA	NA	NA	0	No
16	**Karnataka**	2549	68	0	2617	No
17	**Kerala**	20	0	18	38	No
18	**Madhya Pradesh**	995	246	70	1311	Partial
19	**Maharashtra**	2513	1575	0	4088	No
20	**Meghalaya**	47	3	7	57	No
21	**Odisha**	493	493	0	986	No
22	**Punjab**	593	89	48	730	Yes
23	**Rajasthan**	555	555	328	1438	No
24	**Tamil Nadu**	11762	49	0	2471	No
25	**Telangana**	803	387	142	1332	Yes
26	**Uttarakhand**	150	0	0	150	Yes
27	**Uttar Pradesh**	81	81	15	177	No
28	**West Bengal**	94	94	79	267	Yes

The reported constraints in complete AMR deployment are non-availability of AMR compliant meters or non-availability of communication infrastructure. Considering the envisaged increase in the number of intra State and the need for faster energy accounting/settlement it is absolutely essential to ensure adequate infrastructure for AMR for data collection. SLDCs have also expressed severe limitations in the software available at the SLDCs for data processing and validation.

3.4 Energy Accounting

The SLDCs/RLDCs are mandated by the Electricity Act to keep account of the electricity in the State / Regional Grid. The State Grid are synchronously connected with the Regional Grids in India. The five regional grids also have been synchronously connected to form the National Grid. Open Access in transmission and physical integration of the State and National Grids enabled the market players to trade electricity seamlessly. Thus the electricity markets in India have been integrated. Indian Grid is interconnected with the Grids of the neighbouring countries viz. Bhutan, Bangladesh and Nepal. Electrical energy is being exchanged with these countries. Gradually the volume of electricity traded in the intrastate, interstate, inter-regional grid and trans-national is expected to increase.

Energy Accounting is a pre-requisite to financial settlement of energy exchanges within the grid. Energy Accounting involves book keeping of Long-term, Medium Term and Short-term transactions that were scheduled and dispatched, computation of energy actually delivered into the grid and energy actually withdrawn from the grid by the entities, computation of total transmission losses in the grid. In States where two-part generation tariff has been implemented, the State Energy Account also reflects the monthly as well as the cumulative power station availability for incentive computation.

Energy Accounting is a post facto activity. At the interstate as well as intra State level, the Energy Accounting is being done on a monthly basis except for deviation settlement and reactive energy accounting that is done on a weekly basis. The scheduled energy figures mentioned in the monthly energy statements are used by the utilities for billing and settlement of their scheduled transactions. Therefore, it requires thorough verification and reconciliation. Typical Energy Interchange that is accounted at the intra state level is tabulated below. Out of the 28 SLDCs surveyed, the meter data is

uploaded on the SLDC website in only 4 centres. Further only in 12 out of the 28 SLDCs surveyed, the State Energy Account is available on SLDC website.

Table 5: Typical Energy Interchange at the Intra State level

S No.	SLDC	Last State Energy Account Issued for the month of	Typical Energy (MU) Injection into the State Grid	Typical Energy (MU) withdrawal from the State Grid	Typical % Transmission Losses (of the STU system)
1	Andhra Pradesh	Dec-15	4684	4525	3.4%
2	Assam	Feb-16	652	624	4.3%
3	BBMB	NA	1618	NA	NA
4	Bihar	NA	NA	NA	NA
5	Chandigarh	Apr-16	196	189	3.6%
6	Chattisgarh	Mar-16	2237	2178	2.7%
7	DNH	NA	0	499	NA
8	DVC	NA	NA	NA	NA
9	Delhi	May'16	387	2677	0.8%
10	Goa	NA	365	323	4.5%
11	Gujarat	Feb-16	7532	7257	3.7%
12	Haryana	Mar-16	5070	4947	2.4%
13	Himachal Pradesh	Mar-16	129	663	NA
14	Jharkhand	NA	NA	NA	NA
15	Jammu and Kashmir	NA	142	45	5.0%
16	Karnataka	Mar-16	6469	6218	3.9%
17	Kerala	May-16	2288	NA	NA
18	Madhya Pradesh	Feb-16	6512	6320	2.9%
19	Maharashtra	May-15	12933	12396	4.2%
20	Meghalaya	Jan-16	198	190	4.1%
21	Odisha	Apr-16	2403	2323	3.8%
22	Punjab	Apr-16	-	-	-
23	Rajasthan	Feb-16	6902	6627	4 %
24	Tamil Nadu	Mar-16	9088	NA	NA
25	Telangana	Nov-14	4476	4345	2.9%
26	Uttarakhand	Mar-16	1357	1336	1.5%
27	Uttar Pradesh	Mar-16	8351	8068	3.4%
28	West Bengal	Mar-16	7520	7287	3.1%

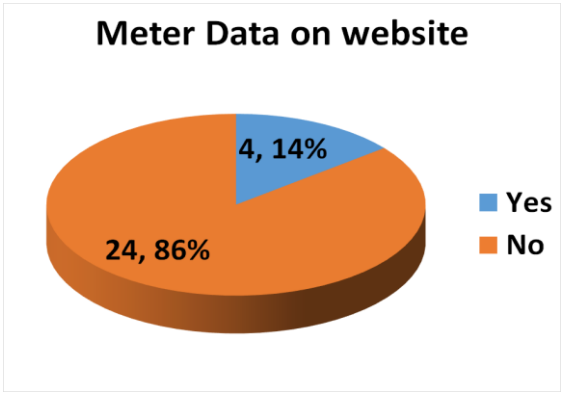

Figure 7: Availability of Meter data on SLDC website for verification and reconciliation

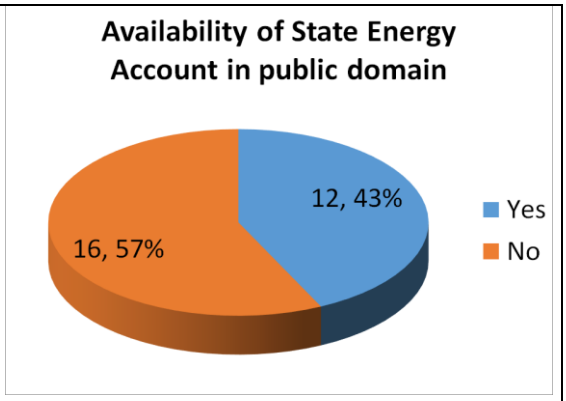

Figure 8: Availability of State Energy Account on SLDC website for verification and reconciliation

At the interstate level, the RLDCs collect and process the energy meter data, Secretariat of the Regional Power Committee verifies the data and prepares the Energy Account. Such an arrangement is missing at the State.

3.5 Settlement System

While Energy Accounting is being done in all the State, the intra state deviation settlement system for all the intra-state entities within a State/UT has been introduced only in six (6) States viz. Delhi, Maharashtra, Gujarat, Madhya Pradesh, West Bengal and Chattisgarh. The present status is given in Table-6. The deviation settlement system in these States except Maharashtra is frequency-linked. In Maharashtra the deviation settlement is based on the Weighted Average System Marginal Price. The States of Andhra Pradesh, Haryana, Karnataka, Kerala, Odisha, Meghalaya, Punjab, Rajasthan, Telangana, Uttarakhand and Uttar Pradesh have implemented deviation settlement system only for IPPs selling power to the discoms under open access in the respective States. Andhra Pradesh and Telangana have adopted the System Marginal Price based settlement while the others have adopted the frequency-linked scheme similar to the interstate level. Draft regulation for intra State DSM in Tamil Nadu has been notified and SLDC Chennai has commenced the preparatory exercise for implementation of the intra state settlement system. In the States where intra State deviation settlement system has been implemented, the settlement period is 15-min. However only 8 out of the 28 SLDCs are doing weekly settlement of deviations.

Table 6: Status of implementation of intra-State Settlement System

S No.	State/UT/Control Area	Settlement System Status	Settlement system for all Intra State Entities w.e.f.	Whether unbundling has been done
1	Andhra Pradesh	Partial		Yes
2	Arunachal Pradesh	-	-	-
3	Assam	-	-	-
4	Bihar	-	-	Yes
5	Chattisgarh	Yes	01.11.2014	Yes
6	Delhi	Yes	01.04.2007	Yes
7	Goa	-	-	-
8	Gujarat	Yes	05.04.2010	Yes
9	Haryana	Partial	-	Yes
10	Himachal Pradesh	Yes	-	Yes
11	Jammu & Kashmir	-	-	-
12	Jharkhand	-	-	Yes
13	Karnataka	Partial	-	Yes
14	Kerala	Partial	-	-
15	Madhya Pradesh	Yes	30.10.2009	Yes
16	Maharashtra	Yes	17.05.2007	Yes
17	Manipur	-	-	-
18	Meghalaya	Partial	-	-
19	Mizoram	-	-	-
20	Nagaland	-	-	-
21	Odisha	Partial	-	Yes
22	Punjab	Partial	-	Yes
23	Rajasthan	Partial	-	Yes
24	Sikkim	-	-	-
25	Tamil Nadu	-	-	Yes
26	Telangana	Partial		Yes
27	Tripura	-	-	-
28	Uttarakhand	Partial	-	Yes
29	Uttar Pradesh	Partial	-	Yes
30	West Bengal	Yes	01.04.2008	Yes
31	UT Chandigarh	-	-	-
32	UT Dadra & Nagar Haveli	-	-	-
33	UT Daman & Diu	-	-	-
34	UT Puducherry	-	-	-
35	DVC	-	-	-

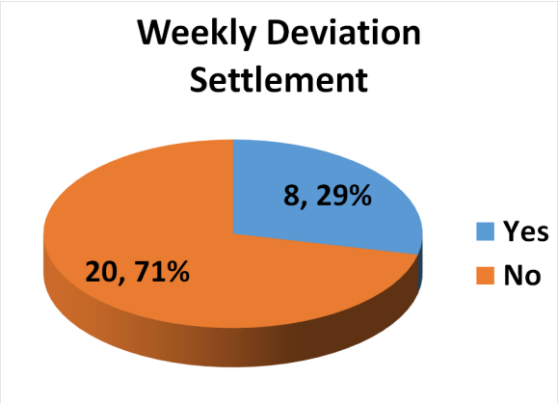

Figure 9: Number of SLDCs having weekly settlement of deviations

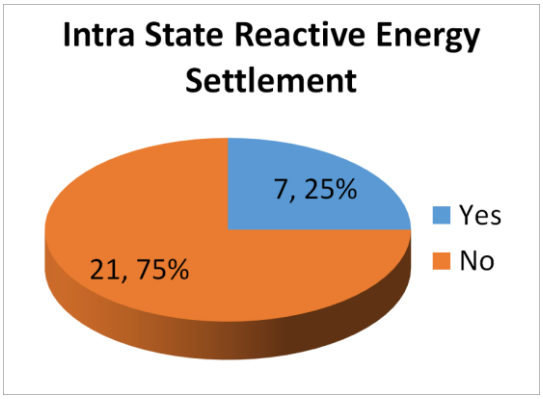

Figure 10: SLDCs administering Reactive Energy Settlement

Thus, the SLDCs could be placed in following one of the following four groups:

Group-A:

States where SLDCs having the first-hand experience of all the aspects of intra State accounting and settlement system – Delhi, Maharashtra, Gujarat, Madhya Pradesh, West Bengal and Chattisgarh.

Group-B

States where deviation settlement system has been introduced for a few intra-state entities or mock exercises have been undertaken by SLDC – Andhra Pradesh, Telangana, Karnataka, Kerala, Uttar Pradesh, Punjab, Rajasthan, Haryana, Uttarakhand, Odisha and Meghalaya. Bhakra Beas Management Board could also be placed in this group since it has also commenced deviation settlement w.e.f 01 June 2016.

Group-C:

States where draft regulations have been notified and preparatory exercises have commenced- Tamil Nadu

Group-D:

States/UT where deviation settlement is yet to commence. Damodar Valley Corporation would also fall under this group.

3.6 Intra State Deviation Account

At the interstate level the RLDCs have been designated to administer all the Regulatory Pool Accounts of Deviation, Reactive Energy, Congestion Charge and Ancillary Services. However at the intra State level only 14 SLDCs administer the Intra State Deviation Pool Account.

Table 7: Typical Deviation A/C for States/UT in Group-A

S No.	SLDC	Deviation Account for Week/Month	Over Generation + Under Drawal	Under Generation + Over Drawal	Payable by members to Deviation Pool A/C	Receivables by Members from Deviation Pool A/C	Revenue Realization in Pool A/C within the due date
			MU	MU	Rs. Lakh	Rs. Lakh	Rs. Lakh
1	Chattisgarh	02.05.2016 to 08.05.2016	4.15	1.35	12.29	0.53	12.29
2	Delhi	08.02.2016 to 14.02.2016	2.71	1.81	71.29	23.64	31.57
3	Gujarat	14.12.2015 to 20.12.2015	88.97	75.31	538.13	538.13	NA
4	Madhya Pradesh	February 2016	18.84	41.78	757.84	757.84	NA
5	Maharashtra	04.05.2015 to 10.05.2015	54.88	51.07	709.44	709.44	709.44
6	West Bengal	28.03.2016 to 03.04.2016	22.83	22.83	101.57	122.86	NA

Table 8: Typical Deviation Account in States/UT in Group B

S No.	SLDC	Deviation Account for Week/Month	Over Generation + Under Drawal	Under Generation + Over Drawal	Payable by members to Deviation Pool A/C	Receivables by Members from Deviation Pool A/C	Revenue Realization in Pool A/C within the due date
			MU	MU	Rs. Lakh	Rs. Lakh	Rs. Lakh
1	Andhra Pradesh	Dec-15	6.63	6.63	311	311	NA
2	Chandigarh	25.04.2016 to 05.05.2016	38.27	3.45	148	1.37	147.57
3	Haryana	21.03.2016 to 27.03.2016	0	0.17	-	344	344
4	Himachal Pradesh	Mar-16	18	26	560	542	560
5	Karnataka	Mar-16	297.80	297.80	113.34	113.34	NA
6	Meghalaya	Jan-16	0.15	0.74	9.70	9.70	NA
7	Punjab	Mar-16	10	8	157	131	105
8	Telangana	Nov-14	179.67	179.67	2863	2863	NA
9	Tamil Nadu	11.4.16 to 17.4.16	--	0.45	7.67	7.67	7.67

For instance in Madhya Pradesh, although the SLDC is collecting/processing the energy meter data and issuing the energy account statements, the Madhya Pradesh Power Management Cell is responsible for billing, settlement and clearing of pool accounts. In Chattisgarh and Haryana, CSPDCL and HVPNL are the Pool account administrators respectively.

The typical details of the intra State Deviation Account issued by the six (6) SLDCs (Group-A) where intra-state deviation mechanism is implemented for all intra State Entities is given in Table 7.

The typical details of the intra State Deviation Account issued by the other nine (9) SLDCs (Group-B) where intra-state deviation mechanism is implemented only for the interstate STOA customers or IPPs is given in Table 8.

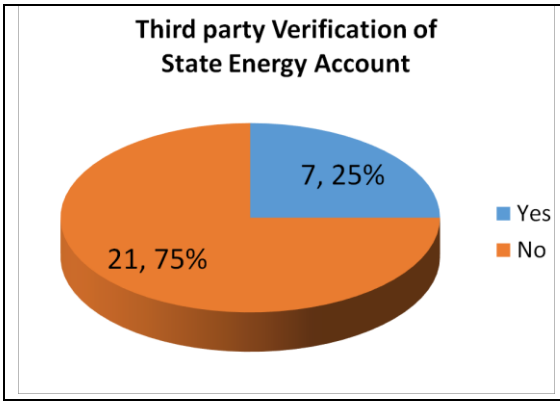

Figure 11: Practice of Third party verification of accounts

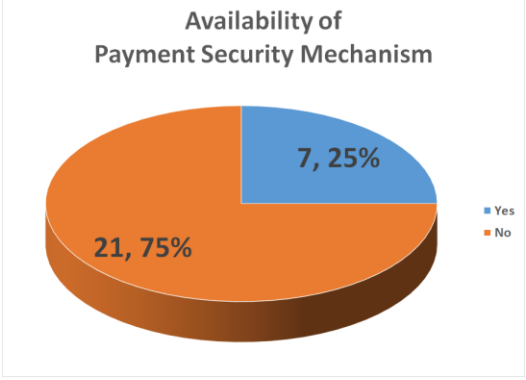

Figure 12: Availability of Payment Security Mechanism for Pool Credits

3.7 Archival and Utilization of Interface Energy Meter data

Energy Meter data is used for computing the active energy deviation from the schedule and the reactive energy charges. Besides the meter data contains a wealth of information regarding the characteristics of generation, load and behavior of utilities to the various market signals that is sought after by analysts and researchers. SLDCs are the de-facto-custodians of Energy Meter data. However, the required infrastructure and logistics for electronic archival, retrieval and analysis of energy meter data was found to be lacking in all the Load Despatch Centres. The prevailing status of archival and utilization of energy data at SLDCs is indicated in the Table-9.

It may be seen that electronic storage of energy meter data in a structured database is available only in five (5) States. Only (7) out of the 28 SLDCs surveyed use the energy meter data for forecasting.

Table 9: Archival and Utilization of Energy Data

S No.	SLDC	Electronic format in which energy meter data is archived	Number of years for which the energy meter data is available at SLDC	Utilization of Energy meter data for load forecasting	Availability of Energy Meter Data on SLDC website
1	**Andhra Pradesh**	Oracle	Above 5years	Yes	No
2	**Assam**	Text	>3 YRS	No	No
3	**BBMB**	NA	NA	No	No
4	**Bihar**	NA	NA	NA	NA
5	**Chandigarh**	Oracle	NA	Yes	No
6	**Chattisgarh**	MRD	1Yr, 7 Month	No	No
7	**DNH**	CSV	3 Yrs	Yes	No
8	**DVC**	NA	NA	NA	NA
9	**Delhi**	RM3 and Excel	5 year	No	No
10	**Goa**	NA	NA	NA	NA
11	**Gujarat**	Text	Since 05-April 2010	Yes	Yes
12	**Haryana**	Text	0	No	No
13	**Himachal Pradesh**	MS-Excel	2-Years	No	No
14	**Jharkhand**	NA	NA	NA	NA
15	**Jammu and Kashmir**	NA	NA	NA	NA
16	**Karnataka**	MS Excel	3 Yrs	No	No
17	**Kerala**				
18	**Madhya Pradesh**	XML	3 Yrs	No	Yes
19	**Maharashtra**	CSV	Aug-11 to Mar-16	No	Yes
20	**Meghalaya**	Text	>3 YRS	No	No
21	**Odisha**	Oracle	04 years	Yes	No
22	**Punjab**	No	No	No	No
23	**Rajasthan**	NA	NA	NA	NA
24	**Tamil Nadu**	NA	NA	NA	NA
25	**Telangana**	Oracle	Above 5years	Yes	No
26	**Uttarakhand**	NA	NA	NA	NA
27	**Uttar Pradesh**	Oracle	> 3Yrs	No	No
28	**West Bengal**	Oracle	08 years	Yes	Yes

4 Summary of Discussions with SLDCs, RLDCs and NLDC

4.1 Background

The sub-committee visited State Load Despatch Centres of Maharashtra, Tamil Nadu, Karnataka, Delhi, West Bengal and BBMB for detailed discussions. In view of the paucity of time, the sub-committee could not visit the other SLDCs. However it interacted with SLDCs of Gujarat, Madhya Pradesh, Telangana, Andhra Pradesh, West Bengal, Rajasthan, Meghalaya and Assam through Video Conference. RLDC/NLDC representatives also participated in the discussions. Thus one-to-one interactions were held with twelve (13) SLDCs. The discussion summary is attached as Appendix-3.

The objective of the exhaustive consultation was to

1. Compile the lessons learnt from the varied experiences of SLDCs who have had the first-hand experience of intra State Accounting, Metering and Settlement System
2. Study the existing set up for scheduling, dispatching, metering, energy accounting and settlement system of States
3. Assimilate best practices that could be benchmarked and replicated in other States/Region
4. Develop a model document containing general principles and guidelines for Energy Scheduling, Metering, Accounting and Settlement System.
5. Develop a consensus among SLDCs for harmonizing the electrical energy accounting and settlement system.

The ABT-UI/DSM is in operation at the interstate level for nearly 15 years. Therefore, the sub-committee had several rounds of interaction at different stages with the subject experts in the Regional and National Load Despatch Centre through Video conference and through electronic blog.

The sub-committee tried to gather feedback from a large cross-section of professionals and experts at the intrastate as well as the interstate level. The draft recommendations of the sub-committee on the intra state accounting and settlement system were also discussed in the meeting of the Forum of Load Despatchers held on 02-March 2016 and 26-June 2016.

4.2 Common Challenges

The common challenges being experienced by SLDCs are listed below:

a. Handling transition
b. Demarcation of boundary between transmission and distribution
c. Allocation of PPAs among discoms
d. Procurement and installation of adequate interface energy meters
e. Interface Energy Meters specification, procurement, testing, calibration, maintenance
f. Merit order dispatch with diverse allocations and technical constraints
g. Administration of deviation by entities that are exempted from deviation accountability
h. Monitoring and collection of data from large number of interface points
i. Maintenance of Old meters - Interoperability issues
j. Detection of bad meter data from 15-minute transmission loss OR when meter is at both end
k. Detection of time drift from frequency code of the block (since average frequency remains 50 Hz most of the time)
l. Recovery of DSM charges due to absence of Payment Security Mechanism
m. Closing the Energy Account due to revisions in regional energy accounts, changes in bifurcation of RE generators (de-pooling based on actual energy)
n. Availability and maintenance of telemetry particularly from RES
o. IT infrastructure- Hardware and software
p. Updation of software to align it with the new regulations and their amendments
q. Constraints in exploiting flexibility of conventional hydro Stations
r. Apportionment of super-pool liabilities among Sub-pool members
s. Harmonization of SERC and CERC regulations
t. Determination of System Marginal Price in real-time and post facto
u. Administration of losses
v. Reconciliation and its periodicity
w. Issues related to TDS, Payment defaults, Late payment Interest, Pool Account Interest
x. HR adequacy, Succession Planning, Mentoring, Capacity building
y. Handling of very large number of entities with small quantum

5 Energy Accounting and Settlement- Architectural Issues

5.1 Fundamental Issues in Accounting and Settlement

The following fundamental issues have a bearing on the energy accounting and settlement system:

1. Market Model: Single Seller-Single buyer vs Multi-Seller-Multi-Buyer
2. Generation Tariff: Single part vs Multi part tariff
3. Granularity of Control Area
    a. Pooling & De-pooling
    b. Transmission Voltage level – Distribution voltage level
    c. Criteria for Pool membership
4. Scheduling and Dispatch
    a. Centralized Vs Decentralized
    b. Simple Merit order or Security constrained merit order
    c. Granularity : 15 min vs 5 min
    d. Seam management during scheduling and curtailment
5. Settlement System
    a. Deviation Accountability of pool entities: Universal or Selective
    b. Physical settlement Vs financial settlement
    c. Single layer vs Multi layer
    d. Net settlement vs Gross settlement
    e. Scalability and flexibility
    f. Granularity– 15 min vs 5 min.
6. Measurement system
    a. Uniformity of Specifications
    b. Reliability, Integrity, Credibility
7. Energy Accounting
    a. Single entry vs Double entry
    b. Uniformity of Statements
8. Truing up Interval: Short vs Large
9. Transmission Charges: Simple vs Elaborate
10. Applicable Rates and Charges: Ex ante vs Post facto
    a. Operating Charges, Transmission Charges, Congestion Charges
    b. Losses
11. Loss administration : Estimated or Actual
12. Nature of Pool
    a. Zero sum Pool or Non-Zero Pool
    b. Pool to Pool Interface: Interlinked or De-linked

13. Pool settlement and administration
    a. Handling reserves, interest, Cash flow
    b. Payment Security Mechanism
14. Decision tools and Regulatory handle for Operators for
    a. Controlling deviation/ACE control in real-time
    b. Optimization in real-time
15. Governance
    a. Roles and responsibilities
    b. Maker-Checker, Self-check, Prudence Check
    c. Integrity and Probity of Accounts
    d. Timeliness
    e. Opportunity for Reconciliation
16. IT tools – Scalability, Procurement, Upkeep
17. Human Resources and Financial Resources

The above issues were deliberated in the Technical Committee of the FOR and in the 16th meeting of the FOLD. Expert Audit Groups of Metering and Settlement in POSOCO were meeting. Available literature was also referred and deliberations were held with domain experts. A web group for online discussions was also created by the name of energy-Metering Accounting and Settlement System (e-MASS) of India that stands for Energy metering, accounting and settlement system. Derived learning from the above initiatives are as below:

5.2 Demarcation of Interface Boundary

The Indian Electricity Grid Code defines 'control area' as an electrical system bounded by interconnections (tie lines), metering and telemetry which controls its generation and/or load to maintain its interchange schedule with other control areas whenever required to do so and contributes to frequency regulation of the synchronously operating system. Regulation 6.4 of the IEGC lays down the criteria to be adopted for demarcation of control area jurisdiction between the RLDCs and SLDCs. Accordingly the Indian electricity grid is demarcated into several Control Areas at the interstate level. For the purpose of energy accounting and deviation settlement five regional pools have been created. All the Regional Entity States/UTs, Regional Entity Generating Stations, HVDC terminal stations and those SEZ who have been granted connectivity from CTU are a member of the Regional Pool. Their exchanges with the grid are metered and deviations are computed.

Similarly at the intrastate level, the typical State pool would comprise of intra State Generators, IPPs, RES, Distribution Licensees and STOA entities connected at transmission level. In view of the envisaged large penetration of small RES generating stations, CERC has recommended that a Qualified Coordinating Agencies (QCA) may be designated to coordinate with SLDC on behalf of the RES developers.

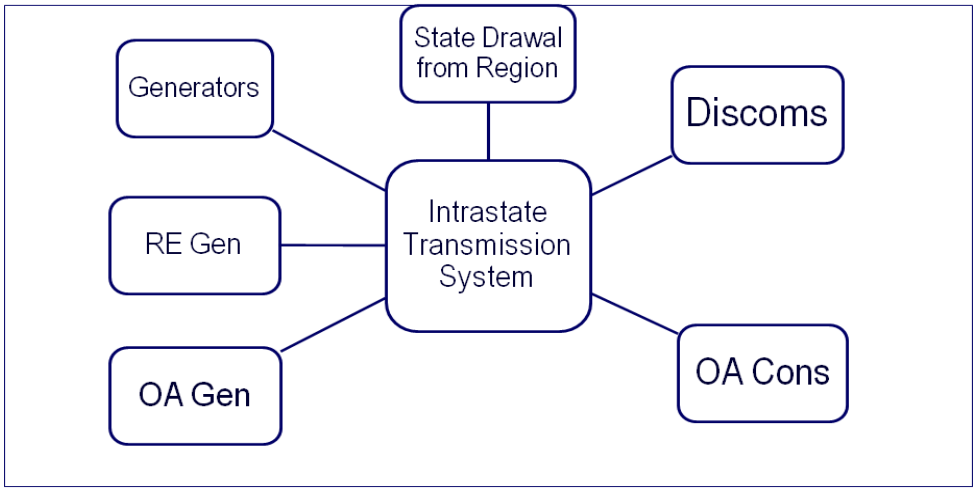

Figure 13: Typical Intra State Pool

The QCA would be responsible for pooling of schedules and deviations at the interface point and de-pooling at the respective boundaries of individual RES developers in that area. Several SLDCs have suggested the need for regulation of the activities of the designated QCAs and further clarification of the functions and responsibilities of the QCA.

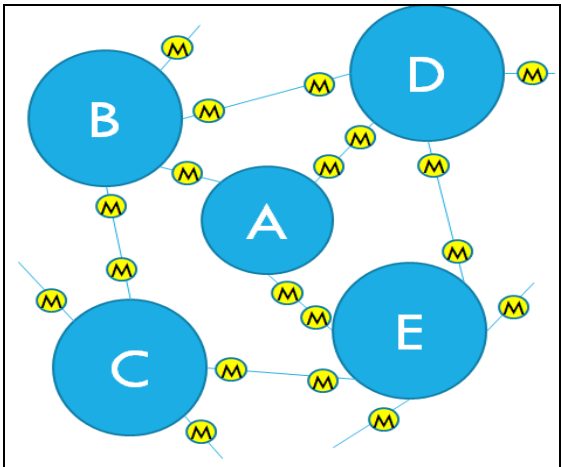

Figure 14: Control Areas bounded by Interface Meters (Source Larry Day)

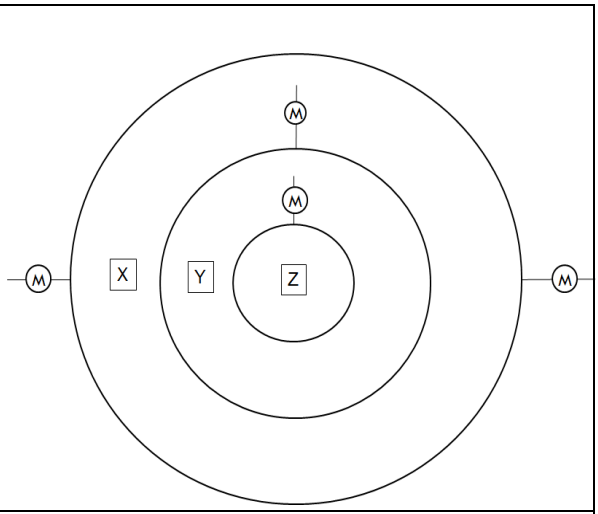

Figure 15: Nested Control Area (Source: Larry Day)

5.3 Distribution System Operators

The State Load Despatch Centre would be responsible for coordinating the scheduling of a intra state generating stations; real-time monitoring of the station's operation; verification of declared station availability and injection schedule; switching instructions; meter data processing; collections/disbursement of deviation charge payments; outage planning etc. within its control area. The growing number of STOA customers, 'Prosumers', Distributed Energy Resources (Roof-top solar) and other market players within the distribution control area would pose a serious challenge during operation and commercial settlement by the SLDCs/RLDCs/NLDC. Internationally the concept of Distribution System Operators (DSO) is being contemplated to handle the network reliability issues with high penetration of Distributed Energy Resources. In India, there are discussions regarding separation of carriage and content at the distribution level. Thus there is a need to constitute DSOs in the Indian system. Few of the large States such Uttar Pradesh and Maharashtra have already created Area Load Despatch Centres or Sub-Load Despatch Centres to take care of the administrative and technical issues within the demarcated areas for jurisdiction.

5.4 Adequacy of Interface Energy Meters

The Interface Energy Meter records are used for energy accounting and settlement of bills. Therefore, it is important that adequate and appropriate class of Meters are placed at all the identified Interface points between Generator & STU system (G-T & RES-T); Distribution Licensee and STU system (D-T); HT consumer & STU system (HT-T); OA & STU system (OA-T); and CTU system & STU system (ISTS-IntraSTS). The Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 mandates installation of interface energy meters as per the philosophy laid down in **Table-10.** These Regulations indicate mandatory requirement to meet compliance. However, for reliability of the energy accounting system it is desirable to have redundant Interface Energy Meters in the system with adequate spares to take care of routine failures and future requirements.

Some of the international best practices in Metering and Accounting are enclosed as Appendix-4. It is recommended that all future procurement of meters shall be conform to the CEA document on "Functional Requirement of Advanced Metering Infrastructure". General Guidelines on the technical specifications is enclosed as Appendix-6.

Table 10: Metering Philosophy as per CEA Regulations

Sl. No.	Stages	Position of Main Meter	Position of Check Meter	Position of Standby Meter
1	Generating Station	On all outgoing feeders	On all outgoing feeders	High voltage (HV) side of Generator Transformers High voltage side of all station Auxiliary Transformers
2	Transmission and Distribution system	At one end of the line between the substations of the same licensee, and at both ends of the line between substations of two different licensees, Meters at both ends shall be considered as main meters for respective licensees.	-	There shall be no separate standby meter. Meter installed at other end of the line in case of two different licensees shall work as standby meter.
3	Inter-connecting Transformer	High voltage side of inter-connecting Transformer	-	Low voltage side of Inter-connecting Transformer
The placement of the Main, Check and Standby Meter for the following case shall be as decided by the Appropriate Commission				
4.	Consumer directly connected to the Inter State or Intra State Transmission System who have to be covered under Availability Based Tariff and have been permitted open access by the Appropriate Commission Or For consumers connected to distribution system and permitted open access by the Appropriate Commission Or Any other system not covered above			

Placement of meters as per CEA Standards ensures that the metering system is N-1 secure. However, in case any meter on an inter-utility feeder were to go out, then the metering system is N-1 insecure till this faulty meter is replaced. For the duration that we have one defective meter, we can use the other end meter for energy accounting. However if this other end meter also becomes defective, then the energy accounting system gets upset. So we must have some norms for replacement of any defective meter; say no more than 3 days to ensure N-1 security of the metering system. Faster detection of meter failure is also desirable as the present one week for meter data collection could become a constraint. Alternatively, more meters could be installed to ensure N-2 or N-1-1 security of the metering system.

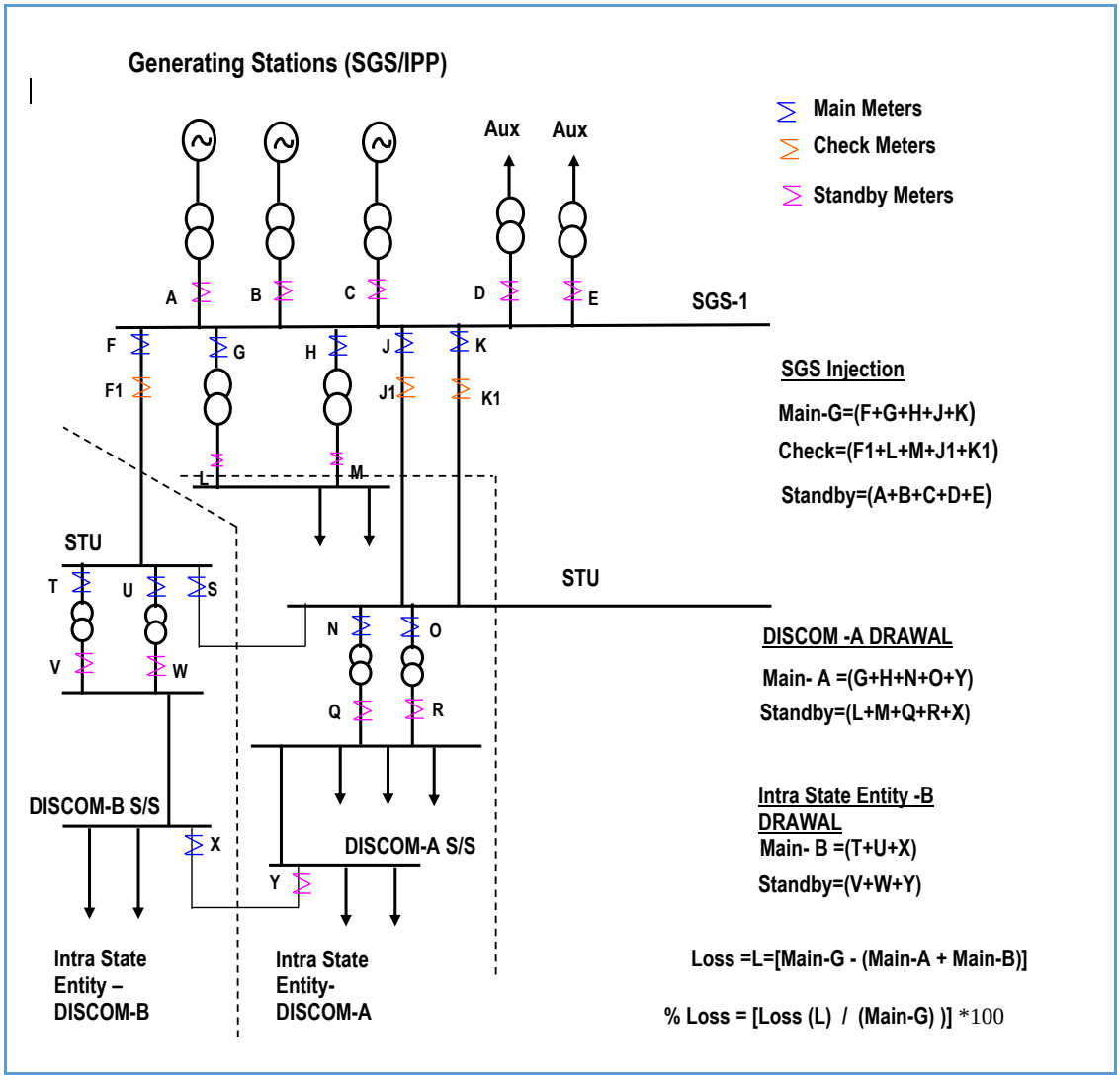

Figure 16: Recommended position of Energy Meters

5.5 Multi-part Generation Tariff

Section 32 of the Electricity Act mandates the State Load Despatch Centres in the State to give directions and exercise such supervision and control as may be required for ensuring the integrated grid operations and for achieving the maximum economy and efficiency in the power system in that State. This calls for valuation of water discharge in multi-purpose hydro resources and merit order operation of the conventional thermal power stations. The above aspects assume significance with availability of surplus generation in the grid particularly when demand in the grid is low and the injection from RES is high. The observations of the K.P. Rao Committee set up by Government of India in 1990 to give its recommendations on the fixation of generation tariff. Relevant extracts from the report are quoted below:

"*A very important aspect is that the system of single-part tariff now in vogue for pricing thermal power and fixed tariff for hydro power have not been conducive to motivate and encourage economic generation of power and its absorption by the Boards, as also in ensuring optimization of integrated operations the grid system. On the thermal side, there are interminable disputes as to who should back down in the event of the Boards having adequate capacity to meet their requirement of power, particularly during off-peak time…*"

"*At the outset, the Committee unanimously agreed that, in overall national interests, economic generation of power should be encouraged. This would imply maximization of generation of power on a least-cost basis to the system, consistent with the objective of meeting the system demand in the best possible manner. It was also argued that the tariff should be able to generate such signals as would encourage and motivate maximization of economic generation of power and optimization of grid operations and that any conflicts of commercial interests between the various organizations on the matter of maximization of economic generation of power and its absorption by the constituent Boards should be eliminated, irrespective of whether such generation takes place in the central generating stations or stations of a Board. It was noted that towards this end, it is necessary to implement merit order operation in a strict and effective manner.*"

"*Hydro resources have thus the capability of providing valuable peaking support. Again, while the financial cost of generation of hydropower is the same whether the power is generated from surplus/spilling waters or from waters stored in the reservoir, its usefulness to the system varies very widely depending upon whether it is able to provide peaking support or whether it is surplus (zero-cost) non-storable energy in a surplus situation and needs to be absorbed as a first charge against the available demand. On the other hand, power from thermal stations involves invariably fuel consumption, which can be saved if other cheaper sources of energy are available…*"

"*The Committee also agreed that the concept of two-part tariff should be as outlined below:*

i)The tariff would consist of :

a. *A fixed charges; and*
b. *A variable charge.*

…"

"*The idea is that the fixed charges, by and large cover sunken costs and do not vary with the levels of generation at the station, whereas the variable charges represent additional costs related to actual generation and vary directly with the levels of generation achieved.*"

"*The existing practice of granting incentive awards based on PLF is another factor which to large extent, militates against backing down thermal stations when they should, in fact by*

doing so on purely economic or commercial considerations. It is necessary to modify the existing incentive schemes to eliminate the undue emphasis on the improvement PLF factor, vitiating economic generation of power….There is already considerable public impression that the Plant Load Factor is an indicator of efficiency. Some publicity to dispel the misconceptions in this respect is called for."

"*Where water can be stored and power generation can be regulated to meet the future demand of the system as an when necessary, the generation may conform to the requirements of the system, peaking or otherwise.*"

Implementation of two-part tariff for intrastate hydro and thermal stations would facilitate implementation of merit order dispatch and optimization of hydro resources. Two-part tariff would also help in implementing net settlement system wherein the capacity and energy charges could be mutually settled between the sellers and buyers while the deviations from schedule would be settled with the pool.

5.6 Faster Scheduling and Settlement

Presently the scheduling and settlement period at the interstate level is 15-min. A number of States have adopted the same. However with the envisaged high penetration of renewable energy in the grid, there would be a need for higher granularity in scheduling and settlement to handle the challenges of high ramp rate and net load following. Relevant extracts from the "Report on India's Renewable Electricity Roadmap of 2030" by Niti Ayog is quoted below:

"*Scheduling and Dispatch: Through both practice and theory, it has become evident that grids that are operated in a manner where scheduling and dispatch are implemented over short time durations (e.g., as low as five minutes) have significantly lower overall costs to consumers as the need for ancillary resources decreases. Currently, in India, scheduling occurs on a day-ahead basis while dispatch occurs on a 15-minute basis. System operations technologies and protocols need to be updated to enable five-minute scheduling and dispatch of all resources connected to the grid and automated incorporation of RE forecasts. It should be noted that accuracy of RE forecasts is significantly higher the closer they get to dispatch. Consequently, the ancillary service requirements will also be lower*"

The States who are about to implement the intrastate accounting and settlement system could leapfrog and go for scheduling and settlement at 5-

min interval. The scheduling software and the energy meters specifications could in line with the above. All the other States and the Regional Pools shall also endeavor to have systems and logistics for 5-min scheduling and settlement system in the next five years.

5.7 Multi-Settlement System

Settlement Systems are the rules concerning the price (s) that will be paid to suppliers or paid by buyers. In a single settlement system, the day-ahead bids are used for scheduling but prices are determined ex post based on real-time dispatch. In a multi-settlement system, the day-ahead bids are used for both scheduling and settling day-ahead transactions. Only deviations are priced ex-post. The multi-settlement system is considered to have merit over single-settlement system. The relevant extracts from the book "Power Market Auction Design" is quoted below:

"*The single-settlement system may appear simpler than a multi-settlement system because it involves a single set of hourly prices and is closer to the way tight power pools operated before wholesale restructuring. However, this simplicity is deceptive. The difficulty with the single ex post settlement is that much is riding on the ex post prices, since all earlier commitments and transactions are settled at the prices established in real time. After the day-ahead schedule is formed, bidders have an incentive to make adjustments to influence the real-time price in a favorable direction. Since the real-time priceis used for all trades, the incentive for manipulation may be large.6 For instance, day-ahead transactions, including bilateral transactions, may account for 95 percent of trades, but these are settled at prices that reflect heavily the 5 percent traded in the real-time market. Bidders can take advantage of short-term in-elasticity in the supply and demand schedules to reap greater profits. Knowing how to do this is complex, and can be exploited best by large bidders with sufficient scale (i.e., larger, more diverse generator portfolios) to make the efforts worthwhile. The added complexity and risk tends to discourage entry and participation by small bidders whose net revenue might be whipsawed by price volatility in the real-time market. This gaming can be mitigated by financial penalties for failures to perform as scheduled, but this raises the question: what are the appropriate penalty values?*"

"*A multi-settlement system mitigates gaming on two fronts. First, the day-ahead bids are binding financial commitments. The bids and resulting schedules are credible precisely because they are financially binding. Second, bidders are unable to alter the day-ahead prices. Day-ahead prices remain fixed for all transactions scheduled in the day-ahead market. Deviations from the day-ahead schedule affect the real-time price, but the real-time*

price issued only to price these deviations. Hence, in a multi-settlement system, the incentive to manipulate the real-time price is not magnified as it is in a single-settlement system. Penalties for non-performance are not needed in a multi-settlement system, since deviations from the schedule are priced correctly. If a generator fails to deliver as scheduled, it is liable for the quantity it was supposed to deliver priced at the real-time price."

"*The multi-settlement system reduces risk for the bidders, since the bidders can lock in day-ahead prices. For the system operator, the multi-settlement system reduces scheduling uncertainty because it discourages schedule changes, and it automatically sets the right penalties for non-performance. The system maintains the flexibility required to respond efficiently to fluctuations in demand and supply.*"

5.8 Buffer between State Pool and Regional Pool

Every change or amendment in accounts or settlement at different layer should avoid sending ripple effect across all the seams thus making it an endless turbulence and never-ending accounting puzzle for all the entities. It is also caused by fundamental flaw of frequent truing up exercise to make the account exact and perfect. For instance few States have a practice of post facto apportionment of metered losses. This make the exercise of energy accounting iterative/recursive and too clumsy to be executed. Seams management is to be appreciated. We need to borrow how financial world handles it. Say for example a change in one wrong entry detected in one vertical of any large group of companies does not demand a change in balance sheet of each of the sub division and the consolidated balance sheet. Similarly, the revision of regional Deviation Energy Account in the super pool should not cause cascading revisions of the Energy Accounts of the States. This should be equally relevant for the National Pool Account or the SAARC Pool Account whenever they are prepared. Adequate buffer/reserves should be maintained in a pool to absorb the ripples in the form of revisions in the super pool. Adequate Payment Security Mechanism should be in place for pool credits. Stringent regulatory / legal provisions for entities defaulting in pool payments are required for ensuring adequate deterrence for defaulters.

5.9 STOA Registry, Clearing & Settlement Agency

Several regulatory pool accounts have been created at the RLDCs to facilitate power market transactions and commercial settlement at the interstate level. Amounts from various obligated entities are billed, collected and disbursed. These include Deviation Pool A/C, Reactive Energy A/C and Congestion

Charge A/C. The Load Despatch Centres are also the designated agencies for facilitating Short term Open Access transactions and also for settlement, billing, collecting and disbursement of STOA charges. Similar functions are to be discharged at the SLDC levels albeit at a larger scale. The energy transactions are scheduled on credit (though after reliability checks) and settled through the respective Load Despatch Centre who perform the role of pseudo Clearing Agency for the bilateral energy contracts.

Post commencement of STOA, several Energy Service Companies (ESCOs) have mushroomed in the Indian electricity market and they are providing an unregulated service of 'organizing/ match making to arrange power at a common delivery point through STOA-Bilateral at an attractive rate. The business of aggregation in Bilateral Open Access is presently unregulated and does not require a license unlike trading. CERC has envisaged the role of Qualified Coordinating Agency (QCA) which would act as aggregator for RES developers. The number of consumers inclined to accept the re-packaged energy product offered by ESCOs has increased manifold and would increase further. In fact there is a renewed thrust at the policy level towards innovations in electricity market such as scheduling of URS through Ancillary Services and Sale of URS by Generating Companies through STOA. The Load Despatch Centres would have to facilitate such transactions. It is expected that with large scale integration of RES in the grid and further evolution of electricity market in India there would be an exponential growth in the number of markets players and energy transactions.

The Deviation Pool Accounts administered by the SLDCs would provide multilateral netting of deviation charges at the State level. The Deviation Pool Account acts as the central counterpart to both the counter parties (Sellers and Buyers) in a trade. The Deviation pool account would be interposed as a Seller to every 'Buyer' and a buyer to every 'Seller' in respect of the trades it receives for deviation settlement. Deviation charges would be deposited by the Entities liable to pay while the Deviation Charges would be disbursed to the Entities that are 'receivable' from the pool. Since the disbursements to the pool members would be made only from the funds available in the pool, it would be imperative to establish a robust Payment Security Mechanism in place.

In the financial market the Clearing Agency provides the guarantee of settlement of trades to all the members maintaining adequate margins. In order to mitigate the counter party risk of the Clearing Agency all the pool members have to maintain adequate margins. The security shortage resulting from default by any member is met from the Settlement Gaurantee Fund and / or the Security Line Of Credit Account (SLOC) by the clearing agency. In case of such default the clearing agency withholds any security payout to the defaulting member & the member is liable to pay default charges. The non-defaulting member is compensated on default day through either cash compensation or some other security. The clearing Agency might reject the trades reported by the members in case the aggregate value of the trades done by the members has exceeded his risk exposure or one party to the trade has been suspended/rendered ineligible by the clearing agency. Similar mechanisms to mitigate the systemic risk and credit risk need to be in place for all Regulatory Pool Accounts administered by the SLDCs.

Thus robust infrastructure and mechanisms for mitigating the systemic and credit risk need to be in place at the Load Despatch Centre. Though the CERC order now allows rejection of an STOA trade for persistent payment default, however there is a growing need for a Centralized Registry / Clearing Agency for interstate STOA bilateral transactions. STOA applicants could be mandated to maintain margin money to schedule STOA transactions on credit. Exposure limits for each market player could be derived from the past record of credit worthiness. These credit ratings could be made available to SLDCs (similar mechanism in place for Bank Loans, Bank Credit Card). The exposure limit (in Rs,) for individual transactions along with the ATC (in MW) could be used as a reference beyond which the STOA approval / scheduling could be disallowed.

Alternately a Clearing & Settlement Organization or Service provider may be set up which can be consulted or engaged by all Load Despatch Centres. Such an institution would serve as a catalyst for intra-state power market development. Such institutional capacity will also be required when introducing Ancillary Service Contracts and for development of a SAARC Power Market in future. Working Group on Power for 12th Plan has also recognized enormity of Challenge in Management of Funds and Pool Accounts and mentioned the need of creating a separate entity.

5.10 Learning from Basic principles of Financial Accounting

Financial accounting system and energy accounting system have several commonalities. Derived learning from the basic principles of financial accounting may be applied to energy accounting system.

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
1	Accrual principle	Accounting transactions should be recorded in the accounting periods when they actually occur, rather than in the periods when there are cash flows associated with them.	Scheduled and Actual Drawal shall be time stamped and computation of deviation shall be done by using the concurrent / contemporary quantities. Time synchronization of Interface Energy Meters is vital. Time drift to be corrected promptly
2	Economic Entity principle	Transactions of a business should be kept separate from those of its owners and other businesses. This prevents intermingling of assets and liabilities among multiple entities, which can cause considerable difficulties when the financial statements of a fledgling business are first audited	Jurisdiction of each entity to be recognized and respected. Interface boundary / Seams between entities should be clearly demarcated by placement of Interface Meters. Scheduling and Settlement of transactions by every entity with the grid is to be accounted distinctly. Own generation to be accounted separately from interchange with the grid. Transactions within a portfolio to be appropriately accounted and settled Super pool and sub-pool to be delinked to avoid iterative / recursive solutions and frequent revisions
3	Conservatism principle	Expenses and liabilities shall be recorded as soon as possible, but to record revenues and assets only when you are sure that they will occur.	Payment to pool account shall be made timely notwithstanding the likelihood of receivables from pool in the future settlement cycle. Deviation and Transmission Losses should be computed and monitored for every time block. Cycle for accounting and settlement of deviation from schedule shall be short (preferably weekly) to facilitate corrective actions by the respective Entities

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
4	Consistency / Comparability principle	Financial statements of one entity must be consistent with other entities within the same line of business. This should aid users in analyzing the performance and position of one company relative to the industry standards. It is therefore necessary for entities to adopt accounting policies that best reflect the existing industry practice.	System for Energy Accounting and Settlement should be harmonized across all States and Regions and consistently applied on all transactions of same category for a meaningful analysis of performance. It is desirable that all States and regions to adopt accounting policies that best reflect the existing industry practice. Deviation of all entities in the pool to be appropriately accounted and settled
5	Completeness principle	Information must be complete in all material respects. Incomplete information reduces not only the relevance of the financial statements, it also decreases its reliability since users will be basing their decisions on information which only presents a partial view of the affairs of the entity.	Reliability of information contained in the Energy Account statement is achieved only if complete information is provided relevant to the transaction and financial decision making needs of the users. Data of all transactions and all meters shall be made available for energy account preparation. Any assumptions shall be avoided as far as possible.
6	Cost principle	Business should only record its assets, liabilities, and equity investments at their original purchase costs	Capacity and Energy Charges should be settled at the mutually agreed rates as per their PPA rather than real-time rate. Multi-settlement is preferable to single settlement
7	Faithful representation principle	Financial information contained in the financial statements should represent the business essence of transactions and events not merely their legal aspects in order to present a true and fair view.	Transactions shall be scheduled and settled as per contract within the appropriate Regulations. All before the fact revisions submitted by the entities within the stipulated time to be incorporated in the interchange schedule. However, post-facto changes in schedule to be discourage and avoided. Interface Energy Meter used for recording actual energy interchange shall be of appropriate accuracy class for faithful measurement

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
8	Full disclosure principle	You should include in or alongside the financial statements of a business all of the information that may impact a reader's understanding of those financial statements. The accounting standards have greatly amplified upon this concept in specifying an enormous number of informational disclosures	Methodology for energy accounting; energy meters and formulae used for computation of interchange with grid; applied transmission losses, rates used for calculating deviation charges, scheduling charges, transmission charges etc. should be disclosed on the website. All such information should be easily accessible to the registered users to enable them to independently compute their liabilities. The Interface energy meter placement, CT/PT ratios and other details should disclosed and submitted before the appropriate commission at period intervals.
9	Matching principle Duality principle Double Entry Principle	When you record revenue, you should record all related expenses at the same time. Thus, you charge inventory to the cost of goods sold at the same time that you record revenue from the sale of those inventory items.	Every Injection schedule (Credit to pool) should have a matching Withdrawal schedule (Debit to pool) corrected to the estimated losses. Total actual injection into the pool equals Total actual withdrawal from pool plus transmission losses plus metering errors.
10	Materiality principle	You should record a transaction in the accounting records if not doing so might have altered the decision making process of someone reading the company's financial statements	All scheduled transactions to be recorded in the energy accounts
11	Monetary unit principle	A business should only record transactions that can be stated in terms of a unit of currency	All the scheduling and actual exchange transactions for each time block shall be recorded that can only be stated in terms of a unit of Power/energy

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
12	Going concern principle	A company or other entity will be able to continue operating for a period of time that is sufficient to carry out its commitments, obligations, objectives, and so on.	There is no absolute need for truing up every 15-minute time block. Business will continue time block after time block, week after week and year after year'. So plenty of opportunities for adjustment and truing up. Similarly post facto administration of transmission losses to be avoided. There could be periodic reconciliation with all stakeholders Due diligence to be applied before extending pool membership to a new entity. Payment Security Mechanism to be in place to ensure stakeholder confidence in pool account settlement. All statutory and regulatory compliances by an entity should be ensured before scheduling its transactions. Dummy readings from Interface Energy Meters should be verified before commencement of scheduling. Institutional arrangement for STOA Registry as well as for a Settlement and Clearing Agency need to be in place for liquidity and efficiency of market operation as well as for long-term sustainability of the sector. Institutional arrangement for market monitoring and compliance monitoring should be strengthened
13	Neutrality principle	Information contained in the financial statements must be free from bias. It should reflect a balanced view of the affairs of the company without attempting to present them in a favored light. Information may be deliberately biased or systematically biased.	Information contained in the energy account statements must be free from bias. It should reflect a balanced view of the affairs of the pool entity without attempting to present them in a favored light.

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
14	Prudence principle	Preparation of financial statements requires the use of professional judgment in the adoption of accountancy policies and estimates. Prudence requires that accountants should exercise a degree of caution in the adoption of policies and significant estimates such that the assets and income of the entity are not overstated whereas liability and expenses are not under stated.	Preparation of energy account statements requires the use of professional judgment in the adoption of regulatory provisions There should be one pair of eyes for making the accounts and another pair of eyes for checking. Post facto administration of transmission losses to be avoided
15	Relevance principle	Information should be relevant to the decision making needs of the user. Information is relevant if it helps users of the financial statements in predicting future trends of the business (Predictive Value) or confirming or correcting any past predictions they have made (Confirmatory Value). Same piece of information which assists users in confirming their past predictions may also be helpful in forming future forecasts.	Information should be relevant to the decision making needs of the user. Information is relevant if it helps users of the energy statements in predicting future trends of the entity (Predictive Value) or confirming or correcting any past predictions they have made (Confirmatory Value). Same piece of information which assists users in confirming their past predictions may also be helpful in forming future forecasts.
16	Reliability principle	Information is reliable if a user can depend upon it to be materially accurate and if it faithfully represents the information that it purports to present. Significant misstatements or omissions in financial statements reduce the reliability of information contained in them.	The implemented schedule and the energy meter reading used for energy accounting shall be validated and reconciled before it is used in energy accounting. Common metering errors to be avoided. Plausibility checks should be carried out to detect bad data. Adequate meters should be in place to take care of bad data. Periodic process audit must be conducted.
17	Revenue recognition principle	Under this principle, revenue is recognized by the seller when it is earned irrespective of whether cash from the transaction has been received or not.	Scheduled Energy to be considered as deemed delivered in a physical energy market.

S No.	Principle	Interpretation for Financial Accounting	Derived learning for Energy Accounting
18	Time period principle	A business should report the results of its operations over a standard period of time. This may qualify as the most glaringly obvious of all accounting principles, but is intended to create a standard set of comparable periods, which is useful for trend analysis.	All energy energy accounts should be prepared and uploaded on respective websites over a standard period of time. The settlement cycle shall be harmonized so that energy accounts of different States are comparable. Timeliness of account preparation and timeliness of payments should be important
19	Understandability principle	Transactions and events must be accounted for and presented in the financial statements in a manner that is easily understandable by a user who possesses a reasonable level of knowledge of the business, economic activities and accounting in general	The energy account statement must be presented in a user friendly and comprehensible format.

5.11 Governance Structure - Roles and Responsibilities

Under the prevailing structure of Electricity Supply Industry in India, the Ministry of Power/Energy of the respective State/Central Government is responsible formulating policy guidelines in accordance with the legislation passed by the Parliament. The Central Electricity Authority is the technical advisor to the Central Electricity Regulatory Commission. As per the Electricity Act 2003 it is responsible for notifying the metering standards. The appropriate Electricity Regulatory Commission regulates the electricity market. The Grid Code and other regulations outline principles and rules for the functioning of the electricity market. The ERCs therefore are responsible for overseeing compliance to the standards and regulations. The recommended governance structure specifying the roles and responsibilities of various entities with respect to the energy accounting and settlement system is elaborated below. :

1. **National Load Despatch Centre**
   a. Updating and issuing the general guidelines on Technical Specification of Interface Energy Meters to be procured by CTU / STU
   b. Notifying the convention to be adopted for Meter serial number on Regional / State basis to ensure uniqueness of Interface Energy Meters across the nation.

2. **Central /State Transmission Utility**
   a. Installing Interface Energy Meters in compliance with appropriate standards and submission of Meter installation report (containing point of installation, date and time of installation, initial meter reading, CTR, PTR etc) to the appropriate Load Despatch Centre
   b. Providing necessary hardware and software at substation level for Automatic Meter Reading
   c. Coordinating with Site Owner to facilitate reliable transmission of meter data to the concerned LDC. Provide reliable communication link from substation to the concerned LDC
   d. Maintaining all Interface Energy Meters along with its accessories such as DCD etc. to ensure their healthiness and performance. Maintenance activities would include but not limited to Meter calibration, time synchronization, meter replacement etc. within reasonable time
   e. Maintaining adequate spare Interface Energy Meters and ensuring healthiness of Meters (keeping them charged to avoid drainage of internal battery)
   f. Maintaining CT/PT inputs, AMR cabling
   g. Providing feedback on metering deficiencies to appropriate LDC
   h. Coordinating onsite testing of Interface Energy Meters at stipulated periods and submit the test certificate to the appropriate Load Despatch Centre
   i. Installing and maintaining of the infrastructure for Automatic Meter Reading
   j. Assessing of future requirement of Interface Energy Meters and its procurement
   k. Liaising with Meter manufactures/vendors – if any problems are encountered in data format, abnormal time drift, hanging when time correction is done, or battery backup button is not working etc.
   l. Maintaining of time drift with respect to GPS time and reporting to LDC
   m. Claiming reimbursement through tariff for all metering activities like procurement, installation, maintenance the SEMs & accessories, DCDs, software, AMR etc.

3. **Site Owner**
   a. Coordinating and cooperating with authorized representatives from CTU/STU for installation and maintenance of Metering System

b. Ensuring safety and security of the Interface Energy Meter installed within its premises
c. Providing redundant communication link from meter location (substation) to the nearest STU/CTU station for transmission of meter data to the concerned LDC
d. Submitting dummy reading to the appropriate Load Despatch Centre before energization of the Interface tie lines
e. Collecting and transferring recorded data of all the Interface Energy Meter from the Interface point to the concerned Load Despatch Centre
f. Maintaining CT/PT inputs, accessories, software associated with the Metering System

4. Regional /State Load Despatch Centre

a. Preparing and advising all concerned on the Metering Scheme for New Entity connected with the grid
b. Reviewing the metering scheme and issuing revision in case of change in network configuration
c. Maintaining record of Healthiness/Test Certificate of Interface Energy Meters
d. Compiling the IEM data received from field
e. Processing the raw data that includes but not limited to checking format correctness, pair checking, voltage input, time correction checks etc.
f. Forwarding the processed and validated data to the Agency responsible for preparing the Energy Account
g. Providing feedback to the CTU / STU on the metering related deficiency
h. Maintaining database of IEM, CT/PT ratios.
i. Uploading the IEM details including the formula being used for computation of interchange. Submission of the complete Metering scheme used for computation of interchange and transmission losses to the respective Electricity Regulatory Commission
j. IEM Data Management and information dissemination to the stakeholders
k. Coordinating Process Audit of the Metering System
l. Reviewing Meter specifications and providing feedback to STU/CTU

5. **Regional Power Committee / State Power Committee**
   a. Reviewing the adopted metering scheme in the Region/State at periodic interval
   b. Preparing Regional / State Energy Account in line with the regulations and uploading it on its website in a convenient format

5.12 Other recommended best practices

a. Uniformity of Meter Technical Specifications
b. Adoption of new technologies-AMR and AMI
c. Adoption of Common Information Model and Uniform file naming convention
d. Adoption of common protocol- DLMS/COSEM/IEC-62053 etc.
e. Compulsory Energy Audit and penal provisions for non-compliance
f. Mock exercises for acclimatizing the stakeholders on the EMASS
g. Workshops for Capacity building

6 Recommendations - Information Technology Logistics

6.1 Background

System Operation and Market Operation are the core functions of the Load Despatch Centres. SCADA/EMS has been the key IT enabler for System Operation function. However, a comprehensive IT enabler for Market Operation function is lacking. The scale of operations, market volume and financial value of transactions demand a comprehensive Market Management System that is robust, reliable, scalable, flexible and efficient.

The role of Load Despatch Centres in Market Operations as enumerated in the Pradhan committee report is quoted below:

"2.3.2 Load Despatch Centres as Market Operators: Market Operation involves generation resource scheduling, managing renewable energy sources, providing common and equal information access to all market players, facilitating open access, seams management, metering system design, meter data collection, validation and processing, energy accounting and settlement, calculation of losses, pool account administration, market surveillance, analysis and other related activities. These functions gained prominence subsequent to the structural changes in sector and introduction of new market mechanisms such as the Availability Based Tariff (ABT), Open Access and Power trading. The LDCs of tomorrow would need to implement new market mechanisms that complement reliability. The complexity in market operation is already increasing due to an increase in the number of market players, evolving market mechanism and increased sophistication in market design. With growing commercial consciousness among the market players, market related activities and tasks, which were formerly done in an off-line mode, have now become a time-constrained activity and moved into the online operation control centre. Moreover, as a "Market Operator", the LDCs have to discharge their duties in a nondiscriminatory and transparent manner."

The Pradhan committee also recognized the role of LDCs as interface between various entities in the Electric Supply Industry. They act as service providers and information aggregators for smooth operation of the market. They collect information from various sources, extract value and disseminate amongst the users and stakeholders. This ensures information symmetry

among market players which is vital for ensuring fairness and equitability in the market.

LDCs are mandated to provide feedback to the electricity regulators, administrators and power system planners The LDCs have to analyse the market data and provide necessary insights and information as desired by these bodies. The LDCs interact with the stakeholders on a day-to-day basis and therefore they act as an important link between the stakeholders and the regulatory agencies. The response of the market participants in the marketplace gets captured through energy account statements. Thus the LDCs require appropriate tools for archiving and big data analysis.

The statistics pertaining to System Operation and the Electricity Market trades need to be disseminated through its publications and website updation. LDCs require a robust website for dissemination of information amongst the stakeholders in real-time.

6.2 Functional Blocks and IT applications required

Energy Metering, Accounting and Settlement falls under the Market Operation function of the Load Despatch Centre as defined in the Pradhan Committee Report.

All the activities in Market Operation are highly data intensive and rigorous. The energy account statements prepared by SLDCs/RLDCs/NLDC/RPC are required by utilities for billing and settlement of their transactions. Thus the Deployment of Information Technology tools is desirable for automation of the above activities. Software applications are particularly required for the following functions:

a. User Registration
b. Open Access processing
c. Energy Scheduling
d. Energy Metering Design and Maintenance
e. Energy Meter Data Management- Collection, Validation, Processing
f. Energy Accounting
g. Active Energy Deviation Accounting
h. Reactive Energy Accounting
i. Transmission Usage Accounting
j. Billing and Settlement

k. Clearing and Pool Account Administration
l. Supervision and Compliance Monitoring
m. Information Dissemination
n. Data Archiving and Retrieval
o. Fees and Charge Billing and Collection
p. Reconciliation
q. Reporting
r. Big Data Analysis

Market Operation function can no longer succeed with fragmented and standalone IT systems. Each process has multiple inputs and interface with internal as well as external systems. Thus standardization, scalability and flexibility is essential. The typical workflow for the above activities is illustrated in the flow charts that follow. These processes need to be automated to enable fast processing of data and minimizing the settlement period.

Several activities such as scheduling and open access processing require web-based interface for facilitating simultaneous and continuous coordination with multiple Users / stakeholders. Such activities require web-based interface for convenience of internal as well as external stakeholders.

The software applications need to be continuously aligned with the evolving regulations and evolving requirement of the stakeholders and Users of the applications.

6.3 Automatic Meter Reading

Presently there are more than 22000 Interface Energy Meters (IEM) installed in the Interface points in intra State System. These meters are placed on the interface points in remote substations. Most of the substations may be neither accessible by motorized vehicle nor would they be having communication infrastructure for electronic data transfer. The number of energy meters would increase manifold with increase in the number of utilities. Collection of meter data from the sites and its compilation at a central location for energy accounting is one of most tedious and time-consuming activity. The delay in collection of meter data delays the preparation of energy accounts which in turns delays the billing and settlement of bulk energy exchanges. The survey revealed that several

SLDCs are unable to prepare deviation accounts on weekly basis. Preparation of energy account on a quarterly basis is a major challenge for as many as 11 SLDCs out of the 28 that responded. The Automated Meter Reading System along with the necessary communication infrastructure is available is available for the entire fleet of meters in only 8 out of the 28 SLDCs that responded to the survey.

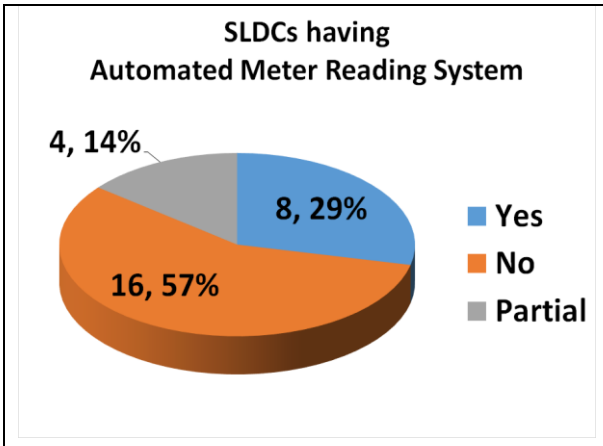

Figure 17: SLDCs having AMR system

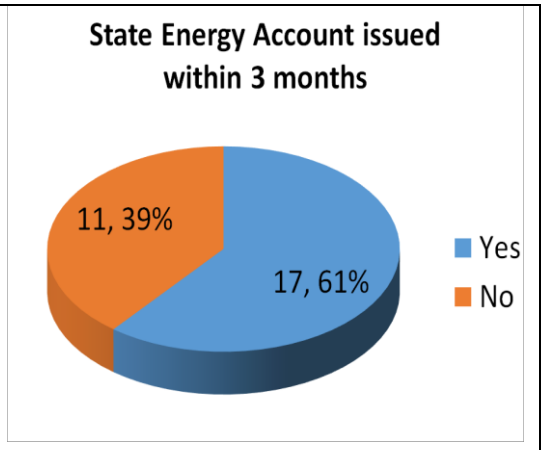

Figure 18: SLDCs where SEA is issued within a quarter

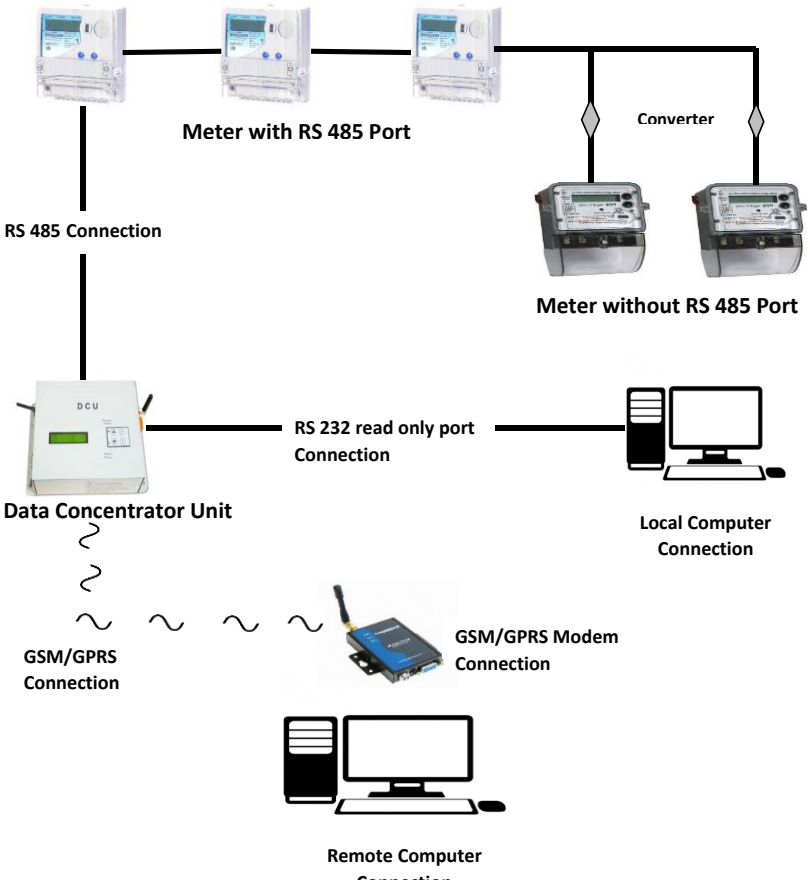

Figure 19: Schematic for Automatic Meter Reading System

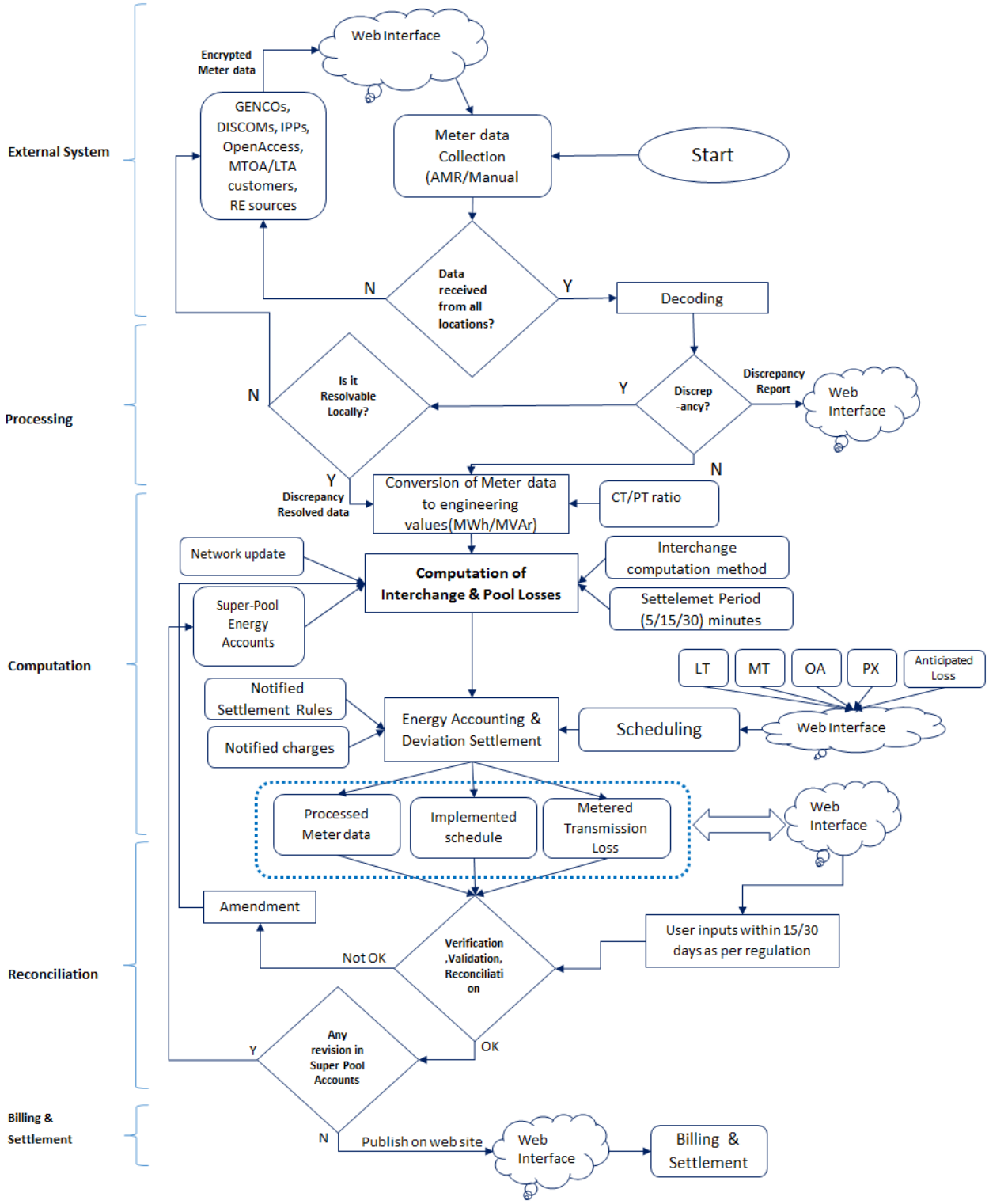

Figure 20: Workflow for Energy Metering, Accounting and Settlement System

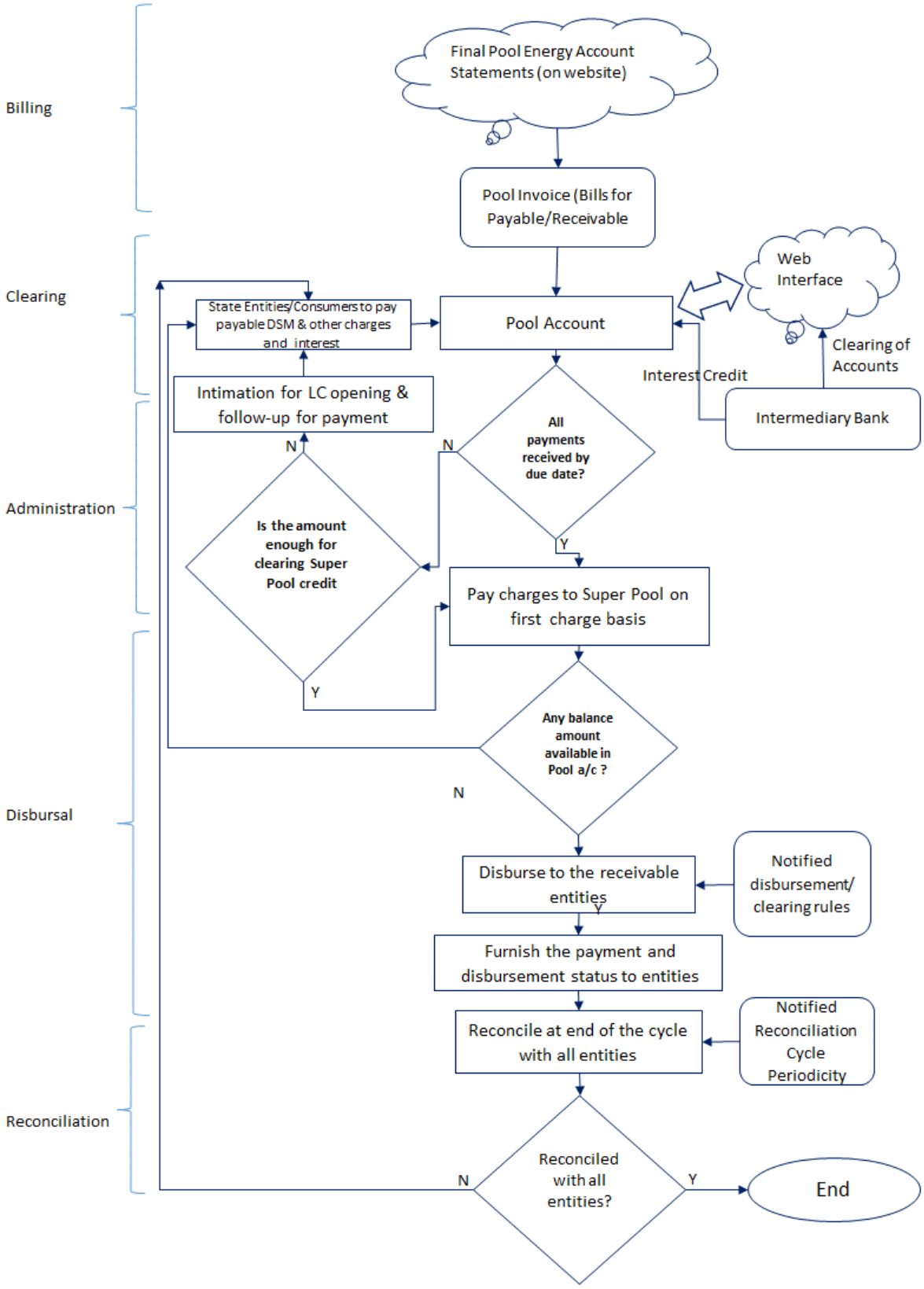

Figure 21: Workflow for Regulatory Pool Account Billing and Clearing

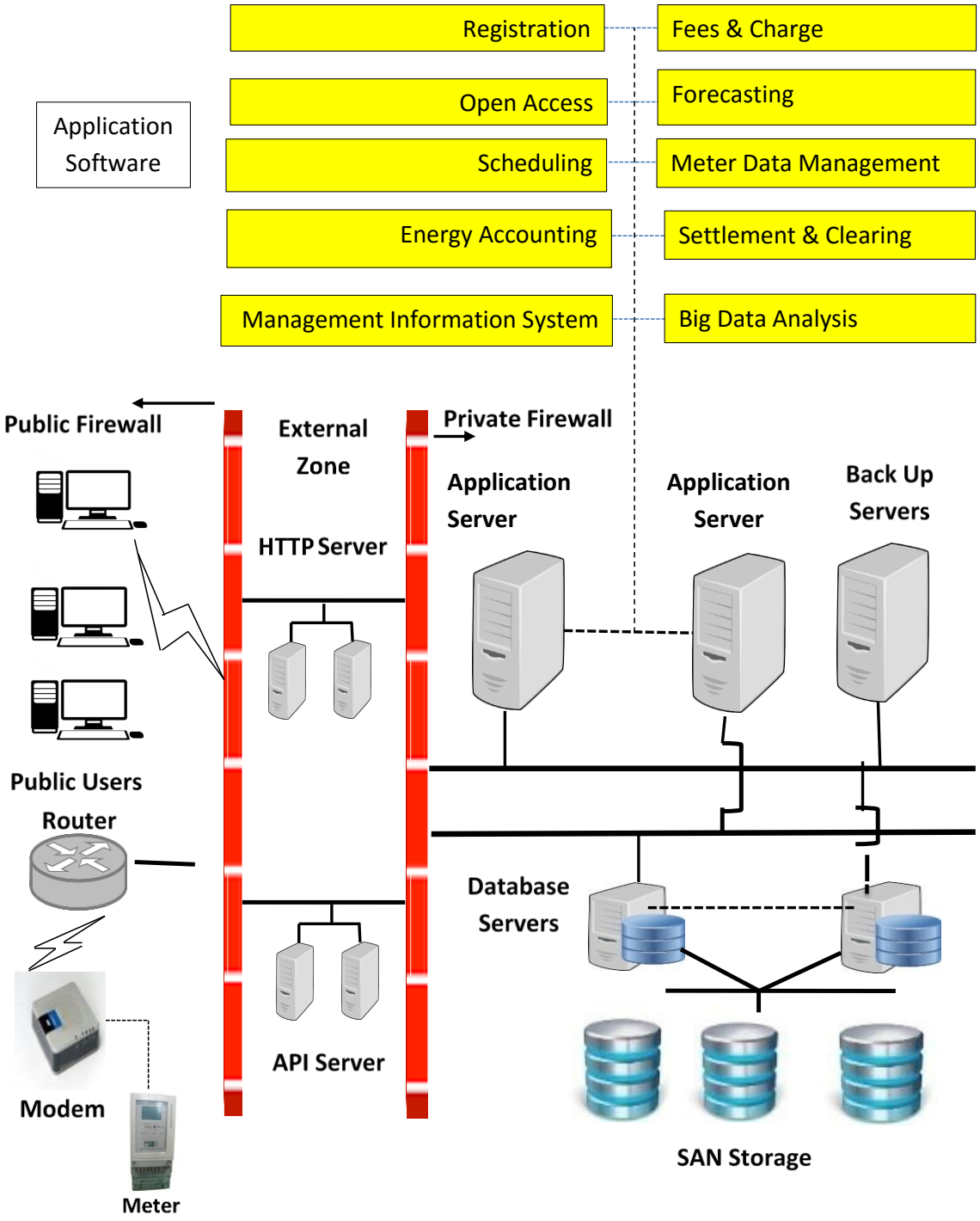

Figure 22: Typical IT Infrastructure in a Load Despatch Centre

6.4 Typical Hardware requirement

The typical hardware requirements for a Data Center in a LDC are as under:

a. Main Web Servers for hosting LDC web portal

b. Main Database Servers for hosting the LDC data

c. Application Servers for hosting the LDC applications

d. Representational State transfer (REST) or Simple Object Access Protocol API servers to provide the data to the application's view and model servers and web servers

e. Caching Servers configured with large amount of memory (typically >64 GB) to provide fast access to the frequently used data (e.g. current day schedules, active STOA transactions etc.) to offload the main database servers.

f. Load Balancer to distribute network load evenly on application and database servers.

g. Backup Appliances on site as well as at the Disaster Recovery Site

h. Network Management Servers to monitor and control the networking infrastructure and internet service providers (ISPs) leased lines.

i. Security Devices such as Routers, Network Firewalls, IDS/IPS, Gateway antivirus.

j. Unified Threat management (UTM) devices to provide all the network security functions (i.e. firewall, IDS/IPS, antivirus etc.) on one device

6.5 Best practices for IT administration in LDC

Few of the best practices for IT administration in a Load Despatcher Centres are listed below:

a. In house Data center with round the clock monitoring

b. IMS and ISMS Certification

c. Business Continuity Plan (BCP)

d. Disaster Recovery (DR) Plan with DR site

e. Mock Drills – Cyber Security, Business Continuity Plan, Disaster Recovery

6.6 Possible models for procuring Software Applications

The LDCs require agile development model for software applications to cater with frequent changes due to regulatory and user requirements. The LDC data models and MIS reports need to be standardized for easy integration with other beneficiaries, other stake holders and LDCs. There could be three different models for procuring Software applications for Load Despatch Centres:

a. In house development
b. Off-the shelf procurement
c. Development by third party based on specifications
d. Outsourcing

All the Load Despatch Centres have experimented with the above models. The 'in-house development' model requires availability of software engineers with domain knowledge of electrical and LDC functions. However attraction, deployment and retention of IT-proficient human resource at Load Despatch Centres is a challenge because they generally cannot match the remuneration/benefits offered by IT companies to its employees. The 'in-house development' model has been found to well on a small scale. However severe limitations emerge during scaling up or at the time of forward, backward and lateral integration with other proprietary systems.

Off-the-shelf solutions such as Enterprise Resource Planning require exhaustive customization before productive deployment. It also requires prolonged hand-holding and periodic tweaking to align the system with the evolving regulations/changing requirements. Number of vendors who provide customized IT solutions for various market operation functions discharged by Load Despatch are either very limited or they lack the power sector domain knowledge required for developing IT solutions.

Procurement of IT solutions from third party is also a challenging from the perspective of finalization of technical specifications, Scope of Work, Assessment of bids, contracting procedural, contract closing and availability of post-delivery support. IT solutions deployed at LDCs call for business continuity and process ownership that cannot be expected from an outsourcing agency. Thus it emerged that development and procurement of IT solutions for Load Despatch Centres is a major challenge that needs to be overcome.

6.7 Case Study of CRIS

The CRIS is an autonomous organization under the Ministry of Railways. It develops and manages the Information Technology applications of the Indian Railways. Their current portfolio of projects covers the gamut of Indian Railways functions, such as passenger ticketing, freight operations, train dispatching and control, crew management, e-procurement, management of Railways' fixed and moving assets, and production of rolling stock. Their Human Resource strength include a pool of competent IT professionals, whose skillsets include system architecture, system analysis and design, and program development, complemented by an experienced group of serving and former Railway personnel with domain knowledge and system implementation skills. They have a collaborative model of working to ensure the delivery of cost-effective, sustainable information systems. CRIS has been successful in using cutting-edge technologies in practical ways to ensure workable IT solutions for the Railways in many areas.

[Source: http://cris.org.in/CRIS/About_us/About_us]

6.8 Centre for Power Sector Information Services

It may be inferred from that the above that there is an urgent need for a 'Centre for Power Sector Information Services' similar to CRIS that caters to the customized requirements of the Load Despatch Centres. The Centre for Power Sector Information Services could collaborate with other IT service providers to provide the IT solutions to the utilities in power sector. The in-house IT team at a Load Despatch Centre could perform the role of project management, system/database/network administration, help-desk support and data centre operations with necessary support from software vendors. The maintenance of IT hardware could be outsourced. LDCs also need to take up vendor development programmes to encourage and attract IT solution providers in Load Despatching.

7 Recommendations - Human Resource

7.1 Organizational structure

Energy Accounting and Settlement function falls under the Market Operation division as defined in the Pradhan Committee Report. It is envisaged that the scale of operations would increase manifold in the near future. Therefore it is recommended that there could be following six sub-divisions or sections within the Market Operation division:

1. Scheduling
2. Short term Open Access request processing
3. Metering
4. Accounting
5. Settlement and Clearing
6. Fees and Charges

The organization chart in Figure-22 provides the layout of the Market Operation Function only.

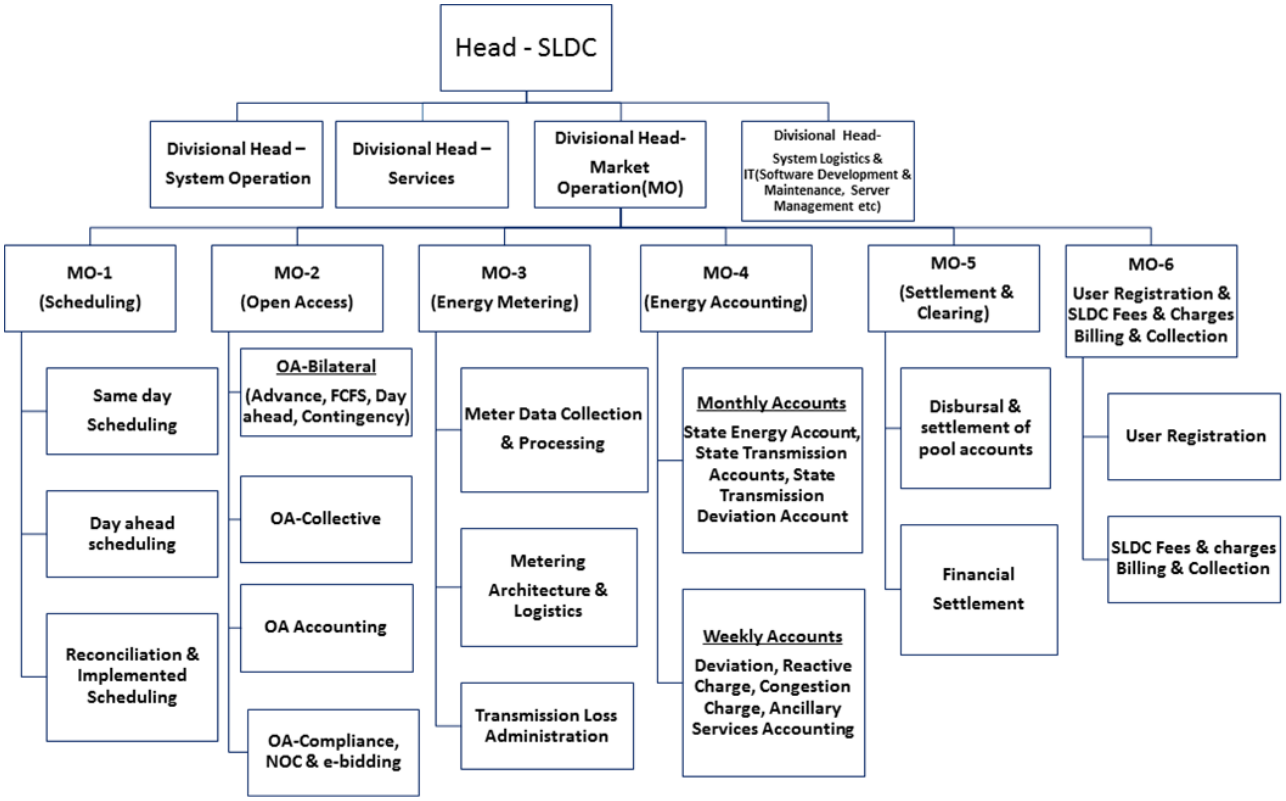

Figure 23: Typical Organization Chart for SAMAST at Intra State Level

7.2 Human Resources – Market Operation

The survey indicated that the human resources deployed in Market Operation division is highly inadequate for handling the enormous and challenging function. The break-up of activities covered under the above sections and the envisaged requirement of Human Resources is tabulated below.

Table 11: Typical number of personnel to be deployed for Market Operation functions in a SLDC

S. No.	Position/Function	Section	No. of Persons
1	Divisional Head	Market Operation	1
2	Chief Coordinator	Scheduling	1
3	Chief Coordinator	Open Access	1
4	Chief Coordinator	Metering	1
5	Chief Coordinator	Accounting	1
6	Chief Coordinator	Settlement & Clearing	1
7	Chief Coordinator	Fees & Charges	1
8	Same day scheduling (assuming 5-Shift Groups)	Scheduling	5
9	Day ahead scheduling		2
10	Reconciliation, Implemented scheduling, MIS		2
11	Short-Term Open Access-Bilateral	Open Access	1
12	Short-Term Open Access-Collective		1
13	Short-Term Open Access-Accounting		1
14	Open Access-Compliance, NOC & e-bidding		1
15	Metering architecture & Logistics	Metering	1
16	Meter Data Collection & Processing		1
17	Weekly Accounts	Accounting	1
18	Transmission Loss Administration		1
19	Monthly Accounts		1
20	Disbursal & settlement of pool accounts	Settlement & Clearing	1
21	Financial Settlement		1
23	Statutory, Regulatory and Legal Compliances		1
24	User Registration	Fees & Charges	1
25	SLDC Fees & Charges		1
	Total		**30**

It may be seen that roughly around 30 persons are required to be deployed to discharge the Market Operation functions with the help of appropriate IT tools. These persons would be other than the persons deployed in System Operation and SCADA/IT logistics. The MO team could be a mix of graduate or diploma holders from varied backgrounds viz- Electrical Engineering, Instrumentation Engineering, Economics, Commerce, Finance, Accounting, Statistics, Law and Management. The personnel must be given adequate exposure in theory and practice of the various electricity market operation activities.

7.3 Human Resources – IT services

The envisaged requirement of IT support personnel is enumerated below

Table 12: In house IT support personnel

Sl. No.	Position/Function	Number
1	Divisional Head-IT	1
2	Software Development	2
3	Database Administrator	2
4	Network Administrator	2
5	IT infrastructure Maintenance	2
6	Total	7

The persons deployed in the IT team to be suitably certified/qualified in their respective domains. Functions such as IT infrastructure maintenance could be outsourced. The IT software development team would have to collaborate with IT service providers for developing customized IT applications.

8 Recommendations: SAMAST

Based on the extensive discussions with the State, Regional and National Load Despatch Centres and deriving from the learning from the experience at the State and Interstate level, the procedure for implementing System of Accounting Metering and Settlement of electrical energy Transactions (SAMAST) in all the States in India is enumerated below:

8.1 Demarcation of Interface boundary & identification of Pool Members

a. All the entities connected at the transmission level of the intra State System to be identified and made pool members
b. Interface locations and tie lines to be notified. small feeders at 33 kV level and below should be out of the intra state energy accounts and must be settled bilaterally between the utilities. Delay in getting meter data from these small feeders should not scuttle the entire weekly system
c. Jurisdiction, roles and responsibilities of SLDC, STU, Users, Market players to be outlined in the respective State Grid Code
d. All pool entities, transmission licensees, distribution licensees and market players to be registered as Users of appropriate LDC.

8.2 Adequate Interface Energy Meters with AMR infrastructure

a. Assessment of locations in the intra system for placement of energy meter for demarcation of interface boundary
b. Installation of IEM- Main, Check and Standby as mandated by the CEA Metering Standards. The CEA Metering Standards stipulate the bare minimum requirement. Faster detection of meter failure is also desirable as the present one week for meter data collection could become a constraint. Alternatively, more meters could be installed to ensure N-2 or N-1-1 security of the metering system. Robustness of the metering system to be enhanced by ensuring N-1-1 or N-2 security of the metering system.
c. Meter placement and submission of dummy reading to be a necessary condition before granting pool membership to an entity and connectivity at any location
d. PT/CVT in all three phases to be provided for implementing electrical energy measurements based on 3-phase 4-wire metering principle
e. SLDC to be responsible for designating placement of meters
f. STU to be responsible for Interface Energy Meter procurement, installation, maintenance, testing and calibration.

g. Interface Energy Meters to be tamper proof and compliant with CEA "Functional Requirements for Advanced Metering Infrastructure"
h. All future procurements of Interface Energy Meters to have recording at 5-min interval and frequency resolution of 0.01 Hz. They must be capable of recording Voltage and Reactive Energy at every 5-min and have feature of auto-time synchronization through GPS.
i. The energy interchange of all the State Entities with the State Grid should be meticulously recorded with the help of energy meters of appropriate accuracy class installed at the interface points as per the CEA Regulations.
j. Meter records of all Interface Energy Meters (Main, Check and Standby) to be collected at respective SLDCs for energy accounting at the State level.
k. Infrastructure for Automatic Meter Reading and Data collection System to be in place. The Interface Energy Meters shall satisfy the functional requirements for Advanced Metering Infrastructure notified by CEA
l. Meter Management System with a provision for automatic data validation, estimation of reading in case of bad data as well as provision for Data security and Big Data Analysis to be in place
m. Database of Interface Energy meter configuration and database (including CT/PT ratio) for the entire system to be maintained by the SLDC and submitted to the appropriate Commission by SLDC on an yearly basis

8.3 Ex-Ante Scheduling

a. Implementation of scheduling mechanism based on Coordinated Multilateral model where the market players would take commercial decisions while security related decisions would be taken by the System Operator
b. 5-min scheduling for addressing ramping challenges imposed by RES to be implemented
c. Scheduling to be based on security constrained merit order with a well-defined time-line
d. Freedom and choice with market players for portfolio management
e. All information related to the interchange schedules (Declared Capacity, Entitlement, Requisition, Schedule, Scheduled Losses, scheduled STOA etc.) to be transparently uploaded on website in a comprehensible format

f. All before the fact changes in schedule to be sacrosanct. No post facto changes in schedule to be allowed
g. Seasonal / Diurnal Energy Banking Contracts between two entities to be converted into separate reciprocal contracts with distinct buyer and seller in each direction specific
h. Energy rate (regulator approved or Market discovered) declared ex-ante shall be used for Merit Order dispatch in real-time. No post-facto modification in Energy rate.
i. Assessment and declaration of Transfer Capability (based on anticipated network, load, generation availability) by the SLDCs. Quarterly feedback by SLDCs to the STU, CTU (through STU), RLDC, RPC and SERC.
j. Transmission Losses recovery in kind; Transmission losses applicable to various category of transactions to be a common knowledge
k. Schedules at various seams/ boundaries to be compiled and published. Care to be taken during curtailment of schedules due to transmission constraints.

8.4 Uniform Energy Accounting System

a. Implemented Schedule (that incorporates all before-the-fact changes in schedule)to be used as a reference for energy accounting;
b. Energy Accounting System to be compliant with the Basic principles of Accounting such as the Double Entry System, Full Disclosure principle, Going concern principle etc.
c. Deviations to be computed with reference to the Implemented schedule
d. Energy Accounts to inter alia comprise of Declared Capability, Entitlement, Requisition, Scheduled loss, Scheduled transactios through LTA/MTOA/STOA-bilateral/STOA-collective, Actual Interchange and Deviation from Schedule
e. Metered Transmission Losses (Energy credit to pool minus Energy Debit from pool) to be computed for every time block on the lines of Profit and Loss Account in Financial System;
f. No post facto administration of transmission losses to be done
g. Formats for Energy Statements issued by SPC/SLDC/RLDC/RPC/NLDC/NPC to be standardized
h. Periodic reconciliations and process audit of accounts to be made mandatory

8.5 Simple, robust, scalable but dispute-free settlement system

a. Settlement system design should be such that it is scalable and functional with multi-buyer, multi-seller, prosumers
b. Each intra State entity (Conventional Generator, Pooled RE Generator, Captive Power Plant, OA customer connected at Transmission level) connected to the Intra State Transmission System to be a member of the pool and separately accountable for deviations
c. Settlement to be multi-layered. Charges for Capacity and Energy to be settled mutually between buyers and sellers while the System Operator to carry out net settlement (Accounting and Billing of Deviation from Schedule)
d. Deviation Settlement Mechanism based on "causer pays" principle, similar to the mechanism at the Inter State level
e. The pool to be surplus by design so that there is a provision of reserve funds
f. State pool to be delinked from super and sub-pool to avoid recursive revisions and collection/disbursement. There may be reconciliation on an annual basis.
g. Gross Settlement for Ancillary Services
h. Non zero sum pool by design to maintain reserves
i. The settlement period to be 15-minute to start with and moved to 5-minutes in next five years.

8.6 Administration of transmission losses

a. Transmission Losses for the Intra State Transmission System to be computed for every settlement period and each settlement cycle
b. Trajectory of Losses over a period (Diurnal and Seasonal) to be monitored and benchmarked. Large variations to be analyzed to identify leakages or corrective measures
c. Difference between the Scheduled Losses and Metered Losses to be monitored but there shall be no post-facto truing up/adjustment of energy accounts or losses
d. Transmission Loss to be considered as a measure of transmission adequacy as recommended in the ECC report

8.7 Transmission Charges

a. Transmission Charges to be in line with the Tariff Policy

8.8 Reactive Energy Pricing

a. Reactive Energy Pricing at inter utility level to be linked to voltage instead of power factor
b. In view of the envisaged challenges due to uneven loading of transmission system with high penetration of RE, the metering of voltage and reactive energy shall be for each time block

8.9 STOA Registry and Clearing Agency

a. STOA Registry and Central Clearing house to be established similar to depositories in capital market
b. Compliance to KYC norms for all market players to be mandated
c. Submission of dummy reading to be a necessary condition before granting pool membership to an entity
d. Depository and repository for OA approvals by SLDCs and ATC for inter state transmission
e. Integrated IT based system to facilitate automatic issuance of OA clearance
f. Mitigation of systemic risk and credit risk for all Regulatory Pool Accounts
g. Guarantee of settlement of trades to all members maintaining adequate margins
h. Exposure limits for each player derived from past record of credit worthiness

8.10 Transparency

a. Rules and Charges for Deviation from schedule to be known ex-ante
b. Transmission charges, System Operators charges applicable to various category of transactions to be declared upfront
c. Detailed Statements related to Declared Capacity, Long-term/Medium-term/Short-term Schedule, Scheduled Transmission Losses, Interface points (tie lines), Interchange Computation formulae, CT/PT ratio, Interface Energy Meter data, Discrepancy statements, Deviation Account, Energy Account, Reactive Energy Account, STOA charges, SLDC charges, Metered Transmission losses, Pool Account

liabilities/Assets/defaults/reserves, etc. to be put in public domain for reference and verification by the respective Entities

d. Formula and Energy Meter reading to be used for computation of interchange with the grid to be made available to the respective Entities through website
e. All Energy Statements and Accounts to be kept open for pre-defined duration for reconciliation at periodic intervals and correction of any errors/omissions
f. Data to be shared for research and academic

8.11 Integrity and Probity of Accounts

a. Interface Energy Meter Testing, Maintenance and Calibration to be coordinated by the STU who may deploy Certified Metering Service Providers. Defective Meters to be immediately notified and replaced within a SERC specified time-frame by the STU with information to the SLDC.
b. Repository of IEM Test Certificates to be maintained at the Load Despatch Centre
c. In order to keep check on the accounting system, the Interchange of the Intra State Entity with the Intra State Transmission System as recorded in Energy Meters to be compared with the Interchange recorded through real-time SCADA by SLDC.
d. Algorithm for 'Meter Data Estimation' (Similar to State Estimation in SCADA/EMS) to be evolved to detect bad data, changes in network configuration. Meter Data Estimation algorithm to be run at SLDC.
e. Implemented Schedule and Energy Account to remain open for 15 days for cross checking and verification.
f. Mandatory Process Audit (Internal as well as external) at periodic intervals to be conducted for stakeholder confidence and risk mitigation. A system of peer review of the account by SLDCs could be done say SLDC-A audits SLDC-B and so on.

8.12 Disbursal and Clearing

a. Electronic clearing through NEFT / RTGS to be mandated

8.13 Statutory Compliances

a. Taxation and other statutory compliance aspects associated with pool accounts to be suitably taken care in the Regulations

8.14 Payment Security Mechanism and Risk Mitigation

a. Periodic reconciliation of payment and receipt in Regulatory Pool Accounts with the stakeholders to be mandated through regulations
b. Highest priority to payment of Deviation Charges to the pool to be mandated through regulations as well as penal interest for each day of delay as is applicable at inter-state level
c. Payment Security through Suitable Financial Instruments
d. Pool reserves (Non-zero sum pool by design) to be used to clear the receivable dues
e. Suitable regulatory provision for habitual / chronic defaulters (such as Sec 25A of the CERC-STOA regulations)

8.15 Archival and Utilization of Energy Meter Data

a. The data related with Implemented schedule, Interface Energy Meter and Deviation to be archived by the SLDC and State Power Committee
b. Energy Meter data to be used for Load forecasting
c. Energy Meter data to be utilized for Big Data Analysis
d. Archived data to be shared for research and academic purpose

8.16 Logistics for SAMAST

a. Adequate and scalable IT infrastructure to be in place with a provision for maintenance and periodic up-gradation
b. Work processes to be automated to the extent possible
c. Development of software applications to be through collaboration of in house team and a long term IT partner so as to be adapt the systems to the regulatory directions and amendments
d. Web-based interface to be deployed wherever feasible (e.g. scheduling Open Access request processing, User Registration etc.)
e. Systems for data archival and retrieval to facilitate 'Big Data Analytics' to be in place
f. Systems to ensure Data security, Cyber Security and Disaster recovery to be in place
g. Energy Accounting and settlement system to be made paperless with the help of IT tools
h. Repetitive and tedious activities to be automated

i. Automatic Meter Reading System to be in place with adequate communication system. Telemetry of Meter data is desirable for faster accounting
j. Separate organization to be established for development of IT applications for Load Despatch Centres / Power Sector utilities on the lines of Centre for Railways Information System. In house IT team at a Load Despatch Centre to perform the role of project management, system/database/network administration, help-desk support and data centre operations with necessary support from software vendors
k. The maintenance of IT hardware could be outsourced. LDCs also need to take up vendor development programme to encourage and attract IT solution providers in Load Dispatching
l. Vendor development activities to be taken up for creating pool of IT service providers in the power sector

8.17 Adequacy of Human Resource

a. Adequate human resources to be deployed for energy accounting and settlement system
b. Training on regulatory provisions, IT provisions and accounting principles to be imparted to keep the HR update and motivated
c. Periodic job-rotation and job-enrichment to be mandated
d. Experts Groups to be formed for knowledge sharing and peer review

8.18 Governance Structure

a. Creation of the State Power Committee with representatives from State Pool members. SPC to prepare the State Energy Account based on the Implemented Schedule and Meter data submitted by the SLDC. One who prepares the energy account to be different from the one who verifies and approves. A System of "Maker-Checker" in energy accounting to be in place similar to the maker checker for financial accounting.

b. The recommended governance structure with roles and responsibilities of various entities in the State for energy accounting and settlement system to be notified by the SERC

8.19 Facilitating enhanced Grid Security and Economic Despatch

a. Identifying marginal cost of generation - commonly the variable cost for cost plus based Thermal Power Stations – separate from fixed cost
b. Separate tariff for peak and off peak generation

c. Two-part tariff for reservoir/pondage based Hydro Power Stations, so long as they are based on cost plus tariff design principles on the lines of Central Hydro Stations (viz. separate capacity charge) to enable utilization of hydro power as flexible resource for peaking, ramping etc. Appropriate tariff for operation of hydro stations in synchronous in condenser mode for voltage regulation.
d. Allocation of existing Power Purchase Agreements (PPAs) between distribution licensees
e. Valuation of flexibility of conventional generating stations for handling inherent variability of demand and RES.
f. Multi-part tariff for conventional stations to be introduced to enable hydro flexing, pumped storage operation, synchronous condenser operation, ramping, load following, peaking, two cycle operation
g. Two-part tariff for RES to be explored
h. Creation of Distribution System Operators to ensure security of the transmission and distribution system with Distributed Energy Resources and Prosumers
i. Introduction of Net metering and TOD tariff

8.20 Implementation of Dispatch with Ancillary Services

a. Freedom and Choice to Entities for revision of schedules for contracts having multi-part tariff.
b. Despatch based on merit order with Ancillary Services for real time imbalance management.
c. Transmission charges to be ignored while issuing despatch directions
d. Pre-defined rules for congestion management (Priority, Market Split)
e. Suitable mechanism for alleviation of congestion in real-time (Curtailment priority of transactions)

9 CHECKLIST FOR IMPLEMENTATION OF *SAMAST* IN SLDC

Milestone	Activity
1	Identification of Intra State Entities
2	Demarcation of Interface boundary for each Intra State Entity
3	Assessment of Meters - Main, Check and Standby
4	Assessment of Automatic Meter Reading logistics requirement
5	Assessment of IT infrastructure (Hardware and Software) requirement
6	Preparation of Bill of Quantities (considering logistics already in place)
7	Preparation of Detailed Project Report
8	Submission of application for funding from Central Government/PSDF
9	Inviting tenders
10	Placement of Award
11	Commencement of Load Forecasting by SLDC
12	Commencement of Interchange Scheduling by SLDC for all the Intra State Entities
13	Completion of boundary metering and AMR system (as envisaged in DPR)
14	Approval of the metering scheme by SERC
15	Establishment of State Regulatory Pool Account
16	Adequacy of Human Resources in SLDC as approved by SERC
17	Implementation of the recommended IT infrastructure-Hardware
18	Implementation of the recommended IT applications- Software a. User Registration b. Short term Open Access Processing c. Scheduling d. Meter Data Processing and Validation e. Accounting f. Settlement g. Billing and Clearing h. Data Archival and Retrieval i. Management Information System j. SLDC Website

19	Computation of transmission losses for each settlement period (15-min) by SLDC
20	Formation of a State Power Committee for preparation of Energy Account
21	Preparation of Energy Accounts by SPC/SLDC and Publication of the following on SPC/SLDC website a. Process document (SAMAST handbook) for the State b. At least four weekly deviation accounts for all intra State Entities c. At least one monthly State Energy Account (SEA) d. List of tie lines for each Intra State Entity with Intra STS e. List of Interface Energy Meters to be used in accounting f. CT/PT ratios to be used in accounting g. Formula to be used for computation of Injection / Withdrawal h. Implemented Schedule – DC, Entitlement, Injection Schedule, Withdrawal Schedule, STOA schedule, Scheduled Losses, Interchange with Regional Grid i. Deviation Rates as notified by SERC j. Comparative plot of Actual Interchange computed from SCADA and from Energy Meter data of each Intra State Entity for at least four weeks k. Plot of measured Transmission Losses for at least four weeks
22	Clearing of Pool A/c Credit / Debit for at least four weeks and its reconciliation
23	Two stakeholder workshops by SLDC on SAMAST system as implemented
24	Quarterly Reconciliation Certificate from all State Pool members
25	At least one annual 'Peer review' of the entire process of SAMAST by any SLDC/RLDC

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Appendix- 1: Terms of Reference of the Sub-committee

FORUM OF REGULATORS (FOR)
C/o CENTRAL ELECTRICITY REGULATORY COMMISSION (CERC)
3rd & 4th Floor, Chandralok Building, 36, Janpath, New Delhi 110 001
☎: 011-23353503/23752958

F. No. 1/14/2015-Reg.Aff.(FSDS)/CERC Dated 20th January, 2016

Subject: **Constitution of "Sub-groups under Technical Committee on Implementation of Framework on Renewables at the State level"**

Sir,

Forum of Regulators (FOR) endorsed draft Model Regulations for Forecasting, Scheduling and Deviation Settlement of Wind & Solar generating stations at the State level. FOR also expressed in-principle agreement for deployment of the State Framework. Further, given the variation in technical and commercial frameworks from one State to another, and to build capacity at the State level, it was decided to form a Technical Committee under the chairmanship of Member CERC, Shri A.S. Bakshi. This Committee comprises of Technical Members of State Commissions of renewable rich States, viz. Tamil Nadu, Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka and Madhya Pradesh.

2. The Committee has met twice. At the first meeting held at CERC offices on 16th December, 2015, unanimous consensus was reached on the need for:-

   (i) Implementation of Availability-Based Tariff (ABT) & Deviation Settlement Mechanism (DSM) in States;

   (ii) Specifying Regulations on Forecasting, Scheduling and Deviation Settlement of Wind & Solar generating stations at the State level

   (iii) Creation of reserves at the State level; and

   (iv) Introduction of Ancillary Services at the State level

3. The second meeting was held at CERC office on 8th January, 2016. Representatives from SLDCs of Gujarat, Rajasthan, Maharashtra, Tamil Nadu were special invitees to this meeting, to share the challenges and learnings encountered during implementation of Availability Based Tariff (ABT) / Deviation Settlement Mechanism (DSM) in the respective States. At the meeting, it was concluded that for taking up planning and implementation at the State level, a small group comprising of one person from SLDC, one from SERC, one from RLDC and headed by Mr. S.K. Soonee, CEO, POSOCO shall be formed for every State that decides to proceed on implementation of ABT/DSM.

4. This sub-group for a particular State formed under the aegis of the Committee would comprise of the following members:-

   a. Shri S.K.Soonee, POSOCO, as Chairman of the sub-group
   b. One representative from SERC (concerned SERC)
   c. One representative from SLDC (concerned SLDC)
      (b) & (c) as above to be nominated by the concerned SERC
   d. One representative from RLDC (concerned RLDC), to be nominated by NLDC
   e. One representative from FOR Secretariat (optional observer)

5. This sub-group shall inter-alia:

   a. evolve a detailed action plan with timelines for implementation of ABT/DSM at the State level
   b. suggest modification of all technical and accounting procedures as may be necessary for rolling out ABT/DSM framework.
   c. assist in drafting of requisite State regulations, or amendments to existing regulations, as the case may be
   d. submit report on progress of the sub-group to the Technical Committee of States every two months

6. The first two meetings of these sub-groups shall be held under chairmanship of Shri Soonee on the following dates:

   a. **Mumbai, 23rd January 2016: Maharashtra SERC, SLDC and WRLDC**

   b. **Chennai, 30th January 2016: Tamil Nadu SERC, SLDC and SRLDC**

7. It is thereby requested that the above States may nominate the representatives to this sub-group prior to these meeting dates.

(Rashmi Somasekharan Nair)
Deputy Chief (RA), CERC

To:

(i) Sh. A.S. Bakshi, Member, CERC	-	Chairman
(ii) Member (Technical), TNERC	-	Member
(iii) Member (Technical), GERC	-	Member
(iv) Member (Technical), RERC	-	Member
(v) Member (Technical), MERC	-	Member
(vi) Member (Technical), APERC	-	Member
(vii) Member (Technical), KERC	-	Member
(viii) Member (Technical), MPERC	-	Member
(ix) Sh. S.K. Chatterjee, Joint Chief (RA), CERC	-	Member

Copy to:

(i) Shri S.K.Soonee, CEO, POSOCO
(ii) ED, NRLDC
(iii)GM, WRLDC
(iv)ED, SRLDC
(v) GM, ERLDC
(vi)GM, NE-RLDC

Appendix-2: Minutes of the Technical Committee Meetings

Minutes of first meeting held on 16-12-2015

1. The first meeting of Technical Committee on implementation of framework for renewables at State level was held under chairmanship of Shri A. S Bakshi, Member, CERC on 16 December 2015. Shri Bakshi welcomed all the Members and highlighted the terms of reference of the Committee.
2. Ms. Shruti Deorah, Advisor (RE), CERC, presented Regulatory Roadmap for States to achieve reliable grid management and large-scale integration of Variable Renewable Energy sources. The presentation discussed agenda for the Committee, recent steps taken by CERC and the need to emulate complementary regulatory framework at the state level. She also informed that 6 states have already implemented Deviation Settlement Mechanism (DSM) in some form. A copy of the presentation is attached as **Annexure-II**.
3. Shri. S. K. SOONEE (CEO POSOCO) discussed the current frequency scenario, requirements and next steps for improved grid management, and elaborated on the complexities involved in Grid Management for the large interconnected Indian grid. He also expressed that challenges in India are different from the developed nations as they had a mature grid when renewable power emerged. A copy of the presentation is attached as **Annexure-III**.

Discussion

4. The Chairman requested the state representatives to briefly summarize the status of implementation of ABT and DSM in their respective states.
5. Shri. R.S. Rathore (RERC) informed that ABT regulations are already in place in Rajasthan. However, work to deploy ABT meters is still in progress and is expected to complete by 31st March 2016.
6. Shri S.A. Kumar (TERC) brought up the challenges being faced in Tamil Nadu to meter thousands of turbines. Tamil Nadu is currently pursuing metering at the pooling station level. CERC staff emphasized that once metering of all conventional generators and all pooling stations with RE generators is complete, implementation of DSM is feasible. Shri S.K.Chatterjee (JCRA, CERC) also underscored that it is best to initiate the process of drafting the regulations now so that they are ready in a few months by the time metering is complete.
7. The Members agreed that there is a need for a robust institution as a system operator, which should be neutral, independent, transparent, non-discriminatory and equipped with skilled manpower. Concept of Distribution System Operator (DSO) on bylines of SLDC was also elaborated.
8. Requirement of Technical Consultant or Partner to iteratively modify the software keeping pace with evolving regulations was discussed. The job of TC would be to provide necessary assistance in load forecasting and strategizing grid management.
9. It was suggested by members that for proper ring fencing of SLDC, it must be isolated from state control. Shri Lad (MERC) emphasized that this needs amendment to the Electricity Act.
10. It was concluded that ABT and DSM implementation in all states is the need of the hour. Proper Forecasting and Scheduling have to be focused upon.

Decision

11. After detailed discussion, there was a unanimous consensus on the need for :-
    (i) implementation of Availability-Based Tariff (ABT) & Deviation Settlement Mechanism (DSM) in States;
    (ii) specifying Regulations on Forecasting, Scheduling and Deviation Settlement of Wind & Solar generating stations at the State level

(iii) creation of reserves at the State level; and
(iv) introduction of Ancillary Services at the State level

12. It was also agreed that in the next meeting, SLDC Heads of 4 states viz Maharashtra, Gujarat, Rajasthan and Tamil Nadu, along with the representatives of respective State Commissions, shall present the status of implementation of ABT/DSM in the respective states.

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

Minutes of the Second Meeting held on 08-01-2016

1. The second meeting of Technical Committee on implementation of framework for renewable at State level was held under chairmanship of Shri A. S Bakshi, Member, CERC on 8 January 2015. Shri Bakshi welcomed all the Members and recalled the decisions taken in First meeting held on 16 December 2016.
2. Ms. Shruti Deorah, Advisor (RE), CERC, presented a summary of conclusions of the last meeting along with a two pronged approach towards the implementation of Availability Based Tariff (ABT)/Deviation Settlement Framework (DSM) at the state level. The first step would be for FOR to facilitate creation of Model Regulations, for which a consultant might be hired by FOR Secretariat. The second step would be to undertake an exhaustive exercise at the state level, which will include gathering requisite data about state infrastructure and preparedness, modifying Model Regulations and adopting it with suitable adjustments, implementation of regulations, installation of required hardware, rolling out of software, etc. A copy of the presentation is attached as **Annexure-I**.
3. Shri. S. K. SOONEE (CEO POSOCO) stated that nuances of every state have to be understood while implementation of DSM. This requires manpower with required skill sets at each SLDC. He expressed that strengthening the manpower is need of the hour. It was also suggested that this matter be taken up for discussion at Forum of Regulators (FOR) meeting.
4. Shri Soonee also dwelled upon the challenges encountered in implementing DSM framework at the regional level, and suggested that those complexities be proactively tackled when implementation is undertaken at the state level.

Discussion

5. The Chairman requested the SLDC representatives to briefly summarize the status of implementation of ABT and DSM along with challenges and learnings in their respective states.
6. Shri. R.A.Sharma (MPLDC) informed that ABT started in MP in 2009. The fluctuations caused by wind are managed by hydro generation. MPLDC is responsible for open access, scheduling, metering and DSM accounting. The financial transactions are being done by MPPPMCL. A copy of the presentation is attached as **Annexure-II**. Shri A B Bajpai (MPERC) informed that Draft Forecasting regulations have been issued and hearing is due on 19 January 2016.
7. Shri Arvind Agrawal (SLDC, Rajasthan) brought up the challenges being faced in Rajasthan related to meter vendors. It was discussed that upcoming Renewable Energy Management Centres (REMC) shall have a major role to play. A copy of the presentation is attached as **Annexure-III**.
8. Shri Venkatesan (SLDC, Tamil Nadu) presented the current status of ABT implementation in Tamil Nadu. A copy of the presentation is attached as **Annexure-IV**.
9. Shri M. Satyamurti (SLDC, AP) presented the status of ABT in Andhra Pradesh. He elaborated that DSM is directly or indirectly already implemented for solar and wind generators in the state. A copy of the presentation is attached as **Annexure-V**.
10. Shri Jayant Kulkarni (SLDC, Maharashtra) presented the settlement mechanism adopted in Maharashtra illustrating the complexities involved. Maharashtra follows a DSM framework that is not linked to frequency, instead, is based on the concept of marginal pricing. It was underscored that the mechanism is not completely effective as PPA generators are not covered under the framework. A copy of the presentation is attached as **Annexure-VI**.
11. SLDC Gujarat sent their presentation via email, though no representative was able to attend (attached as **Annexure-VII**).
12. It was discussed that credibility of Qualified Coordinating Agency (QCA) shall be an important factor in the successful implementation of Forecasting regulations for

renewable generators. States such as Maharashtra emphasized that more clarity is needed on screening QCAs and ensuring financial integrity of the process.

Decisions

13. There was a unanimous consensus on the need for putting in place ABT and Deviation Settlement Mechanism (DSM) at the earliest, along with the regulation on forecasting and scheduling of variable RE, at the State level.
14. Critical to all this is the need for strengthening SLDCs. The recommendations of Gireesh Pradhan Committeee Report on strengthening Load Despatch Centres should be implemented by all States to make RE integration a success. It was agreed that the Report shall be circulated to all SERCs by POSOCO. This report presents a comprehensive plan for staff and skill-building required at SLDCs.
15. It was agreed that Chairperson, FOR, shall be requested to hire a consultant to enable the Committee to draft model regulations for ABT/DSM for states.
16. For taking up planning and implementation of ABT/DSM at the state level, a small group headed by Mr. Soonee, CEO, POSOCO and comprising one representative each from SLDC, SERC and respective RLDC was formed. It was pointed out that Tamil Nadu is ready with draft regulation, and as such the group headed by Mr Soonee should forthwith take up the issues for Tamil Nadu. During the next one month, the group should take up at least two States and present its findings before the Committee.

Minutes of the third meeting held on 10-02-2016

1. The third meeting of Technical Committee on implementation of framework for renewable at State level was held under chairmanship of Mr. A. S Bakshi, Member, CERC on 10th February 2016. Mr. Bakshi welcomed all the members and appreciated the hard work done by the sub-groups.
2. Dr. S K Chatterjee, JC (RA), CERC presented a summary of conclusions of the last meeting. He also updated about the efforts made towards exploring the possibility of engaging consultants for supporting the Committee. That various agencies viz., USAID under the Greening the Grid programme, have offered to support with a technical Consultant.

Discussion

3. Mr. S.K. Soonee, CEO, POSOCO presented the experience and learning of the sub group's visit to SLDC-Kalwa on 23rd January, 2016 and SLDC-Chennai on 30th January, 2016. He appreciated the excellent cooperation from both SLDCs. He emphasized that the problems of SLDCs need to be understood. The nuances of both States were discussed in depth. The presentation is enclosed as **Annexure-II.**
4. Mr. Soonee emphasized that there is a huge scope of better utilization of Hydro plants as they provide the flexibility in generation which is a pre requisite to the integration of renewables given its infirm nature. It was agreed after discussion that State level regulations on hydro tariff should follow the CERC principles (viz., the principles of two part tariff and recovery of capacity charge based on providing 3 hours peak). This will encourage peak support.
5. He also focused on the need of proper energy accounting and metering. It was also proposed that India should adopt a 5 minute settlement period instead of 15 minutes for better granularity and ramp monitoring. Mr. P Rama Mohan, Member, APERC expressed the importance of proper testing and calibration of the meters.
6. Mr. Deepak Lad, Member, MERC, assured that MERC will issue the DSM regulation after analysing the recommendations made by the Committee. He also expressed that the Consultant, as proposed, must be able to provide a guaranteed support in the various facets involved in the implementation.
7. Mrs. A Axilium Jayamary, Director, TNTRANSCO expressed the concern over the source of funding of the proposed activities. Mr. Lad suggested the cost can be incorporated in ARR and PSDF can also be utilised. Mr. Bakshi suggested that 50% of funding may be used from PSDF in order to ensure seriousness amongst the SLDCs. Mr. Soonee emphasized the funds must be released only after certifying that order for equipments has been placed.
8. Mr. A. B Bajpai, Member, MPERC informed that MP has already issued draft Ancillary Services regulations in January 2016 and stakeholder comments have been invited.
9. It was felt that functions of QCA need more clarity. Dr. S K Chatterjee assured that a joint presentation shall be soon made to address the questions pertaining to QCA.

Decisions

1. It was agreed that Chairperson, FOR, shall be requested to authorize the Committee to hire a Consultant to support the Committee in accomplishing the tasks assigned to it. Furthermore, it was discussed that one Consultant per State shall be ideal to work through the entire process of planning and implementation of ABT/DSM at the State level.
2. It was agreed upon that the sub group needs to interact with more States to understand the specificities of implementation for every State. In continuance, it was proposed that Karnataka SLDC shall be visited on 15th February, 2016.

3. All intra-State entities (for instance, the generators) are not subject to deviation settlement at present even in States where ABT has been implemented. It was agreed that the causer pays principle should be followed and all entities responsible for deviation should be accounted for separately.
4. There is an urgent need for putting in place interface energy meters for intra-State entities. Losses in intra-State transmission should be computed. 15 minute accounting is a pre-requisite for seamless integration of RE. Meter should be the starting point of the exercise and the magnitude of investment required to put in place suitable meters should be identified immediately.
5. SERCs should direct the STUs to prepare metering/telemetry plan and send the proposal for part funding from PSDF.
6. Knowledgeable experts could be called for presentation in the next meeting, especially on QCA criteria and de-pooling arrangements for implementation of State level RE forecasting and scheduling.
7. The next meeting of the Committee shall be held on **18th March, 2016 at CERC.**

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

Minutes of the fourth meeting held on 01-06-2016

1. The fourth meeting of Technical Committee for implementation of Framework for Renewables at State level was held under chairmanship of Mr. A. S Bakshi, Member, CERC on 1st June 2016. Mr. Bakshi welcomed all the members and informed that M/s. Idam Infrastructure Advisory Private Limited (Idam Infra) in consortium with The Energy Resources Institute (TERI) has been hired as Consultant to the Technical Committee. Dr. S K Chatterjee, JC (RA), CERC introduced Mr. Ajit Pandit, (Director, Idam Infra) to the committee members.

Discussion

2. Mr. S.K. Soonee, (CEO, POSOCO) presented the progress update and informed the committee about Sub-committee's visit to SLDCs of Maharashtra, Tamil Nadu, Karnataka and Delhi. Interaction with several other States happened via video conferencing. He further elaborated upon the meeting with Forum of Load Dispatchers (FOLD) along with the SLDC survey for benchmarking and scale of operations in which 25 entities participated (including DVC). Based on the findings of the Sub-committee, a draft report has been prepared and circulated. Subsequently, the learnings have been used to evolve a Model Energy Metering Accounting and Settlement System (E-MASS) (the presentation is **attached** as **Annexure-II).**
3. The importance of defining interface points and ensuring main, check and standby meters at all points was highlighted. In addition, Automatic Meter Reading (AMR) should be deployed, but currently only ten States have it. Similarly, communication links have to be strengthened to ensure optimum use of AMR.
4. Mr. Soonee emphasized that it is time that the concept of Distribution System Operator (DSO) should be introduced in India, especially with expected large scale deployment of rooftop solar projects. DSO will be an independent operator having no conflict of interest. Mr. A. B. Bajpai (Member, MPERC) suggested that DSO has to be acknowledged in the regulations. Mr. Deepak Lad (Member, MERC) expressed concern over the ambiguity between scope of SLDCs and DSO. It was clarified that DSO will report to SLDC and the State Regulator. In a way, DSO may act as sub-SLDC.
5. It was discussed that Hydro Power plants must be incentivized when used for peaking as they are supporting the grid during critical times. This may be incorporated in the overall tariff structure.
6. Mr. Soonee expressed his concern that during production cost modeling the RE production cost is taken as zero. This creates a discrepancy in the accounting and settlement. Secondly, it was underscored that no entity should be exempted from submission of deviation data irrespective of whether they are being penalized for default or not.
7. It was also proposed that India should adopt a 5 minute settlement period instead of 15 minutes for better granularity and ramp monitoring. Mr. R. R. Rathode (Member, RERC) expressed concern on the readiness of States to implement this. Mr. Soonee suggested that it can be implemented in a phased manner. This may sensitize the manufactures and SLDCs to adopt the same for further installations.
8. Mr. Soonee acknowledged that the Ancillary Services Regulations have benefitted the sector and the results are encouraging. He also emphasized that a slight error in metering will be always there and must be accepted within the limits as unsettled account.
9. Mr. D. B. Manival Raju (Member, KERC) informed that KERC has issued final Regulations on Scheduling, Forecasting and Deviation Settlement of RE sources.

Decisions

8. It was agreed that States shall give their feedback and comments on the draft report within 15 days.

9. Interaction of Sub-Committee with SLDCs in West Bengal, Rajasthan, Meghalaya is expected to be complete by 15th June 2016. Submission of final report to the Committee will happen by July 2016.
10. The Consultant shall visit Tamil Nadu and Madhya Pradesh and shall present their findings at the next meeting. The Consultant shall prepare Model Regulations and Procedures over the course of the project and guide the SLDCs in preparation of DPR for States, if required.
11. It was suggested that funds for roll-out of E-MASS may be requested from a Central Government fund, such as the PSDF. In this context, it was emphasized that the States must hire and build out the requisite team, as suggested by POSOCO, for planning and implementation at the State level.
12. It was agreed that there is an urgent need for an autonomous organization which will handle all Information Technology (IT) related projects and requests from system operators and manage a centralized database system for Power Sector. Such a body will have experts from IT and Power sector, akin to the Centre for Railways Information System (CRIS), that develops and manages all IT applications for Indian Railways. This may be one of the recommendations of the final report.

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

Appendix-3: SLDC Interactions - Discussion Notes

1. Background

The sub-committee visited/interacted with State Load Despatch Centres of Maharashtra, Tamil Nadu, Karnataka, Delhi, Gujarat, Madhya Pradesh, Andhra Pradesh, Telangana, West Bengal, Rajasthan and Meghalaya to study the prevailing set up for scheduling, dispatching, metering, energy accounting and settlement system within the State. The prevailing status of sub-committee interacted with the SLDC personnel to understand the challenges faced and to deliberate on the likely solutions.

1. SLDC Maharashtra- 23.01.2016

The sub-committee visited SLDC-Kalwa on 23rdJanuary 2016 and interacted with Director (O), MSETCL, Chief Engineer (LD), MSETCL and other senior executives and staff members of SLDC Kalwa. Representatives from WRLDC-Mumbai were also participated. The highlights of the Settlement Mechanism implemented in Maharashtra and the challenges being faced at the SLDC are as below:

Pursuant to the MERC Order in Case 42 of 2006 dated 17 May 2007, Intra-State Settlement mechanism was implemented in Maharashtra in August 2011. The mechanism was implemented in two phases, Interim Settlement Mechanism (from October 2006 – July 2011) with monthly settlement and Final Settlement Mechanism (from August 2011 onwards) with 15-minute block-wise settlement. Settlement period is 15-min and the settlement cycle is weekly. Generators having long term contract with discoms are not subjected to imbalance charges. Their actual generation is allocated to beneficiaries. These generators are immune to the deviations of the State Grid with the Regional Grid. All RE power categorized as in-firm, have also been exempted from imbalance charges (actual energy allocation). The Pool is balanced in terms of both energy as well as charges. State wide Merit Order Dispatch (MOD) is followed by declaring 'ex-ante' prices of the pool. The rates of settlement are not linked to frequency, but are computed on marginal costs of utilities incrementing (having positive imbalance) with the State pool. Under the Final Settlement Mechanism the settlement takes place in following three parts-

- Pool UI – Difference between actual energy drawal and available energy- (at SMP)
- Net UI-1- Deviation from Scheduled drawal -(Pro rata)
- Net UI-2- Deviation from Scheduled generation (to be borne by Discoms only) -(Pro rata)

Metered transmission loss of the intra State System is allocated amongst the State pool members on pro rata basis.

There are around 43 wind energy and 10 solar energy pooling stations and around 8-12 numbers of 33 kV feeders at each station. Several turbines of different owners/ developers/ make are connected on each feeder (typically 33 kV). At some old stations, feeders have wind generation and discom load also. Thus there could be different PPAs of generators connected on a single feeder viz. CPP; OA (third party); Preferential tariff with discom; APPC with discom; Inter-state (CPP/Third party/discom). The other challenges being faced by the SLDC Maharashtra during energy accounting and settlement are as under:

- Difficulty in metering of unit-wise ex-bus generation
- Difficulty in accounting and settlement of deviations caused by non-pool consumers
- Dispatching as per Merit Order when there is difference in the settlement rates at the regional periphery and the System Marginal Price at the State level

- Dispatching as per Merit Order within the ramp rate constraints of generating stations
- Computation of System Marginal Price during real-time with inadequate IT infrastructure
- Computation of Settlement rate in case utility demand is less than technical minimum for all sources
- Regulation of intra State hydro generation such as Koyna (having long term PPA with only one discom) for controlling deviation of the entire State at the Regional periphery
- Rate of derived for final settlement may be different from the System Marginal Prices declared 'ex-ante'
- Settlement of entities connected on a common feeder but having different types of PPAs
- Treatment of OA generators frequently changing status between inter-State / intra-State transactions
- Administration of deviation charges (DSM as well as RTDA) and congestion charges among the State pool members on account of deviations at the State interface with the Regional Grid
- Post facto administration of metered transmission losses
- Vetting of the weighted average rate (of Preferential/APPC) computed by the Qualified Certifying Agency by the SLDC
- Validation of the Available Capacity declared by the RES by SLDC
- Order dated May 17, 2007 in Case No.42 of 2006 for introducing availability based tariff in Maharashtra. Main highlights with regard toextending this arrangement to generating station are as follows:
- Settlement of deviations is done on weighted average systemmarginal price in Maharashtra in order to ensure proper economicsignal to market participants.
- Distribution licensees and the transmission open access users(subject to fulfillment of certain qualification criteria) operating withinelectricity market of Maharashtra shall be state pool participants.
- Generators are not considered for imbalance pool settlement.Similar treatment is given to RE generators.
- With regard to CPP using conventional power sources, deviationson transactions will be accounted at the consumer end as in case ofdistribution licensees.
- Whereas the Commission in its Order dated 11 April 2014, CaseNo.56 of 2012 noted that all members contributing to deviation in the system should be pool members. The Commission envisages the migration to the new frequency linkedIntra-State ABT mechanism to be in two phases:
    - Phase I – Implementation of scheduling and frequency linked deviation settlement mechanism;
    - Phase II – Implementation of Sate level customization for improvingthe BSM after ensuring successful implementation of Phase-I.

2. SLDC Tamil Nadu – 30.01.2016

The sub-committee visited the SLDC Chennai on 30th January 2016 and interacted with Managing Director, Director (O), Chief Engineer (Grid Operation) and other senior officials of SLDC/TANTRANSCO. Few staff members from TNERC and

representatives from SRLDC-Bengaluru, WRLDC-Mumbai also participated. The highlights of the discussion are as given below.

The committee was apprised that Tamil Nadu had been a pioneer in promoting Renewable Energy Sources in the country and they were also promoting open access transactions below One Mega Watt (1 MW). Presently Load forecasting is being done by SLDC on 15-minute block in consultation with TANGEDCO (Sole DISCOM). Scheduling of 63 number of intra-State conventional generating stations is being carried out by SLDC with the help of software developed in house. On behalf of RE generators, National Institute of Wind Energy (NIWE) has taken up a pilot project for RE forecasting (only for wind generation, not for solar) to the entire state. The forecasts are being forwarded to SLDC on an experimental basis (Corresponding to the 2/3 quantum of RE Generation, expected to complete the balance 1/3 quantum also by February 2016). Tamil Nadu allows the private RE developers to bank the surplus energy for the whole financial year (April – March) with generation in 4 or 5 months only. When the developers draw this banked energy during the peak season it leads to financial losses to TANGEDCO.

Tamil Nadu SERC had issued draft regulations for implementation of ABT/DSM and for Forecasting, Scheduling, Deviation settlement Mechanism and related matters of Wind and Solar Energy Generation sources in Tamil Nadu. SLDC Tamil Nadu has started working towards implementation. Challenges envisaged in rolling out of the new regulations are as under:

- Conversion of single part tariff to two part tariff
- Settlement of Energy Banking Contracts
- Segregation of distribution boundaries, Identification of Intra State Entities
- Assessment of interface energy meter requirement
- Energy Meter procurement, testing and installation
- Creation of IT infrastructure (hardware and software) for scheduling, energy meter data collection, processing, validation, energy accounting, billing and settlement
- Telemetry of interchange by Intra State Entities with Grid
- Conducting mock exercises, testing
- Procurement and deployment of Load Forecasting software
- Limitations in exploiting the inherent flexibility of hydro stations due to the single part tariff for hydro
- Valuation of flexibility services required - Ramping, Peaking, Load following etc.
- Preparation Open Access schedules for every settlement interval
- Treatment of Tax, Interest on pool accounts maintained by SLDC to be elaborated in the regulations
- Supervision of energy leakages with the help of off line simulation, State Estimator, Energy Meter
- Meter testing, calibration, maintenance
- Ensuring regular update of software as per the changes in the regulations and ensuring scalability of IT systems deployed
- Demarcation of distribution Zones for demand forecasting, demand management, evolution of DSOs in future

3. SLDC Karnataka- 15.02.2016

The sub-committee visited the SLDC Bengaluru on 15th February 2016 and interacted with Chief Engineer (LD), KPTCL and other senior officials of SLDC. Few staff members from KERC and representatives from SRLDC-Bengaluru, WRLDC-Mumbai also

participated. Representatives of SLDC, KPTCL gave a presentation on the profile of the Karnataka power system and the energy accounting and settlement system in place. The highlights of the discussion are given below.

- One State owned Generation Company KPCL and one Transmission Company KPTCL. SLDC is under the control of KPTCL
- Five Distribution companies viz BESCOM, MESCOM, HESCOM, GESCOM and CESC and very few Private players (Jindal). The purchases for the DISCOMs are made by an entity known as PCKL
- Load forecasting based on historical data and generation availability for Next day. Forecasting for wind & solar is not in place
- Transmission company controls upto 11kV feeders
- All generators [excluding wind and minihydel] with installed capacity 25 MW & above connected to the Grid are scheduled and dispatched by SLDC. Intra-state ABT shall be applicable to the following:
    - All ESCOMs and Hukeri Society
    - All State owned generating stations –25 MW & above
    - IPPs of 25 MW & above
    - Bio-mass and Co-generation plants of 25 MW & above.
    - CPPs supplying power to the grid-25 MW & above
- Hydro excluded for a period of one year from intrastate ABT due to certain issues in implementation of Interstate ABT in NER Hydro
- Joint Responsibility for implementation given to KPTCL and ESCOMS, But Ultimate responsibility on SLDC
- CERC DSM charges applicable on STOA customers.
- 2244 Interface billing meters are already in place on the LT side of 66/11 kV and 110/11 kV transformers. HT side meters are not ABT compliant. Only Main meters are available. No check meters/ standby meters. There are plans to install billing meters and shift the discom metering point to HT side.
- AMR for 60-65 % meters already in place
- SCADA is available for generation upto 11 kV
- Detailed real-time data available on SLDC. Distribution Control Centres with full visibility of network are in place and functional 24x7
- Generally load shedding free supply
- The entire process divided into three basic processes viz Scheduling, Monitoring and Billing
- Day ahead schedule / Entitlement from SLDC as per allocation on declared availability of Generation
- There are two set of Allocation of Share from KPCL stations/IPPs is given by Government of Karnataka
    - One set used for Real time drawal Schedule (as per their last 5 years demand)
    - Another set used for Commercial Purpose for payment of Bills (to offset based on financial conditions of Distribution company)
- Implemented Schedule on Real time, considering
    - Actual State and IPP Generation & ESCOM wise allocation as per PPA / G.o.K directives using SCADA Real time data
    - CGS as per schedule.
    - Power Exchange /IEX purchases of ESCOM s
    - NCEPs as per ESCOM wise PPAs using SCADA Real time data
    - Open Access schedule as per agreements.

  - Wind generation taken at injection points from pooling stations.
- Resource scheduling for discoms done as per allocations by Govt of Karnataka. These schedules used for operation purpose only. Implemented schedule is the actual schedule which is considered for Billing
- The real time telemetry of 220 kV transformers, Inter ESCOM flows, IPP injections both direct and calculated, CGS Actual flow are available for monitoring at SLDC. Displays created for monitoring are as under
  a) Day ahead schedule (Entitlement) & Implemented Schedule.
  b) Inter Escom flows
  c) CGS Schedule and Actual with latest revision
  d) Frequency and corresponding Deviation rate
  e) State demand in MW
  f) Actual Load & Deviation in MW
- All 33kV substations and 11kV and Above Generation covered under SCADA. SCADA transducer 0.2% class accuracy is installed as per KPTCL. Infrastructure is good, No issues
- At the end of the month, meter data is collected at the Energy Billing Centre. Meter reading reconciled through negotiation meeting
- Implemented Schedule which is actual schedule based on real time availability, is considered for Billing Schedule. Minute wise actual generation of RES is considered as implemented schedules for settlement. Billing for RES done on monthly energy injected/drawn
- Energy meter reading of 220 kV transformers, Inter ESCOM flows wherever available is considered. In absence of meter data, SCADA data of 15 minute block is used. SCADA 15 minute Energy parameter of IPP / NCEP generation below 220 kV level is considered for Actual consumption of each ESCOM. Manually downloaded data of those IPPs who are not integrated in SCADA are considered.
- CGS Schedule, Actual & Deviation at the interstate periphery is used as declared by SRPC in their website. Proportionate Intra State ABT and deviation is arrived at considering the drawl of each ESCOM in the block and the CGS deviation in the block. The Energy overdrawn / underdrawn by ESCOM as against its schedule is computed.
- State hydro tariff ~ 64 paise/unit, single part tariff
- Net settlement by SLDC
- Deviation charges already applicable for STOA consumers
- Based on energy consumption & paying capacity of the discoms final allocations is issued by Government of Karnataka with the objective is to rationalize tariff. However this is tantamount to post-facto change in allocations of discoms.
- The allocation used in settlement and billing is different from that used in operation. Thus there are post facto change in schedules except the schedules for STOA contracts
- Deviation settlement is done in two parts. Deviation Bill negligible
  - Component-1: Deviation of the State as a whole apportioned to ESCOM in proportion to implemented schedule and actual.
  - Component-2 : For the Energy overdrawn / underdrawn by the ESCOMs from the State Energy pool, the applicable rate is Average Purchase Cost + Nominal Deviation rate in that time block
- Billing cycle is as under

  - The CGS implemented Schedule, Actual and deviation is provided by SRLDC /SRPC which is two weeks following the billing week period.
  - The CGS implemented Schedule, Actual and deviation, is an input for generating the Intra State ABT bill.
  - The two components of the Intra State ABT Bill will be generated on the third week following the Billing week as the CGS data is available only after two weeks following the Billing week.
  - Truing done on monthly basis
- Intra State transmission losses computed on monthly basis (in the range of 3-4 %)
- No Interstate sale/purchase RE
- No documented intra State Constraints
- Deviation control with reservoir based hydro such as Sharavathy,
- 9 out of 10 units of Sharavathy always on bar, Good FGMO response observed
- Intra State Transmission Charges on MVA
- Issues is backing down of thermal generation in the absence of enabling regulations
- Concerns raised regarding inflexible Kaiga Nuclear Station, Karnataka being in highest slab of PoC Charges and Losses unlike Kerala
- Concerns raised regarding variations in Solar generation due to sudden cloud cover
- Govt. of Karnataka had notified implementation of intra-state ABT w.e.f. 01.02.2016. Three-part tariff for State thermal generating Stations is proposed for implementation w.e.f 01.04.16. SLDC is preparing the Energy Account and the Deviation Account. However, the applicable deviation rates are yet to be notified.

4. SLDC Delhi – 10.03.2016

The sub-committee visited the SLDC Delhi on 10th March 2016 and interacted with General Manager and other senior officials of SLDC Delhi. Few staff members from DERC and representatives from NRLDC-Delhi, WRLDC-Mumbai also participated. Representatives of SLDC, Delhi gave a presentation on the the energy accounting and settlement system in place. The same is enclosed. Following points were gathered from the presentations and discussions.

ABT/UI mechanism was rolled out in Delhi w.e.f 01st April 2014. Initially it was applicable for Badarpur Thermal Power Station (Central Sector Station with 100% allocation to Delhi) only. Installation of energy meters for all other intra State Entities was completed before 01st April 2007. Thus jurisdiction was clearly defined with placement of interface meters before commencement of intra State ABT for discoms and other intra State generators.Transition was handled successfully.

- Inter DISCOM Transfer-1. (Facilitation of Intra -state market by System Operator). Takes place on Day Ahead Basis. No revisions allowed.
  - Each DISCOM informs about its Surplus and Deficit to SLDC on Day Ahead Basis. Any excess capacity in the hands of any of the Distribution Companies / Agency, at any time, is offered to other Distribution Companies in Delhi, before it is sold outside the State.
  - The needy DISCOMs places their requisition to SLDC for the next day.
  - SLDC distributes the individual surplus to needy DISCOM based on Weighted Average Entitlements as per the DERC order dated 31.03.2007. Inter Discom power Transfer is finalized by SLDC.
  - The Inter Discom transfer takes place at the rate of IEX + 10 paise/unit (based on the order issued by DERC on 28.11.2013) with the settlement mechanism same as that of the Energy Exchange.
- Inter DISCOM Transfer-2 (Post Facto Settlement mechanism)

  - The Inter Discom Transfer of surplus energy is drawn out to avoid the penalties for Over-drawl and Under-drawl as stipulated in the Deviation Settlement Mechanism Regulation notified by CERC:
  - SLDC draws out the surplus / shortages of Individual Discoms from their Final Implemented Schedule and Actual Drawl based on SEM reading. Based on this shortage/surplus SLDC shall distribute the individual surplus to the needy Discoms when both surplus and needy Discoms violate the limits specified in Deviation Settlement Mechanism Regulations.
  - The rates would be as per the rates mentioned in Deviation Settlement Mechanism at each frequency regime.
- Lag in Issue of DSM account by 6 to 7 weeks.
- Excel Based programme presently being used for energy accounting and settlement.
- Main and check meters installed but Standby meters not installed in the State. Discom meters used in case of main/ check meters showing incorrect readings.
- Loss Computation presently done on daily Basis (not on 15-min Block basis).
- Average of the previous year loss used as loss figure for the present year.
- There are presently three intra-state Open Access Customers (of > 1 MW) in the State. 18 new intra-state open access customers have applied for the license. Out of these 18 customers, 7 to 8 OA customers will start their transactions within 2 to 3 months time.
- SAP Attempted but not implemented.
- Some lag, Some issues in scheduling of Bawana and ER generators

Few of the Key learning from the interaction are listed below:

- Accreditation / Process Audit of Energy Metering, Accounting and Settlement System essential for risk mitigation
- Most interface points in Delhi are 220/66 kV or 220/33 kV Transformers
- SLDC is collecting only the data from Main and Check Meters. LT side meter data taken only in case of exception
- Computation and trending of transmission loss for each time block could be used for probity check
- Error Detection to be Institutionalized
- Payment Security Mechanism for all Pool Accounts to be mandated
- Delayed payments and defaults by discoms in Delhi
- Market Discovered price could be used as a reference price for day-ahead bilateral contracts
- Approved by DERC
- Coarse Optimization: Shortage-Surplus settled within the State first. PX rate minus 10 paisebeing used as Energy rate for Day-ahead Inter-Discom Transfer in Delhi (IDT-1). The methodology is approved by DERC.It appears to be a better solution as compared to invocation of Sec 11 of EA by Govt in some States in the past. Though mechanism working dispute free but may have issues in case of large change in availability. Earlier proposal of indexing the real-time inter State Deviation rate with market discovered MCP could be re-visited.
- Implementation of "Causer pays principle" in true spirit is desirable for bringing accountability in entities
- Delhi's deviation at Regional boundary being apportioned among discoms in proportion of weighted average entitlement.
- Vulnerable to disputes in future with increase in awareness and stakes

- It tantamount to - Disciplined Discoms shielding indisciplineddiscoms
- Post facto changes in reference quantities defeats the objective of bringing in behavioural change envisaged in the ABT mechanism
- Though process is transparent yet self computation of bill is difficult - thus it increases challenges in reconciliation
- Incentive for disciplined Discom (for accurate load forecast, demand management, operation etc) getting diluted
- Valuation of Flexibility and Ancillary Services required for handling demand variability
- Delhi has above average density of commercial/domestic load
- Delhi is low on RE but diurnal and seasonal variation in Delhi demand is high (from 1300 MW to 6500 MW...five times)
- Demand highly weather sensitive and hostile
- Peaking Tariff, Ramping and Regulation Service required
- Mechanism for Intra State Congestion Management to be envisaged
- By and Large intra State network within Delhi congestion free because of open 220 kV loops
- Likely congestion consequent to loss of BTPS
- IT Logistics to be strengthened :In house developed MS Excel programs serving the purpose to bridge the transition. However data security, data archival, big data processing a major issue with in house solutions. Over engineered off-the-shelf IT solutions may fall flat during implementation (resistance to change, dynamic regulations). Experience of SAP at SLDC and RIMS at DERC unsatisfactory. Software should not dictate the mechanism. Robust, Flexible, Scalable database solutions desired (REC experience relatively successful)
- Activity listing, Model Functional architecture required for all SLDCs

5. SLDC Gujarat – 10.05.2016

The sub-committee interacted with the Chief Engineer, SLDC Gujarat through Video Conference on 10th May 2016. Representatives of WRLDC, NLDC also participated in the discussion through VC. The challenges being experienced by SLDC Gujarat as enumerated by SLDC team were as under:

- Monitoring and collection of data from large number of intra State interface points is a major challenge in absence of AMR.
- Maintenance of Old meters is difficult due to Interoperability issues
- Difficulty in detecting bad meter data even from 15-minute transmission loss OR even when meter at both end
- Difficulty in detecting time drift from frequency code of the block (since average frequency remains 50 Hz most of the time)
- Difficulty in full recovery of DSM charges due to absence of Payment Security Mechanism
- Difficulty in closing the Energy Account due to revisions in regional energy accounts, changes in bifurcation of RE generators (de-pooling based on actual energy)
- Achieving Merit order dispatch due to due to diversity in allocations is challenging
- Maintaining telemetry particularly from RES
- Absence of Spinning reserve, Pumped Storage

During deliberations SLDC Gujarat agreed on following points

- Suggested changes in Technical Specification of meters in respect of 5-min, GPS synchronization, recording of voltage/kVAr etc.)
- Need for Operational Planning, Rolling schedule say Week-ahead OR D-3 scheduling
- Scientific Algorithm for bad meter data detection (similar to State Estimation in SCADA)
- Further discretization of scheduling and settlement period from 15-min to 5-min (though computational and other challenges increases)
- Need for Reserve Fund at State Level to avoid frequent revision in State Pool on account of revision in super pool or revision in a/c of certain pool member
- Need for process audit and formation of Expert Group of SLDC/RLDC personnel for process audit
- Payment Security Mechanism for Pool A/c
- IT partner (SLDC already has a contract with Infosys for scheduling, Open access, accounting etc.)
- Combined meeting of WR States- Maharashtra, M.P. Gujarat, Chattisgarh on Intra State ABT issues.
- Discussion of draft report at FOLD before putting up to FOR

6. SLDC Madhya Pradesh – 12.05.2016

The sub-committee interacted with the Chief Engineer, SLDC Madhya Pradesh through Video Conference on 12th May 2016. The representatives of WRLDC, NLDC also participated in the discussion through VC. The highlights of intra State ABT and DSM implementation in Madhya Pradesh are as under:

- MP was the first state in Western Region to implement full-fledged Intra state ABT w.e.f 30.10.2009.
- Rigorous ground work was done by SLDC prior to implementation. It involved Mock drill for 2 years & several workshops & orientation programmes with stake holders (DISCOMS, IPPs, OA customers, GENCOs)
- ABT/DSM are applicable to intra-state entities (3 DISCOMs, 1 SEZ, some of the hydro stations – Indira Sagar Hydro PS, Open access customers). Hydro stations of MPPGCL, Omkareshwar Hydro PS & RE generators including Biogas /Biomass stations are exempted at present.
- Grid Access to new intra-state entity is being granted after due compliance to telemetry & metering (with AMR facility) requirements.
- Scheduling coordination including information exchange (Requisition/ schedule etc.) is being done through email. Web based scheduling is envisaged in near future.
- There is a provision for change in allocation by MPPMCL among the 3 DISOCOMs during the day.
- Energy & deviation Accounting (viz. SEA, DSM, SRA, Transmission Loss accounting) is being done on monthly basis. Pool account management & reconciliation is being done by MPPMCL.
- 80-85% meter data collection is being done through automated meter reading (AMR) & rest is through manual data transfer via email.
- All (~2862 MW) Renewable energy (RE) generators are metered except a few connected at lower voltage level (below 33 kV).
- SERC has adopted the FOR evolved model regulation (on RES) & the draft has been issued on 08.12.15 with slight modification w.r.t. the deviation charges slabs for RE generators for different ranges of absolute errors.

- Deviation accounting of solar power scheduled beyond the state boundary is being done at par with that for conventional generators.
- 2-part tariff structure is in place for hydro stations.
- Accounting & billing of (state) transmission charges is being done by STU.
- SLDC fees & charges are applicable to DISCOMS only in the ratio of allocated transmission capacity. Capex is not a part of SLDC fees & charges & is approved separately (on 5-yearly basis) by SERC.
- Intra-state Ancillary Services: Draft regulation has been released by SERC.
- Total Human Resource deployed (SLDC & back-up SLDC): 131 (45 executives & 86 non-executives).
- IT Expense in ABT/DSM Implementation: Project Cost: 4Cr (including AMC for 7 years), Vendor :Kalkitech. This package (procured in 2006 & due for up-gradation in 2016) covered modules for ABT, DSM, Open Access, Outage Planning.

The challenges in implementation of intra State ABT/DSM in M.P. are as under:

- Lack of redundancy of interface meters (no provision for standby meters in state regulation) is a major challenge in meter data validation. However they have made amendment in the state settlement code (BSC-2015) to deal with erroneous meter data by computed/assessed figures.
- Meter Data collection from a large number of remotely located meters with communication bottleneck.
- Unavailability of interface meters on LV side of transformers – May require amendment in regulation.
- Deployment of manpower of requisite quantity & quality – Separate recruitment for SLDC was suggested.
- Implementation of requisite software & its customization while addressing issues like scalability & adaptability with respect to change in regulatory regime & several other factors.
- Handling excessive & frivolous schedule revisions from variable RE generators (88 pooling stations in MP) in real time: CE (LD) suggested to make such requests for schedule revision chargeable so as to act as deterrent. However it might require further deliberation in view of the associated issues like taxation, post facto reconciliation and more.

Other issued deliberated during the discussion

- Exploring the concept of IT-partners in view of the need for sustainability, replicability & scalability of the software used by LDCs.
- Need for vendor development workshops under the aegis of FOLD.
- Detailed deliberation of all generic issues of SLDCs & their compilation for putting before the Forum of Regulators (FOR).
- Need for moving from 'compliance' to 'excellence'.
- Use of State Estimation techniques for Meter data validation (bad data filtering etc.)
- Need for process audit & provision for maker-checker philosophy in scheduling & energy accounting.
- Realistic Estimation for manpower considering all present & future activities for a robust EMASS.
- Need for sensitization of SLDC functionality in all relevant forums.

7. SLDC Andhra Pradesh and Telangana – 27.05.2016

The sub-committee interacted with the representatives of SLDC Andhra Pradesh and Telangana jointly through Video Conference on 27- May 2016. Representatives of WRLDC, NLDC also participated in the discussion through VC. Both the States have

similar intra state settlement system. From the discussion, it was understood that the existing Settlement System in Andhra Pradesh and Telangana covers only the monthly settlement of Energy between Discoms. Energy Settlement of active power is done for every 15-min time block. The Energy account provides the details of energy consumed by the Discoms with respect to their allocations; the extent of Discom deviations w.r.t. their load forecast; the generator deviations w.r.t. their schedules; The loss incurred by the Discoms in 15min time block wise w.r.t. their power purchases.

The feedback of the representatives of Andhra Pradesh and Telangana for overcoming the prevailing limitations and challenges in implementation of Intra-State ABT is listed below:

- All the generators and distribution licensees within the State have to be covered under the ambit of Intra State Settlement System.
- Intra State Deviation Pool account is to be created.
- All the Generators and entities connected at 132 kV and 220 kV level shall be made members of the Intra State Deviation Pool account pool members. Applicability of ABT for embedded generators in the Discoms, HT consumers also to be decided.
- Suitable software need to be developed and deployed. Preferably the software shall be common to all states.
- At present only Main meters are existing at the T-D boundary points. Check meters have to be installed for T-D boundary points where ever required as per CEA regulations. Main, Check and standby meters are existing for most of the generating stations connected to STU network. Check & Standby meters are to be installed wherever mandated.
- Delay in collection of MRI data for all the boundary meters from field could be avoided with the help of AMR infrastructure. In the absence of AMR infrastructure, additional manpower (or outsourced staff) should be deployed to download and collect the meter data on weekly basis for weekly settlements. Else, the deviation settlement may be done on monthly basis instead of weekly.
- Technical specification for Interface Energy Meters should be standardized for all States.
- Load forecasting and RES forecasting is required in view of large quantum of envisaged Solar and Wind generation.
- Presently AP Power Purchase Co-ordination Committee (APPCC) purchasing power on behalf of both Discoms and sharing it as per their allocations. Instead, the purchased power shall be allotted to Discoms on day-ahead basis as per their anticipated requirement.
- Existing long-term PPAs should be aligned to implement three part tariff covering Fixed Charge, Energy Charge and Deviation Charge.
- SLDC loses operational flexibility if all the generators and beneficiaries comes under ABT/Deviation Settlement System. Therefore, Ancillary Services is must for load generation balance within the State. Ancillary Services similar to the RRAS mechanism should be in place at the intra State level to cover the intra State Generators.
- In case of forced outage of any generator, while system is operating at lower frequency, SLDC is requesting discoms for load shedding immediately but in ABT regime SLDC can reduce schedule only after four time blocks. This point also may be taken care in implementation.

8. SLDC West Bengal – 09.06.2016

A meeting of the Sub-committee with SLDC West Bengal was held at ERLDC Kolkata on 09-Jun-16. The meeting was chaired by CEO, POSOCO. Sh S. K. Chatterjee, Jt. Chief (RA), CERC, representatives from WBERC, WB-SLDC, GM, ERLDC and other officials

from ERLDC were present. NLDC and WRLDC representatives participated through Video Conference.

It was an interactive session with deliberation on several aspects of the existing scheme of scheduling, metering, energy accounting, deviation settlement, taxation in West Bengal. During the meeting the way ahead in meeting forthcoming challenges in accommodating the deluge of Open Access application, renewable integration, forecasting, development of intrastate ancillary market, utilization of flexibility of pumped storage hydro towards achieving overall reliability and economy was also deliberated. Highlights of the discussion are as under.

- Intrastate ABT is implemented since 1st April 2008.
- Deviation Settlement Mechanism of CERC is followed by WBERC at intrastate level
- Intra-state entities : 4 DISCOMs & 5 GENCOs (1 solar plant - SIIPL Durgapur of 5 MW), NIL - OA customers
- No deviation charge is applicable on Solar generation up to 10 MW. DSM liability is transferred to DISCOMs.
- Load forecasting is yet to be commenced at SLDC.
- Energy Metering: Presently there are main & check meters at more than 150 locations. 100% boundary metering is yet to be achieved. Data conversion is done through manufacturer software & further meter data processing is done by in-house software. Error detection is being done through cross checking for '0' meter data, Main vs Check comparision, CT/PT failure flag (*). Chairperson emphasized the provision for maker-checker system & auditing of meter data.
- Energy Accounting: SLDC issues weekly deviation account, Monthly DC certificate & scheduled energy certificate for all intrastate LTA transactions, certificate for Solar Energy Injection (Schedule =Actual);
- ALDCs despatch intra-DISCOM generators & factor in merit order in managing power purchase profile of the DISCOMs.
- SLDC follows a system of Nominal DC / Actual DC declaration on day ahead basis to take care of availability in case of fuel shortage scenario. It was pointed out that since the state regulations lacking provisions for DC demonstration, higher peak DC that off-peak, definition of Peak duration etc, (unlike IEGC), it might lead to gaming by the generators.
- Issue of negative pool component out of intra state DSM pool was especially highlighted by SLDC representative. Chairperson advised WBSLDC carry out the analysis for an extended period rather than only a single time block. Any DSM pool, by design must be non zero & positive in long run, barring short term excursions on either side. He highlighted the need for introduction of hysteresis among payables & receivables wrt the pool so as to bring in discipline into overall system operation & pool administration. Chief (RA), CERC also advised in similar lines that SLDC may adopt basic principles of the CERC Regulation and at the same time address their state specific constraints so as to evolve a sustainable regulatory regime at intra-state level.
- Annual loss is approved & declared by the state Commission which presently stands at 3.1%. Chairperson emphasized the need for SEM data based (15 min block wise) loss accounting by SLDC.
- SERC declares annually & same is applied as STU charge. (STU charge @ Rs.1234 /MW/day)
- Billing. collection & Disbursal: Done by Accounts Officer at SLDC.

- Taxation Issues: WBSLDC had in past raised the taxation issues being faced by SLDC (as a facilitator of pool a/c settlement) with IT dept & got exemption u/s 10(46) of IT-Act 1961. SLDC agrred to share the document received from IT dept.
- Intra state Ancillary Market: Chief (RA), CERC advised for having provisions in State Regulations for tapping the potential of PSP hydro stations (viz. Purulia) by trading its services in the proposed intrastate ancillary market. He emphasized on the need for separate tariff determination for PSP-Hydro stations by the SERCs & development of a complementary market mechanism so as to fully utilize the flexibility of PSP stations thereby contributing to overall economy in the state.
- Manpower: Presently 31 engineers (AE/DE/SE) are deployed at SLDC with Zero Certificaton. Out of these, 23 are into real time operation & rest are managing off-line functions of SLDC.
- Annual SLDC Fees & Charges: Rs 1601.64 Lakh for last FY
- Annual SLDC Operating charges collected: Rs. 35.5 Lakhs.(@ 0.5 p/unit)

9. SLDC Rajasthan – 10.06.2016

The sub-committee interacted with SLDC, Jaipur, Rajasthan on 10 June, 2016 through Video Conference. The meeting was chaired by CEO POSOCO from ERLDC Kolkata with active participation from officers from SLDC Rajasthan, ERLDC, NRLDC, NLDC, WRLDC. Various aspects of implementation of intra state ABT, scheduling, forecasting & imbalance handling, installation of a robust metering infrastructure & enabling regulatory provisions at intra-state level was deliberated. Summary of the discussion is as under.

- Chairperson explained the objective of the subcommittee in identifying & bringing forth before the FOR committee, the generic & specific problems being encountered by the states, while picking up strengths & best practices being followed so as to devise a road map for a robust energy accounting & settlement system.
- Basic objective of any accounting system is to have clarity & transparency as to 'whom to pay', 'who is to pay' & 'in which way' with provision for adequate checks, balances at every stage.
- SLDC personnel clarified that Intrastate ABT regulation is in place but is yet to be implemented. Tendering is underway for the procurement of requisite infrastructure.
- There is a plan for installation of 5000 TOD meters at 184 identified (boundary points) locations out of which 525 meters are ABT compliant. They agreed to comply to CEA metering standards while installing the boundary meters.
- Presently the regional DSM liability is being transferred to the 3 DISCOMs of Rajasthan on prorate basis.
- Meter Data Processing: A separate department is yet to be established for meter data processing at SLDC.
- Scheduling
    - Conventional generators are being scheduled by SLDC;
    - Scheduling of RE generators are being done on trial basis;
    - Individual Entity based scheduling is the next step envisaged by SLDC;
- Chairperson advised that any 'scheduling' be it for conventional generators, load entities, RE generators, must be backed by 'forecasting' so as to add credibility to it. Further, enabling regulatory provision is an imperative for implementing 'real time revision & post facto reconciliation' of 'schedules', duly factoring in the transmission loss measured on a periodicity of 15 min. through adequate boundary metering.

- Deviation handling: State level DSM is yet to be implemented in Rajasthan. It shall be in line with CERC regulations. For RE generators they are about to adopt the FOR evolved model regulation which envisages an absolute error based deviation settlement mechanism.
- Chairperson opined that design of any intrastate DSM has to essentially ensure
  - Power purchase portfolio management by DISCOMs on merit order,
  - Non zero & non negative pool by design by introduction of hysteresis (in terms of time & money) between payables & receivables so that pool remains surplus at any given time.
- IT Infrastructure : SLDC has envisaged separate staffing for implementing & managing IT infrastructure with creation of a separate post for CE (IT & Communication) for effective implementation of the Regulations. Chairperson advised to look into feasibility of 3 different models for implementation of an enabling IT infrastructure viz (a) Inhouse development model (b) Contract based software development & (c) Technology partnership model.
- Energy accounting & Audit: Accounting of embedded OA customers in Rajasthan is being done by the DISCOMs. Under drawls is non-payable. Over drawl (drawl > contracted demand) is charged at DISCOM tariff
- Chairperson emphasised on the need for a robust accounting division equipped with provisions for maker-checker system, third party audit for ensuring prudence check at every stage. It was unanimously agreed that separate accounting units for billing, collection, settlement & reconciliation is always preferable considering the high stakes involved. Web-displaying of accounts to be done to ensure transparency.
- REMC: REMC function has already been started at SLDC with a dedicated team. One DSO per area is envisaged to act as an aggregator for RES.
- Chairperson emphasized on recognizing data as a major asset of LDCs & devising systems for data archival, retrieval & analysis with provisions for Big data analytics.
- Taxation: Jaipur Discom (JVVNL) has reportedly got tax exemption vide an order from the APTEL. Chairperson opined that though no relaxation is sought from taxation, the LDC must strive to remain beyond the TDS net for facilitating open access & settlement of pool accounts.
- Other Issues:
  - Reactive Power Scheduling at intrastate level for facilitating large scale RE integration
  - Need for defining role & responsibility of Aggregators (QCAs) in the regulations ensuring their accountability & neutrality towards forecasting & scheduling of RES.
  - AMR Implementation
  - Exploring feasibility of 5 min wise scheduling as advised by the Niti Ayog, for better managing the fast ramping down of Solar generation at sunset & better peak load following.

10. SLDC Meghalaya – 20.06.2016

Sub-committee interacted with SLDC Meghalaya on 20.06.2016 through Video Conference. Discussion highlights are as under :

- SE (SLDC) and EE (SLDC) from SLDC Meghalaya, GM, NERLDC, AGM- NLDC, DGM (MO), NERLDC, Mrs. Usha, Mr. N.R. Paul, Mr. Shaddruddin, and Mr. Vivek Pandey participated

- SLDC formed in the year 2003. Single discom and a common holding company for Discom, STU and Genco
- SLDC headed by SE (SLDC). He reports to the Director of the holding Company
- Predominantly hydro generation in State. Two part-tariff implemented for Hydro.
- Interstate STOA commenced from 2009. Presently 7 STOA customers. DSM applicable to only these STOA customers. Boundary meters for STOA customers is in place.
- Interface meters are of the same specifications as at interstate. Remote reading of Meters through GSM
- 132 kV and above considered as transmission voltage level. Telemetry for G-T points available at SLDC. Total 120 Meters envisaged for intraState G to T & T to D as per CEA regulations. ~ 40 meters at G to T already placed.
- Discom control centre yet to be established
- Daily MU/day declared by hydro. Schedule prepared by SLDC
- Load forecasting by Discom. SLDC also started.
- Reservoir Hydro gen is regulated for Deviation control
- Settlement period 15 min : Monthly
- Settlement Cycle and billing : Monthly, System for reconciliation in place
- 4 % transmission losses notified by SERC for intra State system for this FY based on historical data by SLDC
- CEA/CERC Regulations are adopted as it is
- Presently software for scheduling and energy accounting provided by NIC. New CDAC Software under implementation
- Meghalaya meeting its RPO obligation through REC purchase
- Meghalaya is selling 6 MW of RES power (small hydro) round the clock to Assam through STOA (via trader). This started in March 2016. This is to ensure non-solar RPO compliance of Assam. Meghalaya SLDC is certifying the RES generation.
- No deviation charges receivable for under-drawal but payable for O/D @ 105% of DSM rate STOA customers. SLDC only prepare deviation account. No reserves held by SLDC. No TDS deducted at source by STOA customers. Most of the STOA are through PX, only few bilateral STOA
- RPO obligation as per SERC order. REC purchased by holding company from PX.
- DISCOMs coordinates with NERLDC for any payment etc.
- Total SLDC strength is 30. Out of this 3 officers for MO including one accountant.
- SLDC expenditure recovered through separate ARR. Apportioned to GENCO & Transco in 50:50 ratio
- Separate fund for capacity building and training
- SLDC suggested for harmonizing SERC and CERC regulations

11. SLDC Assam – 20.06.2016

Sub-committee interacted with DGM (SLDC) from SLDC Assam on 20.06.2016 through Video Conference. Discussion highlights are as under:

- State Govt. and AERC has advised for ring fencing of Assam SLDC. AEGCL is in the process of ring fencing and associated activities like ARR of SLDC.
- Intra State ABT / DSM yet to be implemented in Assam. There is a plan for installation of around 600 nos. of TOD meters at 359 identified (interface points) locations which will be ABT compliant. It was proposed to be done out of the PSDF funding (Rs. 300 crores) received by AEGCL. This will pave way for intra-state ABT in Assam. Meter

installation will be done within one year. AEGCL shall comply with CEA metering standards while installing the boundary meters. With new TOD meter installation, AMR also will be in place for automated data collection. CT/ PT procurement also envisaged

- At present about 300 SEMs are in place (L&T make) installed about 8 years back. Due to various issues, only monthly readings from these meters are used for accounting.
- As there is only one DISCOM in Assam, the regional Deviation charges liability is being transferred to the DISCOM (APDCL). DISCOM pays to deviation charges pool and also settles payment to ISGS.
- PoC charges are paid by the STU (AEGCL).
- State level DSM is yet to be implemented.
- Power purchase portfolio management is done by DISCOM which is APDCL. This is done on merit order basis and daily advice sent to SLDC from APDCL for sending requisition to NERLDC.
- Intrastate ABT regulation is yet to be in place.
- No separate department like Market Operation at SLDC for data processing and computation. There are 3 executives for this activity out of total 20 in SLDC.
- State generators are being scheduled by SLDC and scheduling is done on 15 minute time block basis. Scheduling to DISCOM is done after application of apportioned transmission loss as decided by SERC. In the absence of 15 minute block accounting, scheduling does not have monetary implication.
- Meter data collection through Joint Meters Reading
- Consumption of Discoms and transmission losses being computed by SLDC. Transmission loss varies from 2- 4 %. Notified by SERC every quarter
- SLDC is planning for implementing & managing IT infrastructure with an independent Information Technology department.
- Weekly Deviation account not prepared but cumulative deviation energy accounted on monthly basis
- Load forecasting and Generation scheduling coordinated by SLDC. Scheduling has no commercial implication
- 12 STOA customers
- Pool account maintained and administered by transmission wing

12. SLDC BBMB – 23.06.2016

The sub-committee visited SLDC-BBMB in Chandigarh on 23.06.2016 and interacted with Member (Power), Chief Engineer (SO), Power Controller and other staff members of SLDC BBMB. GM-NRLDC and DGM (SO), NRLDC were also present. The discussion summary is as under:

- BBMB is a peculiar arrangement having own generation and transmission. BBMB has power stations at Bhakra (left and right bank), Dehar, Pong, Ganguwal and Kotla. BBMB generating stations have been recognized as intra State entities in the IEGC and its scheduling is coordinated by SLDC BBMB in consultation with the partner States of Punjab, Haryana, Rajasthan and Himachal Pradesh
- The transmission system of BBMB is a part of the Inter State Transmission System in Northern Region.
- BBMB does not have native load unlike DVC
- Member (Power), BBMB expressed the need for improving the energy accounting and computation of transmission loss in the BBMB system

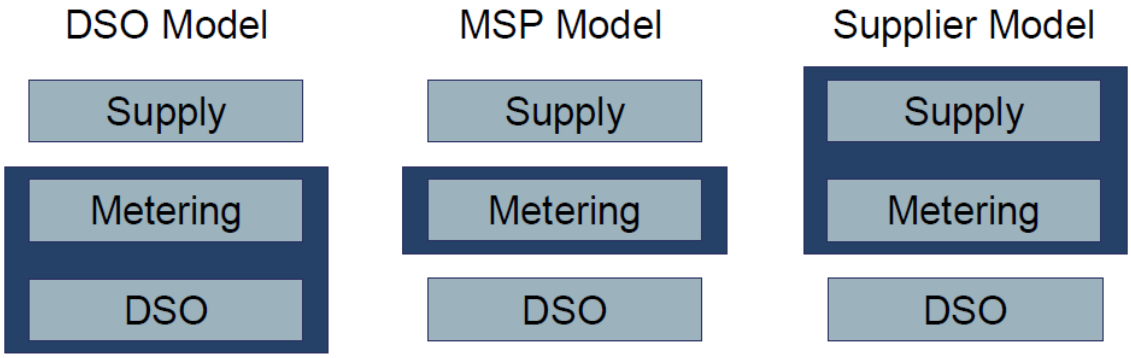
- It has four substations in Punjab viz. Jamalpur (Ludhiana), Jalandhar, Sangrur and Barnala BBMB. In Haryana, it has 10 substations viz. Dhulkote, Panipat, Jagadhari, Kurukshetra, Bhiwani, Hissar, CharkhiDadri, Ballabgarh, Samaypur and Rohtak Road. (Narela has both dtl and BBMB portion on extended bus).
- From the BBMB substations in Punjab, Punjab draws power at 220/132 kV and 220/66 kV ICTs as well as 220 kV lines. So meters are placed on these lines and ICTs essentially to determine Punjab drawal. An added complexity is that if we consider Bhakra/Ganguwal complex where significant generation is injected, the evacuation is from a mix of BBMB and state owned lines. Thus if there are 4 lines to Jamalpur, 2 belong to PSEB and 2 to BBMB. The meters at Bhakra/Ganguwal complex are essentially to determine power plant net injection. Similarly 220 kV Ganguwal-Mohali D/C line belongs to PSEB and Punjab drawal is being metered at Ganguwal end.
- Summarising all the 220 kV and 132 kV buses at BBMB station are treated as ISTS points from where off take is there by the states. BBMB system is wheeling a significant quantum of power.
- There is confusion over ownership in some cases such as the lines emanating from 220 kV Pong.
- Pre ABT, BBMB would prepare a monthly statement and send to NREB indicating the residual energy for Punjab, Haryana, HP, J&K that needed to be booked from other Central Sector Stations. Since at that time there was no 400 kV or 220 kV ISTS point in the whole NR2 region, so 400 kV Muradnagar-Panipat, 220 kV Btps-Ballabgarh and Panipat- Narela were the only points and were termed as drawal by BBMB from Delhi/UP. BBMB had meters only at Ganguwal complex and a 4% notional loss was applied to determine Punjab's offtake.
- In 1997-98, when meters had to be placed for ABT implementation in Northern Region, the meter locations for computation of drawal of Punjab and Haryana were identified by NRLDC in consultation with BBMB. For 14 substations, BBMB had only single phase bus PTs, they had to procure new bus PTs for measuring ICT flows as per the 3 phase 4 wire metering principle
- Metering is in place in all the GTs of BBMB Generating Units and at all the interface points of BBMB with Haryana, Punjab, HP ,Chandigarh & Delhi and also with ISTS points (except few small 11 KV feeders).
- For validation of data, check of Zero vector sum for all the nodes of BBMB System is being carried out regularly.
- IN compliance to the CERC in the matter of extending UI mechanism to BBMB generators, NRPC had been computing the energy deviations from BBMB generating stations. However the UI charges were not applicable. Subsequently CERC vide its order in petition 251/GT/2013 had directed that the DSM would be applicable on BBMB generating stations also. Accordingly the deviation settlement for Bhakra, Dehar and Pong has commenced w.e.f. 01.06.2016.
- It emerged that SAMAST could be quickly implemented in BBMB as well as DVC.

Appendix-4: Metering and Accounting-International Practices

1. Basic Metering Market Models

There could be three basic metering market models

i) The DSO owns and operates the metering infrastructure and performs metering services.
ii) An independent Metering Service Provider (MSP) performs metering services. The owner-ship and operative responsibility for the metering infrastructure could lie with the MSP ('fat' MSP) or with the DSO ('lean' MSP).
iii) The metering function is performed by the supplier in a liberalized metering environment



2. International Practice

In most countries for example Austria, Belgium, Denmark, Italy, Norway, Spain and Netherlands the responsibility for metering activities (installation, maintenance, meter reading, data management, etc.) lies solely with the Distribution System Operator (DSO). In United Kingdom and Germany, other companies, such as a metering company or/and a supplier and/or a DSO, may also be responsible for metering operations. In several countries metering remains part of the regulated DSO functions, although sometimes consumers and suppliers are also allowed to own meters. The costs of meters are recovered via the regulated network charges, and investments in metering equipment are subject to regulatory approval. Although the regulatory regimes vary from country to country, all regulatory regimes known to us apply an ex-ante regulatory review and explicit approval of investments before inclusion of costs in the allowed revenue.

3. PJM Metering:

- Each PJM Member is responsible for properly maintaining its metering and telemeter equipment in accordance with applicable ANSI standards.
- All PJM Members involved with any interface with PJM abide by the general guidelines for Billing Meter Standards
- PJM members are mandated to ensure that reliable and compliant operational metering equipment is in place for any metered service that is billed.
- PJM Members are responsible for the accuracy of the data they send to PJM. A maximum of 2% overall inaccuracy in the repeatability of data from transducers or potential transformers/current transformers (PTs/CTs) is allowed for instantaneous monitored values

- Meter information is automatically and electronically communicated to PJM by the producer, host utility, or transmitter in order to ensure timely accounting and billing. This enables PJM to identify and resolve erroneous information and to account and bill for services. Communication between PJM Members other than PJM may utilize any method, such as voice notification or paper document if mutually agreeable.
- Billing metering systems are capable of collecting and storing bi-directional information for intervals as determined by the parties involved. The expense and practicality of reporting information for small data intervals may not be cost effective or prudent. The average of instantaneous values can be used, provided that a mutually agreed upon accuracy is obtained and applicable standards are achieved. Meter intervals can be of lesser duration for some services, but common intervals are fifteen minutes, thirty minutes, and sixty minutes.
- The megawatt-hour (MWh) is the standard unit of service measurement. Service may be measured in kilowatt-hours (kWh) if required by specific services, local or state regulations, host utilities, service providers, or as are mutually agreed upon by the parties involved. kWh information may be used by the parties involved but must be converted to MWh information before transmission to PJM.
- All metered generator data values are to be supplied to the required parties in "net" form. "Net" shall be defined as "gross" output minus unit station light and power components. When metering limitations require "gross" values to be used, the "gross" to "net" calculation method must be approved by the PJM Operating Committee for use by PJM Members in the calculation of "net" data values.
- All meter records and associated documentation is retained for a period of seven years for independent auditing purposes.
- Accuracy: The minimum metering accuracy for each measuring device is defined by prevailing ANSI and NERC standards. The manufactured accuracy class of all energy interchange billing devices should be accurate within ±0.3% of full scale.
- **Location of Meter Points:** Interchange billing metering is provided on the system as follows
    - Transformers: Through-Transmission — EHV interchange metering points are provided from the secondary side of all through-transmission transformers connected to the 500 kV EHV system. For example, interchange metering is provided on the 230 kV side of a 500/230 kV through-transmission transformer.
    - Generators and Transformers Radially Tapped — Generators and transformers that are not through transmission (including unit station service transformers) and that are tapped directly on the 500 kV EHV system are provided with interchange metering on the primary side (500 kV) of the step-up, station service or radial transformer. For instance, a generator connected to the EHV system has an interchange metering point on the 500 kV side of the unit step-up transformer. All other generators and transformers not connected to the 500 kV system provide information as received from the high side or the low side of the unit transformer
    - **Alternative Approach:** In lieu of providing interchange billing metering, a PJM Member may elect to install a watt-hour metering system on the opposite side of the transformer than directed above (the 500 kV side of the through-transmission transformer or the 230 kV side of the radial transformers) provided that a compensation system is included to capture and adequately adjust interchange values to account for transformer losses. Any design for alternative metering approaches shall be documented and made known to PJM and all parties involved. Any alternative approach must be approved by PJM.

- **Metering Task Force:** There is a Task Force constituted known as Metering task force which creates consensus on metering issues related to operations, settlements and compliance, with a specific focus on updating and enhancing Manual Metering Requirements. Technical issues such as metering accuracy, redundancy and maintenance is studied in the context of metering performance requirements for State Estimation, Settlements, and other critical data use cases. Factors such as precedence of existing Manual and Tariff language, preponderance of actual installed equipment performance, actual operational and market needs, overarching regulatory and compliance rules, and historical development of existing rules and company integration into PJM, may be taken into consideration.

4. CAISO Metering Practices

- CAISO Metering Inspector or a qualified electrical contractor installs the Revenue Meter socket and supporting equipment.
- CAISO Metering Inspector must program, test, and document CAISO Metering Facilities.
- Resource owners
    - Contracts a Meter Services company to provide all aspects of CAISO metering test and maintenance.
    - Own the CAISO Metering Facilities
    - Maintains the CAISO Metering Facilities
    - Ensures the accuracy of the meter data
    - Submits the original prints and CAISO Metering Certification Form to CAISO for review and approval
    - Contracts a CAISO Authorized Inspector to verify Metering Facilities and submit Site Verification Forms to CAISO
- If a certified meter of a Metered Entity requires repairs (hardware and/or communications), it is necessary to have the repairs completed within. Where there is no ISO Certified Backup Meter installed, repairs need to be completed within 48 hours of the notification by CAISO. A Metering Exemption may be required to continue processing Meter Data.Where there is an ISO Certified Backup Meter installed, repairs need to be completed within five Business Days of the notification.

References:

1. "ERRA Licensing and Competition Committee" Issue Paper Regulatory Aspect of Smart Meters prepared by KEMA
2. "Cluster Analysis of Smart Metering Data" by Research Center for Information Technology Karlsruhe Germany.
3. "CEER Benchmarking Report on Meter Data Management Case Studies" by Council of European Energy Regulators ASBL 28 rue le Titien, 1000 Bruxelles Arrondissement judiciaire de Bruxelles RPM 0861.035.445
4. "Metering Best Practices A Guide to Achieving Utility Resource Efficiency" Prepared by Pacific Northwest National Laboratory for the Federal Energy Management Program U.S. Department of Energy.
5. Market Monitoring from http//: www.caiso.com
6. PJM Manual 01 " Control Center and Data Exchange Requirements" Revision: 31 Effective Date: November 18, 2015

Appendix-5: Settlement and Clearing : International Experience

1. Elexon, United Kingdom

Elexon is a Not for profit organization with an independent board structure. It is completely owned however not controlled by NGET (National Grid Electricity Transmission), the Transmission System operator. NGET's ownership is passive and symbolic, it has no liability or control on Elexon's financials. Elexon is the United Kingdom's Balancing and Settlement Code Company and its primary objective is to deliver UK's Balancing and Settlement Code. Balancing and Settlement Code is a regulation which lays out the governance procedures for Electricity Balance and Settlement in UK. Prices and payments of the balancing mechanism are managed by Elexon.

All Licensed electricity generators and suppliers in the UK are obliged to become the signatories to the Balancing and Settlement Code (BSC), whereas for other parties it is voluntary. Non-physical traders including investment Banks can also be BSC parties. Each BSC Party is required to lodge collateral with Elexon to ensure that there are sufficient funds or Credit Cover available to cover that Party's Trading Charges should the Party become unable to pay.

Elexon's costs are worked out in the start of each financial year are paid for by BSC Parties. The amount each BSC Party pays depends on their market role and the volume of energy they generate, supply or trade. There are over 200 BSC parties and Elexon transacts over 1.5 Bn pounds annually. It has roughly around 125 employees. ELEXON has four wholly-owned subsidiaries: ELEXON Clear Limited, Poolserco Limited, Poolit Limited and BSC Co. Ltd.

Elexon Clear is the 'BSC Clearer' and is the Legal Counter party to all Balance and Imbalance Transactions under the Balance and Settlement . All the parties receive and pay to Elexon Clear trough clearing Banks. Elexon Clear makes payments and settlements to BSC parties on a daily basis.

Apart from its role as the Balancing and Settlement Company, Elexon also provides Historical data for analysis to non- BSC parties at a cost, it provides dedicated operational support for BSC Parties. Elexon also provides Training Modules on BSC. Elexon has made a strong case in recent years to diversify and grow beyond the role as the BSC Co.

2. APCS Power Clearing and Settlement Organisation, Austria

APCS Power Clearing and Settlement is an Independent Balancing and Clearing Company (including Market operator and Billing Agent). APCS is a stock corporation and is owned by companies from the energy industry other industrial companies and financial institutions. As a part of restructuring and liberalization of Austrian energy market, the Federal Ministry of Economic Affairs and Labour appointed APCS Power Clearing and Settlement as the clearing agency for the Verbund Austrian Power Grid (APG) balancing area w.e.f. 1st October 2001. APCS also owns a percentage in the Exaa Energy Exchange, Austria.

As the clearing agency, APCS is responsible for organising a competitive balancing energy market for electricity. It also provides services for determination, pricing, clearing and settlement of balancing energy. It verifies the technical and financial requirements of

parties for them to be approved as independent market participant. For these services, participants are charged a clearing fee.

It provides Technical settlement, which includes calculation of balancing energy in every 15 minute time block. Financial Settlement Services includes calculation and settlement of net payables and receivables by each participant. Financial settlement services for Balance energy and Charging Fees are primarily provided through the clearing Bank-Oekb, which is also one of its owners. OeKb is also responsible for Credit Analysis of participants and certain aspects of risk management and Fee charges comprises of two major components- It charges fees from all Balance parties as Euro per MWh of energy consumed and Euro per MWh of Energy Traded.

As a risk mitigation measure, it requires all parties must deposit Base collateral and variable collateral based on the amount of Balancing Energy Traded/ Consumed by them. It is a lean organization and has less than 100 employees.

3. OeMag Corporation, Austria

Oemag is a state licensed organization, which is the designated the clearing and Settlement Agency for 'Green Power' in Austria. It was appointed by the Federal Ministry of Economic Affairs and Labour. OeMag is jointly owned by Austrian power grid, two control zone managers, two financial Institutions and two industrial sector companies.

It is responsible for managing the balancing, clearing and settlement of subsidized Renewable energy in Austria. It is also responsible for delivering Renewable Energy from suppliers and allocation to Traders. It also manages budgets and Funds for promoting electricity from renewable sources. It provides clearing and settlement services for Renewable Energy Generators, Network Operators and Power Traders.

4. Chamber of Electric Energy Commercialization (CCEE), Brazil

CCEE was created in 2004, it is a private, not-for-profit entity. It is responsible for administrating energy sales and purchases contracts by public distribution utilities, it is also responsible for conducting energy purchase auctions for distribution utilities and it takes care of accounting and settlement activities. CCEE mediates the supply guarantee contracts each distribution utility has to sign, in order to reduce defaulting risks.

In the short term or spot markets, CCEE is responsible for balancing of energy and is responsible for accounting and settling differences between the amounts of energy contracted and those effectively consumed or produced by the agents. In this market, every contractual difference is accounted for and financial settlement is made monthly, based on prices which are calculated weekly.

For Financial Settlements, CCEE has engaged of a financial institution which also has the custody of financial guarantees to ensure the safety of the procedure and risk reduction of operations. The Board of Directors of the CCEE is a collegiate body consisting of five professional executives, elected by the General Assembly with the mandate of four years, being allowed a single renewal.

5. Energy Market Company (EMC) , Singapore

The Energy Market Company Ltd (EMC) was established in February 2001. It is a Joint venture between the Electricity regulator and a New Zealand based private sector organisation. It is the licensed market operator of Singapore and responsible and is

responsible for operating and administering the wholesale functions of the National Electricity Market Singapore (NEMS). Its responsibilities includes calculating prices, scheduling of generation, clearing and settling market transactions, and procurement of ancillary services.

The EMC is also the financial clearinghouse for the wholesale market and settles transactions including energy trading, primary, secondary and contingency reserves, bilateral contracts and contracted ancillary services (black-start and fast-start services). It is also responsible for fee recovery for EMC and Power System Operator (PSO) administration charges. The settlement systems use the energy prices determined daily by Energy pricing software and the metering data generated by a third party.

Settlement in the wholesale market is carried out daily. A debtor has to pay the EMC for transactions twenty days after the trading day. A creditor for a trading day is paid by the EMC on the twenty first day. To cover the 20-day exposure of a debtor and the time required to initiate a suspension when a market participant defaults, a market participant must provide on-going collateral (credit support) covering 30 days of trading to the EMC.

A market participant may chose to settle amounts owing under its bilateral contract with another market participant either through the EMC's settlement system, or directly with their contracting party.

6. Australian Electricity Market Operator (AEMO), Australia

AEMO manages the National Electricity Market of Australia. It is responsible for market operation, system operation of the National Electricity Market of Australia and also gives inputs to regulators on Transmission Planning.

As part of responsibility as a Market Operator, AEMO is also responsible for clearing and settlement of various transactions. AEMO calculates the financial liability of all market participants on a daily basis and settles transactions for all trade in the National Electricity Market weekly. This involves AEMO collecting all money due for electricity purchased from the pool from market customers, and paying generators for the electricity they have produced.

AEMO is also responsible for preparing settlement calendars for various products and services. All participant are required to lodge collaterals with AEMO to minimize risk arising out of default, it also has detailed procedures in place to deal in case there are defaults by members.

The settlement process involves determining financial liabilities, issuing accounts, and settling amounts payable and receivable for electricity sold to and purchased from the pool. AEMO uses the services of web portal of Austraclear Clearing and Settlement Limited for transactions (www.asx.com.au/settlement/asx-austraclear.htm). All participants must be registered with Austraclear for settlement and clearing services.

Appendix-6: Technical Specifications of Interface Energy Meters

(General Guidelines)

1. The energy metering system specified herein shall be used for tariff metering for bulk, inter-utility power flows, in different States of India. One static type composite meter shall be installed for each EHV circuit, as a self-contained device for measurement of active energy (MWh) transmittals in each successive 5 minute block and certain other functions, as described in the following paragraphs. All meters may be DLMS compliant for Interface Energy Meter (IEM) communication protocol. It must also be compliant for Indian Companion COSEM standard. Data security shall be ensured as per IEC-62056-51 standard (three layers of security). Detection of Tamper conditions as included in IEC 62056 standard must be mandatory for DLMS compliant meter protocol. Meter shall comply with IS 164444 for all its requirements.

2. The meters shall be suitable for Advanced Metering Infrastructure (AMI) with bidirectional communication. The meter shall communicate with Data Connector Unit (DCU) / Access Point/ HES on any one of the communication technologies mentioned in IS 16444.

3. The meter shall have a feature of upgrading the latest firmware remotely.

4. The meters shall be suitable for being connected directly to voltage transformers (VTs) having a rated secondary line-to-line voltage of 110V, and to current transformers (CTs) having a rated secondary current of 1 A (model-A) or 5A (model-B). Any further transformers/transactions/transducers required for their functioning shall be in-built in the meters. Necessary isolation and/or suppression shall also be built-in, for protecting the meters from surges and voltage spikes that occur in the VT and CT circuits of extra high voltage switchyards. The reference frequency shall be 50Hz.

5. The active energy (Wh) measurement shall be carried out on 3-phase, 4-wire principle, with an accuracy as per class 0.2 S of IEC-62053-22:2003. In model-A (for CT secondary rating 1A), the energy shall be computed directly in CT and VT secondary quantities, and indicated in watt-hours. The meter shall compute the net active energy (Wh) sent out from the substation bus bars during each successive 5-minutes block, and store it in its memory up to second decimal with plus sign if there is net Wh export and with a minus sign if there is net Wh import . It shall also display on demand the net Wh sent out during the previous 5-minute block.

6. Further, the meter shall continuously integrate and display on demand the net cumulative active energy sent out from the substation bus bars up to that time. The cumulative Wh reading at each midnight shall be stored in the meter's memory. The register shall move backwards when active power flows back to substation bus bars.

7. The meter shall count the number of cycles in VT output during each successive 5-minutes block, and divide the same by 300 to arrive at the average frequency. This shall be stored in the meter's memory in Hertz up to second decimal . The average frequency of the previous 5-minutes block shall also be displayed, on demand in Hertz.

8. The meter shall continuously compute the average of the RMS values of the three line-to-neutral VT secondary voltages as a percentage of 63.51 V, and display the same on demand. The accuracy of the voltage measurement/computation shall be at least 0.5%, a better accuracy such as 0.2% in the 95-105% range being desirable.

9. The Reactive energy (VARh) measurement shall be carried out on 3-phase, 4-wire principle, with an accuracy as specified in clause 11.0 of IEC 62053-23:2003. In model-A (for CT secondary rating 1A), the energy shall be computed directly in CT and VT secondary quantities, and indicated in watt-hours. The meter shall compute the net Reactive energy (VARh) sent out from the substation bus bars during each successive 5-minutes block, and store it in its memory up to second decimal with plus sign if there is net VARh export and with a minus sign if there is net VARh import . It shall also display on demand the net VARh sent out during the previous 5-minute block.

10. The meter shall also compute the reactive power (VAR) on 3-phase, 4-wire principle, with an accuracy as specified in clause 11.0, and integrate the reactive energy (VARh) algebraically into two separate registers, one for the period for which the average RMS voltage is 103.0% or higher, and the other for the period for which the average RMS voltage is below 97.0%. The current reactive power (VAR), with a minus sign if negative, and cumulative reactive energy (VARh) readings of the two registers shall be displayed on demand. The readings of the two registers at each midnight shall also be stored in the meter's memory. In model-A (for CT secondary rating of 1 A), the reactive power and reactive energy transmittals shall be computed in VAR/VARh directly calculated in CT and VT secondary quantities. When lagging reactive power is being sent out from substation bus bars, VAR display shall have a plus sign or no sign and VARh registers shall move forward. When reactive power flow is in the reverse direction, VAR display shall have negative sign and VARh registers shall move backwards.

11. In the model-B (for CT secondary rating of 5A), all computations, displays and memory storage shall be similar except that all figures shall be one fifth of the actual Wh, VAR and VARh worked out from CT and VT secondary quantities.

12. The meters shall fully comply with all stipulations in IEC standards 62052-11:2003 and 62053-22:2003, except those specifically modified by this specification. The reference ambient temperature shall be 30° C.

13. Errors shall be reasonable for all power factor angles from 0° to 360°.

14. For reactive power (VAR) and reactive energy (VARh) measurements, IEC 62053-23:2003 shall be complied with. The accuracy of measurement of reactive energy shall be as per class 2.

15. Each meter shall have a test output device (visual) for checking the accuracy of active energy (Wh) measurement. The preferred pulsing rate is twenty(20) per Wh for Model-A and four(4) per Wh for model –B. It shall be possible to couple this device to suitable testing equipment also.

16. No rounding off to the next higher last decimal shall be done for voltage and frequency displays. All 5 minute Wh figures shall however be rounded off to the nearest last decimal.

17. The three line-to-neutral voltage shall be continuously monitored and in case any of these falls below about 70%, a normally flashing lamp provided on meter's front shall become steady. It shall go off it all three voltages fall below 70%. The time blocks in which such a voltage failure occurs/persists shall also be recorded in the meter's memory with a symbol "*". If 3 Phase RMS voltage applied to the IEM is in between 5% to 70% of rated voltage,

IEM should record low voltage symbol "L" in place of star(*) and If Voltage is less than 5% of rated voltage, SEM meter should record Zero voltage symbol "Z" .The lamp shall automatically resume flashing when all VT secondary voltages are healthy again. The two VARh registers specified in clause 7.0 shall remain stay-put while VT supply is unhealthy. When Bay feeder is out, facility should be provided to download data on backup system (battery) independently & see on display on offline mode.

18. The meters shall normally operate with the power drawn from the VT secondary circuits. The total burden imposed by a meter for measurement and operation shall not exceed 10 VA on any of the phases. An automatic backup for continued operation of the meter's calendar-clock, and for retaining all data stored in its memory, shall be provided through a long-life battery, which shall be capable of supplying the required power for at least 2 years. The meters shall be supplied duly fitted with the batteries, which shall not require to be changed for at least 10 years, as long as total VT supply interruption does not exceed two years. The battery mounting shall be designed to facilitate easy battery replacement without affecting PCB of the meter. The meters shall not require any separate auxiliary supply for their operation. All displays may disappear on loss of VT supply.

19. Each meter shall have a built-in calendar and clock, having an accuracy of 10 seconds per month or better. The calendar and clock shall be correctly set at the manufacturer's works. The date (year-month-day) and time (hour-min.-sec.) shall be displayed on the meter front (when VT supply has been connected), on demand. Meter shall have the intelligence to synchronize the time with GPS signal and can be possible through a single click from the software itself while connecting the meter with PC. Limited time synchronization through Rs-485 port shall be possible at site. When an advance or retard command is given , twelve subsequent time blocks shall be contracted or elongated by five seconds each. All clock corrections shall be registered in the meter's memory and suitably shown on print out of collected data. Standard for time synchronization shall be as per IS16444/IS15884 Standard.

20. Each meter shall have a unique identification code, which shall be marked permanently on its front, as well as in its memory. All meters supplied to as per this specification shall have their identification code starting with "IM", which shall not be used for any other supplies. "IM" shall be followed by a dash and a eight digit running serial number, further followed by a dash and "A" for Model-A, and "B", for the use with CT secondaries of 1 A and 5 A respectively.

21. Each meter shall have at least one eleven (11) character, seven-segment electronic display, for indication of the following (one at a time), on demand:

i) Processor's identification code and model : EM12345678A
ii) Date (year month day) : 20160311 d
iii) Time (hour min. sec.) : 195527 t
iv) Cumulative Wh reading : 12345678.6 C
v) Average frequency of the previous block : 49.89 F
vi) Net Wh transmittal during the previous block: - 28.75 E
vii) Net VARh transmittal during the previous block: - 18.75 R
viii) Average % voltage : 99.2 U
ix) Reactive power (VAR) : 106.5 r
x) Voltage - high VARh register reading : 01234567.5 H
xi) Voltage - low VARh register reading : 00123456.4 L
xii) Low battery indication

22. A gold plated touch key or push button shall be provided on the meter front for switching on the display and for changing from one indication to the next. (The display shall switch off automatically about one minute after the last operation of touch key/push button). When the display is switched on, the parameter last displayed shall be displayed again, duly updated.

23. Each meter shall have a non-volatile memory in which the following shall be automatically stored:

i) Average frequency for each successive 5-minute block, in Hertz up to second decimals.

ii) Net Wh transmittal during each successive 5-minute block, up to second decimal, with plus sign if there is net Wh export and with a minus sign if there is net Wh import

iii) Net VARh transmittal during each successive 5-minute block, up to second decimal, with plus sign if there is net VARh export and with a minus sign if there is net MVARh import .

iv) Cumulative Wh transmittal at each midnight, in eight digits including one decimal

v) Cumulative VARh transmittal for voltage high condition, at each midnight in eight digits including one decimal

vi) Cumulative VARh transmittal for voltage low condition, at each midnight, in eight digits including one decimal

vii) Date and time blocks of failure of VT supply on any phase, as a star (*) / (L)/ (Z) mark

24. The meters shall store all the above listed data in their memories for a period of fifteen (15) days. The data older than fifteen (15) days shall get erased automatically.

i) Each meter shall have an optical port on its front for tapping all data stored in its memory using Laptop along with required optical to USB converter .In addition to the above each meter shall also be provided with a RS-485 as well as LAN port for RJ 45 connection on one of its sides, from where all the data stored in the meter's memory can also be tapped into the local computer directly, The overall intention is to tap the data stored in the meter's memories once a week from any of the above mentioned ports and transmit the same to a remote central computer using AMR (Automatic Meter reading) system or other means of communication , through the local PC.

ii) All meters should be compatible with Optical port, RS-485 port and LAN port all together at a time and communicate independently. It shall also be possible to obtain a print out (hard copy) of all data collected from the meters, using the local PC. Data collection from any local laptop/PC should be possible by installing data collection software.

iii) All meters shall have internal chargeable battery to power-up the meters during the shut down condition of the element and adapter to be provided at each station where meters are installed to charge-up as and when required. Internal battery can be replaced and provided by suppliers.

iv) Meter protocol shall be such that slave ID of the meter can be accessed remotely from control centre in case of meter replacement without any manual intervention in AMR system.

25. The whole system shall be such as to provide a print out (both from the local PC, and from remote central computer) of the following form:

```
20  49.82       +16.28       +12.63       49.63       +15.95 +10.55
    EM-12345678-A       12345678.6     01234567.5     00123456.4     16-03-2016
00  49.99       +14.72            -16.25       50.20       +13.83  -12.63
```

The above data shall be available in text file format (file extension as per IEEE standard) exportable to Excel. This data shall be available in second text file format (file extension as per IEEE standard) exportable to Excel. Also, the system needs to provide additional data in the format mentioned in ANNEXURE-I . This data shall be available in second text file format (file extension as per IEEE standard) exportable to Excel .The user shall have the option to download one or both text files. Format to be approved during technical demonstration. Indication of time retard or advance to be provided without disturbing the proposed format.

26. The meters shall be supplied housed in compact and sturdy, metallic or molded cases of non-rusting construction and/or finish. The cases shall be designed for simple mounting on a plane, vertical surface such as a control/relay panel front. All terminals for CT and VT connections shall be arranged in a row along the meter's lower side. Terminals shall have a suitable construction with barriers and cover, to provide a secure and safe connection of CTs and VTs leads through stranded copper conductors of 2.5 sq. mm. size.

27. All meters of the same model shall be totally identical in all respects except for their unique identification codes. They shall also be totally sealed and tamper proof, with no possibility of any adjustment at site, except for clock correction.

28. The meters shall safely withstand the usual fluctuations arising during faults etc. In particular, VT secondary voltages 115% of rated applied continuously and 190% of rated for 3.0 seconds, and CT secondary current 150% of rated applied continuously and 30 times of rated applied for 0.5 seconds shall not cause any damage to or maloperation of the meters.

29. The meters shall also withstand without any damage or maloperation reasonable mechanical shocks, earthquake forces, ambient temperature variations, relative humidity etc. They shall have an IP-51 category dust-tight construction, and shall be capable of satisfactory operation in an indoor, non-air conditioned installation.

30. The meters shall continue to function for the remaining healthy phase(s), in case one or two phases of VT supply fails. In case of a complete VT supply failure, the computation of average frequency (as per 5.0) shall be done only for the period during which the VT supply was available in the 5-minute block. Any time block contraction or elongation for clock correction shall also be duly accounted for.

31. The harmonics shall preferably be filtered out while measuring Wh, VAR and VARh, and only fundamental frequency quantities shall be measured/computed.

32. Either the meters shall have built-in facility (eg. test links in their terminals) for in-situ testing, or a separate test block shall be provided for each meter.

33. The Contractor shall provide the necessary software which would enable a local IBM-Compatible PC to:

i) Accept the data from the /RS-485 port and store it in it's memory in binary read only format in an user-defined file name(file name format must be ddmmyysubstation name-utility name),
ii) Polling feature along with a task scheduler to run the data downloading software at a pre-designated date and time repeatedly or by manually selecting a meter. File naming for such downloaded data should also be in user-defined format**.** A detailed activity log shall also be available for each downloading operation,
iii) upload/import meter data (binary files) in the software for further processing. While uploading, there shall be provision to upload all selected files with single key-stroke
iv) Convert the binary file(s) to text file(s).There should be provision to select multiple files based on filename, convert all selected files with single key-stroke and store the text files in the same location where binary files are stored.
v) Display the collected data on PC's screen in text format, with forward/backward rolling,
vi) Print out in text format the data collected from one or more meters, starting from a certain date and time, as per operator's instructions,
vii) Transmit the collected data, in binary format, through an appropriate communication link to the central computer, starting from a certain date and time, as per operator's instructions, and
viii) Store the collected data in binary format, on a CD/Pen Device. In addition to above, in general the software should be able to convert DLMS/COSEM compliant IMs data to existing format as well as in tabular (.csv) format as applicable

34. The above software shall further ensure that absolutely no tampering (except total erasures) of the collected metering data is possible during its handling by the PC. The software shall be suitable for the commonly available PCs, and shall be supplied to Owner in a compatible form to enable its easy loading into the PCs available (or to be installed by the Owner/others) at the various substations.

35. Quality Assurance

The quality control procedure to be adopted during manufacture of the specified equipment shall be mutually discussed and finalized in due course, generally based on the established and proven practices of the manufacturer. The software should be user friendly and can be easily installed in any PC/Laptop irrespective of operating system of the PC/Laptop and also shall certified for ensuring data handling capabilities. The same should be demonstrated by party during technical evaluation only. During demonstration standard meter to be brought by party Therefore software shall be offered for technical compatibility, which will be evaluated technically, before taking up further necessary action in the procurement process.

36. Testing

All equipment, after final assembly and before dispatch from manufacturer's works, shall be duly tested to verify that is suitable for supply to the Owner. In particular, each and every meter shall be subjected to the following acceptance tests:

i) Verification of compliance with Table 4 under clause 8.1 of IEC-62053-22:2003, in both directions of power flow, for class 0.2S.
ii) Test of the register ratio and the impulse value of the transmitting device, for both directions.

iii) Verification that VARh measurement errors are within values permitted for class 2 in Table 6 of IEC 62053-23 for both directions of power flow.
iv) Effect of ±10% variation in measuring circuit voltage, on accuracy of Wh and VARh measurement
v) Power loss.
vi) Dielectric properties.
vii) Starting and running with no-load for Wh and VARh, in both directions.
viii) Functional checks for display and memory.
ix) Accuracy of the calendar and clock.
x) Accuracy of voltage and frequency measurement.

37. Any meter which fails to fully comply with the specification requirements shall be liable to be rejected by the Owner. However, the Owner may purchase such meters at a reduced price in case of marginal non-compliance, at his sole discretion.

38. Acceptance Tests for PC Software and data down loading using RS-485 port

All IMs after final assembly and before despatch from Contractor's/Manufacturer's works shall be duly tested to verify that they are suitable for downloading data using Optical port and RS-485 port and shall be subjected to the following acceptance test:

i) Downloading Meter Data from the Meter(s) to PC
ii) Compatibility with PC Software
iii) Functioning of advance and retard time commands
iv) Per meter downloading time verification

39. Type Tests

One (1) out of every hundred (100) meters shall be subjected to the complete range of type tests as per IEC-62053-22:2003, IEC-62053-23:2003 and IEC 62052-11:2003, after final assembly. In case of any failure to pass all specified tests, the contractor shall arrange to carry out the requisite modifications/replacements in the entire lot of meters at his own cost. After any such modifications and final assembly, two (2) meters selected out of the lot by the Owner's representative shall be subjected to the full range of type tests. The lot shall be accepted by the Owner only after successful type testing.

40. The meters used for type testing shall be separately identified, duly marked, and supplied to the Owner in case they are fully functional and as good as other (new) meters, after necessary touching up/refurbishing. In case this is not possible, the contractor shall provide their replacements at no extra cost to Owner.

41. The Contractor shall arrange all type testing specified above, and bear all expenses for the same.

42. Installation and Commissioning

The static energy meters specified above shall be installed at various EHV substations owned by the Owner, DISCOMs and other agencies, throughout India. The exact location and time-table for installation shall be finalized by the Owner in due course, and advised to the contractor, such that contractor's responsibility in this respect ends within six (6) months of completion of all supplies.

43. The Contractor shall be responsible for total installation and commissioning of the meters (along with test blocks, if supplied separately) as per Owner's advice, including unpacking and inspection on receipt at site, mounting the meters on existing control and relay panels at an appropriate viewing height, connection of CT and VT circuits including any required rewiring, functional testing, commissioning and handing over. The Contractor's personnel shall procure/carry the necessary tools, equipment, materials and consumables (including insulated wires, lugs, ferrules, hardware etc.)

44. As a part of commissioning of DCDs the Contractor shall load the software specified in clause 33 and 34 into the PCs at the respective substations, and fully commission the total meter reading scheme. He shall also impart the necessary instructions to substation engineers.

45. Following technical information shall be furnished by the Bidders in their offers:

i) Foreseen dimensions of proposed meter.
ii) Expected weight of proposed meter.
iii) Dimensions and weight of the test block, if supplied separately.

46. Warranty :

i) 60 months Years for the Meter.
ii) The warranty would include repair, replacement , part material replacement cost and one way (return) transportation cost (including insurance of transit)
iii) Meter software, if upgraded by OEM should be supplied free of cost with initiation taken from party. Remote service person name to be indicated during bidding
iv) Meters which are found defective/inoperative at the time of installation or become inoperative/defective within the warranty period, these defective/inoperative meters shall be replaced within one month of receipt of report for such defective/inoperative meters.

47. For RS485 Compatibility (plus, minus, common terminals to be provided for easy termination of daisy chain/similar connection or direct connection to PC by a cable) should be provided separately to collect data from meter independently by PC/Laptop. Any additional cable (with optical adapter or converter) or Software as required for data downloading from special energy meters to laptop are to be supplied.

48. Should be supplied with latest/compatible software (should be compatible with old & new meters data download handling). Any new software as required to be installed within warranty period are to be done by party or through remote support to client

49. The total arrangement shall be such that one (1) operation (click on "data down load from meter" button on software)can carry out the whole operation in about five (5) minutes per meter or preferably faster.

50. The layout of software front end/user interface has to be approved by bidder during technical evaluation/demonstration. However a standard template sheet will be provided along with bid for ref.

51. Software for windows/office/antivirus to be supplied. Antivirus SW should not slow down processes and same will be demonstrated during technical demonstration.

52. Above spec. is minimum only, any higher standard required for the purpose intended (meter data handling) would be assessed by vendor and would be supplied accordingly. The DRS should be approved during drawing approval stage.

53. SCC

i. Meter should be accomodatable in existing C&R panel of standard size (Alstom/ ER/ABB/Siemens) in kiosk or C&R panel with door closed. If required before bidding, bidder may collect necessary data or else the scope is deemed to be included.

ii. Step by Step procedure (on screen shot type or desktop video capture) (SW to be supplied during TOC) for
    1. Installation/Re-installation of Database handling software in to Laptop / PC
    2. Meter maintenance/site-testing procedure as per relevant IS/IEC standard.
    3. Procedure for data downloading from Meter by Laptop/Desktop PC.

iii. The Meters are to be used as Interface energy meters in transmission system of STU (State Transmission Utility). As on date of delivery, the supplied meters shall comply all statutory regulation as required under CERC/CEA/IEGC as applicable and the same should be declared by the supplier during delivery along with warranty certificate.

Appendix-7: Automated Meter Data Reading (AMR) system

(General Guidelines)

1. Intent of AMR

The intent AMR scheme proposed in this document is to automate the task of data collection from each meter/location periodically and storing the same in a database (RDBMS like Oracle, MS SQL Server, My SQL etc). Data from the database will be used by separate software (not in the scope of AMR) for validation and further processing. However, preliminary validation is to be inbuilt in central data collection system (CDCS) envisaged in this scope. Concept diagram of the indented AMR is given below:-

5. Energy Meters

Energy Meters to be covered under proposed AMR system are Interface Energy Meters (IEMs) manufactured as per Technical Specification of STU. Each IM has been provided with an optical port (as per IEC 1107), both RS-485 port and RJ-45 port.

6. Data Collection Unit

A Data Collecting Unit (DCU) installed at each location will act as interface between central data collection system at SLDC and IMs installed at that location. DCU shall collect data from energy meters and sent the same to CDCS. DCU shall also report diagnostic information of the energy meters to CDCS.DCU shall have following functions:-

- Providing energy data and status to CDCS.
- Acquiring energy data and status from energy meters.
- Providing energy data and status to local computer.

Each meter has a unique identification number and each meter location has unique identification code. DCU shall collect data from a single or group of meters based on meter number or meter location code.

DCUs shall collect data from energy meters and transfer the same to CDCS. DCUs should provide a RS-232/LAN/USB port for communication with local personal computer or terminal.

7. Central Data Collection System

A Central Data collecting system shall be provided at respective SLDC. This system will manage all functionalities of collection of data through DCUs, validate the data, store the data in a RDBMS, and manage the complete AMR system. Software will also have a scheduler for scheduling the task of collection of data periodically. Provision of extracting data from the database in the text files as per existing format for all or selected meters for further processing by Energy Accounting software is also to be build in data collection software.

8. Communication System

Communication system to be used for transfer of data from DCU to CDCS may be GSM/GPRS etc. However, if GPRS service is not available at any location then any other communication system such as GSM/PSTN/Optic Fibre may be used. Bidder is free to suggest alternative communication media if it is more efficient and cost effective.

9. Interface Converter Unit

Each energy meter to be included in AMR system has an optical interface (as per IEC 1107) and also provided RS-485 port in addition to optical port. Wherever RS-485 port is available, it should be used for connectivity to local DCU and transfer of data from meter to DCU/CDCS. In case energy meter does not have RS-485 port, an Interface Converter Unit (ICU) should be supplied and installed for conversion of communication signals form optical port to RS-485 port. Each ICU should meet following requirements:-

Appendix-8: Interstate Energy Metering Accounting and Settlement

1. Interstate Metering System

Availability Based Tariff and Unscheduled Interchange Mechanism was implemented at the Regional level in phases between 2002 to 2007 The scheduling of Interstate Generating Stations (Regional Entity) is coordinated by the concerned Regional Load Despatch Centre in line with the Scheduling Code stipulated in the CERC Regulations on Indian Electricity Grid Code. The Interface Energy Meters are procured and placed as per the CEA Metering Regulations at the interface points identified by the RLDC. The database of the Interface Energy Meters along with the CT/PT ratios is maintained at the RLDCs. The data from all the Interface energy meters (Main/Check/Standby) installed at a particular location is downloaded with the help of Data Collection Device (DCD) by the substation personnel and forwarded to the respective RLDCs in encrypted format on weekly basis through email. The coded file received at RLDCs are converted to text files using the software provided by the meter manufacturer. This data is processed with the help of in house developed software. Validation checks / Pair checks are carried out to identify bad data/metering errors. Discrepancies observed in the meter data during validation are noted and suitably taken up with the field staff for future corrections. The day is divided into 96 time blocks of 15-min each. The actual injection/drawal by each control area regional entity is calculated by RLDCs in each 15 minute time block. Trending of transmission loss in the Interstate grid is also computed for every time block. Abnormal patterns, if observed, are further investigated and analyzed to rule out any deficiencies associated with the metering system. In the event of failure/bad data from the Main meter, its reading is substituted by the data from Check/Standby Meter using appropriate transmission loss. Time synchronization of the meter and their calibration is carried out at stipulated intervals.

2. Interstate Energy Accounting

At the end of the day, the RLDC prepares the Implemented Interchange schedule (Injection and Withdrawal Schedule) after incorporating all before the fact revisions. The Implemented Schedule containing the Declared Capability of the Station, Entitlement of the beneficiary from various stations, Requisition submitted by the beneficiary for LT/MT transactions is uploaded on the website for verification by the respective entities. The approval of STOA transactions and the energy scheduled in also uploaded on the website. The meter data along with the actual drawal by reach regional entity and regional entity wise 'Implemented Schedule' is forwarded to the RPC secretariat. The RPC secretariat prepares the Active Energy Deviation Account, RRAS Account, Reactive Energy Account and Congestion Account on a weekly basis and uploads it on its website. RPC secretariat also prepare Regional Energy Accounts (REA), Regional Transmission Accounts (RTA), Regional Transmission Deviation Accounts (RTDA) are prepared by the RPC secretariat on a monthly basis. Contents of the monthly Regional Energy Account are as under:

- Plant Availability Factor of ISGS: *Monthly and cumulative*
- Monthly Scheduled Energy :*from each ISGS to each entity*
- Weighted average entitlements: *For each entity from each ISGS*
- Monthly Scheduled Energy: *through LTA, MTOA, STOA bilateral and through Px (s)*
- Incentive to the generating stations: *based on Scheduled PLF*

3. Interstate Energy Settlement

The philosophy of Net Settlement is in place at the Interstate level. Based on the Regional Energy Account issued by the RPC secretariat, the Generating Companies raise the bills for the Capacity Charges and the Scheduled Energy Charges while the CTU raises the bill for ISTS transmission charges as per the monthly RTA/RTDA. These bills are settled mutually between the concerned utilities. The RLDC maintains the Regulatory Pool accounts on the Active Deviation (DSM), Reactive Energy Interchange and Congestion Charge on respective Regional Entities. The Active Energy deviation pool is non-zero by design. Capacity as well as Energy Charges for Regulatory Ancillary Services dispatched from an ISGS in real-time by NLDC (RRAS) are cleared by the RLDCs with the DSM Pool of the respective regions.

The RLDCs/NLDC are the designated Nodal Agencies for STOA (Bilateral/Collective) transactions. The bills for approved STOA transactions are raised and settled by the respective RLDC/NLDC as per the STOA regulations. In STOA also the buyer seller settle the trade mutually. RLDCs/NLDC only collect and disburse the Operating Charges and Transmission Charges to the respective utilities.

4. Pool Account Administration

The RLDCs are designated by the CERC to administer all the Regional Regulatory Pool Accounts viz. Active Energy Deviation Account, Reactive Energy Account, Congestion Charge account and Ancillary Services Account. Separate Bank Account has been created for clearing of the receipts and disbursals associated with Regulatory Pool Accounts. The regional entities are mandated by the CERC regulations to assign highest priority to pool account liabilities. There are provisions related for timely payment and surcharge for late payment. Defaulters are mandated to provide payment security. External pool debtors have priority over internal pool debtors. The pool is settled within 21 days as per the following time line.

Week	Days after the last day of Accounting period	Week Day	Activity
W	0	Monday to Sunday	Scheduling and Delivery of the contract
W+1	2	Monday-Tuesday	Meter Data Collection for the previous week (W)
W+1	4	Thursday	Processed Data forwarded to RPCs after complete validation/checks
W+2	9	Tuesday	Weekly DSM account issued by RPCs
W+3	19	Friday	Last day for clearing the outstanding by pool creditors (within 10 days of issue of DSM account)
W+4	21	Saturday - Monday	Clearing the outstanding to pool debtors by RLDC from the available funds in the pool account (*within 2 days of the receipt of amount in pool)*

The collection and disbursement of the STOA charges is done by the RLDCs/NLDC. In case of default in payment of STOA charges, the RLDCs have been empowered to curtail / deny STOA to the defaulting entity.

All financial transactions with the Regulatory Pool Accounts and for STOA are through Electronic transfer. Surplus revenue in the regulatory pool accounts are transferred to the Power System Development Fund.

5. Transparency, Integrity and Probity of Accounts

The complete details associated with the Meters (viz. List of Meters, CT/CVT Ratio, Type of Meters, Locations); Interchange schedules (viz. Injection Schedule, Withdrawal Schedule, Scheduled Transmission Losses) and Actual Interchange of each regional entity (Injection, Drawal); and Pooled Losses) are uploaded on the website of the respective RLDCs. The details of the formula used for the computation of interchange of the control area with the interstate grid are also uploaded on the website of the respective RLDC.

6. Verification and Reconciliation

The transmission losses in the regional ISTS for every 15-min is computed weekly. The average losses for the last 52 weeks is also uploaded on the website. The pattern of ISTS losses is monitored. Any abnormal value is examined in detail to identify the root cause.

As per the IEGC 6.5.22 the RLDC's computation are open for checking/verification for 15 days. The Inter regional schedules are reconciled among the RLDCs and Regional entities before forwarding to the secretariat of the RPC. Errors/omissions in the Implemented schedule or Deviation Account if pointed out by stakeholders within the stipulated period are suitably corrected by issuing a revision.

As per the IEGC Complementary Commercial Mechanism, clause 8, the computation by RPC secretariat is open for checking/verification for 15 days. The issues related to metering, meter discrepancies and error in computations can also be discussed in the Commercial sub-Committee Meeting of the respective Regional Power Committee.

Since the Implemented schedule, meter details, meter data and computation formula are available on the website, any utility can compute its interchange with the grid and deviation from schedule on its own. The applicable charges can also be computed independently as the settlement rules and rate charts are notified by the CERC in its regulations/orders. Thus there are adequate avenues for cross verification and reconciliation.

7. Salient features SAMAST at the Regional level are tabulated below:

S No.	Particulars	ER	NER	NR	SR	WR	All India
1	Conventional Generating Stations	18	10	39	24	42	133
2	Renewable Energy Stations	1	0	3	0	0	4
3	Discoms/Buyer	8	7	19	7	11	52
4	HT consumers / CPPs connected to ISTS	0	0	2	0	0	2
5	Total Active Pool Members	27	18	63	32	49	189
6	GT -T Interface (Thermal/Hydro)	50	10		94	126	451
7	STs & ICTs Interface with ISTS	106	20		73	317	934
8	RES - T Interface	10	0		0	0	16

S No.	Particulars	ER	NER	NR	SR	WR	All India
9	ISTS-InSTS Interface	98	10		260	694	1147
10	CTU-STU Interface	159	53		42	172	1470
11	CTU-IPP Interface	26	0		16	135	233
12	Total Interface	449	93		485	1444	4251
13	Make of Energy meter	L&T	L&T Secure Elster	L&T Elster Secure	L&T Secure Elster	L&T Secure Elster	
14	Are the meters AMR enabled?	Yes	No	Partial	No	No	
15	AMR Vendor	TCS	NA	Kalkitech	NA	NA	
16	Meter Accuracy Class	0.2S	0.2S	0.2S	0.2S	0.2S	
17	Least Metering Interval possible	15-min	15-min	15-min	15-min	15-min	
18	Number of Main Meters	107	150	750	385	670	2062
19	Number of Check Meters	103	0	200	119	181	603
20	Number of Standby Meters	663	225	830	459	593	2770
21	Total Meters	873	375	1780	963	1444	5435
22	Last REA issued in the month	Jun-16	Jun-16	May-16	Jun-16	May-16	
23	Maximum energy consumption achieved in	Apr-16	Jul-15	Aug-15	Apr-16	Oct-15	
24	Typical Energy (MU) Injection into the ISTS	6818	989	18524	12010	17490	55831
25	Typical Energy (MU) withdrawal from the ISTS	6668	954	17981	11684	16861	54148
26	Typical ISTS Losses (in %)	2.2	3.5	2.9	2.7	3.6	3.01
27	Active Energy Settlement System in the Region	Net	Net	Net	Net	Net	
28	Deviation Account Administrator	ERLDC	NERLDC	NRLDC	SRLDC	WRLDC	
29	Active Energy Deviation rate used	CERC-DSM	CERC-DSM	CERC-DSM	CERC-DSM	CERC-DSM	
30	Settlement Period	15-min	15-min	15-min	15-min	15-min	
31	Deviation Settlement Cycle	Weekly	Weekly	Weekly	Weekly	Weekly	
32	Applicability of Deviation Charges on Solar / Wind RES	Yes	Yes	No	Yes	Yes	
33	Reactive Energy Interchange Settlement	Yes	Yes	No	Yes	Yes	
34	Typical Deviation Energy (MU) in a week due to Over Gen/UD	258	31	195	63	231	779
35	Typical Deviation Energy (MU) in a week due to Under Gen/OD	255	13	51	106	301	725
36	Typical Amount Payable to Regional Pool A/C (Rs. Lakh)	1716	405	5374	1385	2958	11839
37	Total Amount Receivables from Deviation Pool A/C (Rs. Lakh)	1587	365	2558	641	1508	6658

S No.	Particulars	ER	NER	NR	SR	WR	All India
38	Total Recovery in Deviation Pool A/C within due date (Rs. Lakh)	88	0	814	1385	1823	4110
39	Payment Security (LC/BG) for Receivable in Deviation Pool A/C	Yes	Yes	Yes	Yes	Yes	
40	Availability of Energy meter data in RLDC	Since 2003	Since 2003	Since 2002	Since 2005	Since 2002	
41	Format in which energy meter data is archived	Text/ Oracle Database	Text / Oracle Database	Text / Excel	Text	Text	
42	Is the Energy meter data used for load forecasting in the Region?	No	No	Yes (for solar)	No	No	
43	Is the Energy Meter data utilized for Big Data Analysis ?	No	No	Yes	Yes (Loss Analysis)	No	
44	Is the REA available in public domain?	Yes	Yes	Yes	Yes	Yes	
45	Is the REA verified by third party ?	No	No	No	No	No	
46	Peridocity of REA reconciliation with Regional Entities	No	No	No	No	No	
47	Availability of Energy Meter Data on RLDC website	Yes	Yes	Yes	Yes	Yes	
48	Availability of Deviation Account on RPC website	Yes	Yes	Yes	Yes	Yes	
49	Number of personnel deployed in Real-time functions	17	17	16	12	12	74
50	Number of personnel deployed Off-line functions	19	15	28	24	35	121
51	Number of personnel deployed in Commercial & Finance functions	11	7	15	10	10	195
52	Number of personnel deployed in Grid Security related functions	9	5	4	7	6	31
53	Annual RLDC Revenue from STOA for 2014-15 (in Rs. Lakh)	174	131	783	410	687	2186
54	Annual RLDC fees & Charges for 2014-15 (in Rs. Lakh) (Provisional)	4375	2238	4024	4306	4750	22160

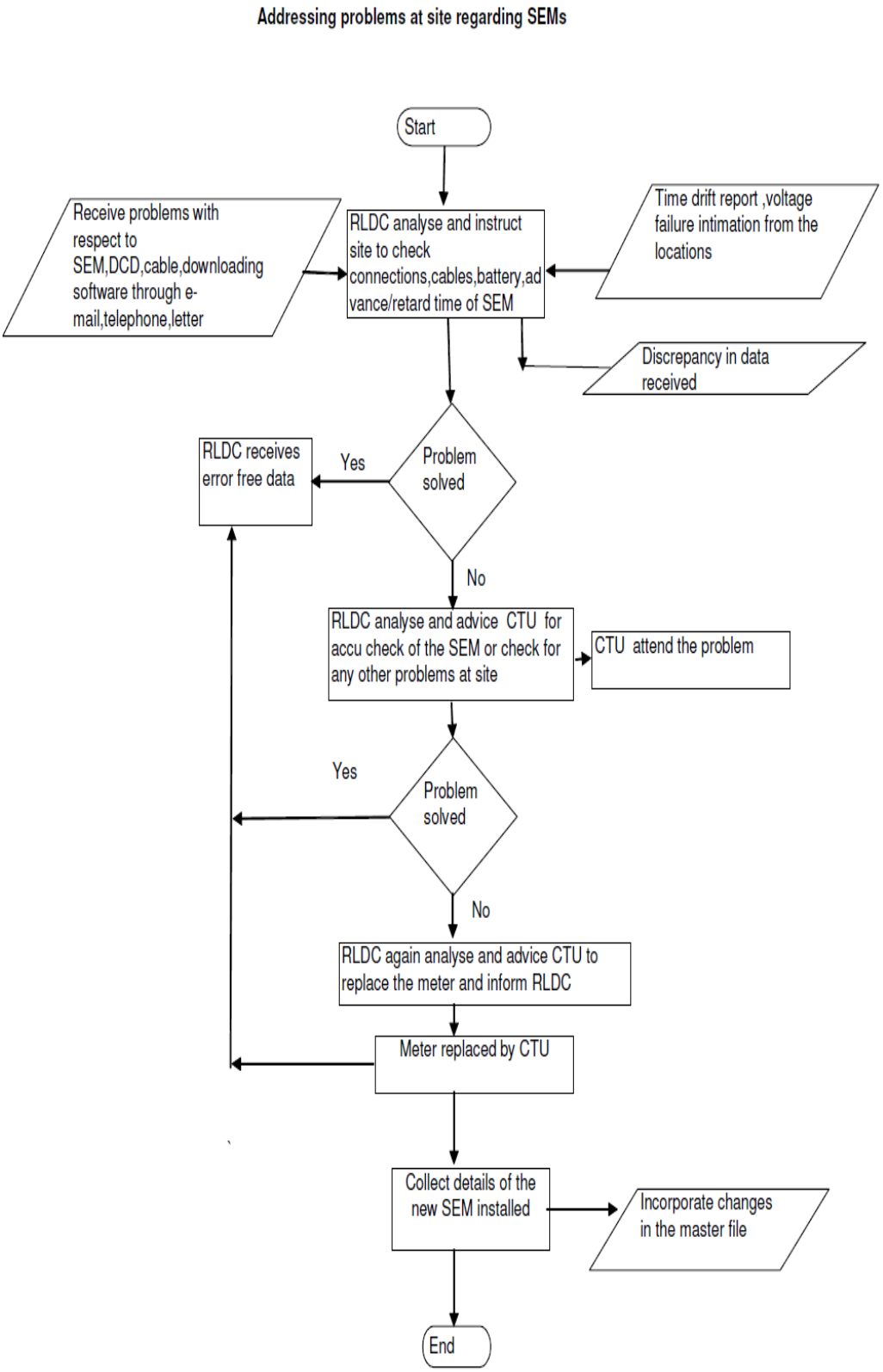
8. Common Metering Errors experienced at ISTS level are listed below:

The common metering errors include, change in IEM at substation without intimation at RLDC, CT Ratio Errors, Zero recording in IEM meters installed on HV/LV side of ICT, Under recording in IEM, Abrupt changes in Injection/Drawal/Loss due to time drift. Details are listed below:

a. Non-availability of all 3 phases PT/CVTs at all locations.
b. Usage of BUS PTs/CVTs for metering of transformers. The shutdown on BUS resulted in non-recording of data in multiple transformers at one location. The Bus change over switch were utilized.
c. Usage of PTs/CVTs and CTs of opposite side of the Delta-Star transformers. The 30 degree phase change caused wrong data recording.
d. Current Transformer (CT)/ Potential Transformer (PT)/ Voltage Transformer (VT) or Capacitive Voltage Transformer (CVT) connection/other issues related
e. Wrong polarity connection of CTs (P1-S1) to the meter resulting in
f. Polarity of all 3 phases reversed : sign reversal of the data recorded
g. Few phase polarity reversed : Lower reading
h. After shutdown works or extension of CT input to other devices, the all or two or one phase CT remaining shorted in the Terminal Block (TB): This would result in zero, two third or one third data recording respectively.
i. Fuse failure of PT/CVT supply to meter for one phase or two phases or all phases resulting in one third, two third or zero data recording respectively.
j. Loose connection of CVT supply to the meter resulting in lower data recording (as per meter specification data recorded with * mark when in a time block any time voltage of any phase was below 70% of nominal)
k. Non communication of change in CT ratio changes or wrong CT ration communication to the control centers and thus wrong computation of energy accounts as well as losses.
l. Meter and Meter Reading Instrument (MRI)/ Data Collecting Device (DCD) related:
m. Long outage of feeder and thus no CVT supply to the meter for long resulting draining of internal battery backup provided and thus no data downloading possible with the use of battery backup.
n. Non charging of DCD and thus issues in timely data down loading.
o. Meter not responding to DCD commands:
p. In most cases reason being lead connecting Optical Connector and DCD being faulty.
q. In some cases meter being faulty and need to be replaced.
r. Non charging of meters kept in store and therefore clock drifting by very high time difference.
s. Truncating the time blockwise energy recording in the meter memory to the desired number of decimal in place of rounding off the readings. This resulted in large difference in day total energy vis-s-vis summation of all time block energy of the day.
t. High time drift in meters
u. CT ratio used being much lower than occasional very high current in the primary: Memory space restricted in meters and therefore, overflow of secondary data recorded for the time block. (telemetry system data also get frozen)

v. Non filling of zero data in remaining time blocks wherein feeder/line was under shutdown and data down loaded through use battery backup.
w. Some time issues like non information of changes in bays (bay swapping) in a substation, line getting tapped (usually lower voltage lines) have also been experienced.

9. Process for troubleshooting Metering Errors



10. Meter Certification

The Interface Energy Meters are tested and calibrated at periodic interval. A sample caliberation certificate is placed below:

ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION
(Accredited by the National Accreditation Board for Testing and Calibration Laboratories, Govt. of India)
ERDA Road, Makarpura Industrial Estate, Vadodara-390 010, India.
EPABX : +91 (0265) 2642942, 2642964, 2642377, 3043128 / 29 / 30 / 31 / 33
Fax : +91 (0265) 2638382
E-mail : erda@erda.org
Web : http://www.erda.org
Certificate No.: T-1871

TEST REPORT **SHEET 1 OF 6**

NAME & ADDRESS OF CUSTOMER	**REPORT NO.**: RP-1516-050831	
	DATE: 25/03/2016	
POWERGRID CORPORATION OF INDIA LTD. NORTHERN REGION-1, HEADQUARTERS, B-9, QUTAB INSTITUTIONAL AREA, KATWARIA SARAI, NEW DELHI-110016.	**CUSTOMER REF No.:** P.O. No.: 5100001508 **Dtd.:** 29/07/2015	
	DATE OF SAMPLE RECEIPT	**DATE OF TESTING**
	25/03/2016	25/03/2016

SAMPLE DESCRIPTION		**SAMPLE IDENTIFICATION**	
3 Phase 4 Wire System Electronic Trivector Meter		**Sl. No.**	**ERDA SAMPLE CODE No.**
Type/Model :	ER300P	NP-1259-A	WO-1516-10312/416
Voltage/Freq. :	3x63.5V / 50Hz		
Current :	-/1A (Ib: 1A, Imax: 1.2A)		
Pulse rate :	50/unit (Wh, VArh)		
Class :	0.2S		
Year :	1999		
Make :	LARSEN & TOUBRO LIMITED, MYSORE, INDIA	Meter with insulating enclosure and electronic display	
Location:	220kV KANPUR FEEDER - 3 - Main Meter		

TEST DETAILS	**TEST SPECIFICATION**
1 Tests of accuracy requirements	Cl.No.8.0 of IEC: 62053-22, 23 & 62052-11-2003
1.1 Limits of error due to variation of current	Cl.No.8.1 of IEC: 62053-22, 23 & 62052-11-2003
1.2 Test of starting condition	Cl.No.8.3.1 & 8.3.3 of IEC:62053-22,23 & 62052-11-2003
1.3 Test of no-load condition	Cl.No.8.3.2 of IEC: 62053-22, 23 & 62052-11-2003

WITNESS BY: Mr. Vikas Khare, Manager, NTPC, Unchahar

NOTE: 1) Only the tests asked by the customer have been carried out.
2) Meter was tested considering class 2 for reactive mode as per Customer request.
3) After Testing seal fixed on meter bearing ERDA Seal No.: 0304698.

REMARK -The above energy meter conforms to the requirements in respect of the tests carried out.

PREPARED BY **CHECKED BY** Dr. Vinod Gupta **APPROVED BY**

Notes :
1. This report relates only to the particular sample received in good condition and tested at site NTPC, Unchahar.
2. This report cannot be reproduced in part under any circumstances.
3. Publication of this report requires prior permission in writing from Director, ERDA.
4. Only the tests asked for by the Customer have been carried out.
5. In case of any dispute, Vadodara will be the exclusive jurisdiction & shall be construed as where the [illegible] has placed.

Caution: ERDA is not responsible for the authenticity of photocopied or reproduced test reports.
ERDA provides support to Customers for verification of authenticity of the test reports issued by ERDA.

ELECTRICAL RESEARCH AND DEVELOPMENT ASSOCIATION
(Accredited by the National Accreditation Board for Testing and Calibration Laboratories, Govt. of India)
ERDA Road, Makarpura Industrial Estate, Vadodara-390 010, India.
EPABX : +91 (0265) 2642642, 2642664, 2642377, 3043128 / 29 / 30 / 31 / 33
Fax : +91 (0265) 2638552
E-mail : erda@erda.org
Web : http://www.erda.org
Certificate No. : 1001

TEST REPORT NO. : RP-1516-050831 DATED: 25/03/2016 SHEET 2 OF 6

Sl No.	Particular of tests & Cl. No.	Requirement as per specification			Obtained value	Remarks
1	Test of accuracy requirements (Cl. No. 8.0 of IEC: 62053-22 & 23)					
1.1	Limits of error due to variation of the current (Cl.No. 8.1 of IEC: 62053-22 & 23)	Active Energy			Meter No. :	Conforms
		With balanced loads		3phase	RP-1259-A	
		Current	cosΦ	Limit	Obtained %error	
		0.01In	1.0	±0.4	-0.02	
		0.02In	1.0	±0.4	-0.05	
		0.05In	1.0	±0.2	-0.08	
		0.1In	1.0	±0.2	-0.07	
		0.2In	1.0	±0.2	-0.08	
		0.5In	1.0	±0.2	-0.05	
		1.0In	1.0	±0.2	-0.03	
		Imax	1.0	±0.2	-0.03	
		0.02In	0.5ind.	±0.5	+0.02	
		0.05In	0.5ind.	±0.5	-0.08	
		0.1In	0.5ind.	±0.3	-0.10	
		0.2In	0.5ind.	±0.3	-0.08	
		0.5In	0.5ind.	±0.3	-0.07	
		1.0In	0.5ind.	±0.3	+0.17	
		Imax	0.5ind.	±0.3	+0.04	
		0.02In	0.8cap.	±0.5	-0.07	
		0.05In	0.8cap.	±0.5	-0.09	
		0.1In	0.8cap.	±0.3	-0.04	
		0.2In	0.8cap.	±0.3	-0.07	
		0.5In	0.8cap.	±0.3	-0.08	
		1.0In	0.8cap.	±0.3	-0.06	
		Imax	0.8cap.	±0.3	-0.05	

TE 1923238

PREPARED BY

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15. SLDC Goa- V.G.S. Kunkoliekar, Shilpa
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18. SLDC Jharkhand –Shailendra Prakash
19. SLDC Odhisha – P.K. Mishra, P.K. Das
20. SLDC West Bengal – D. Bhattacharyya, M. Sarkar
21. SLDC DVC-S.K. Kundu, P. Biswas
22. SLDC Andhra Pradesh – A. K V Bhaskar
23. SLDC Telangana -P Suresh Babu
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WISEMEN SPEAK

"You can't manage what you can't measure" – Edwards Deming

"In God we trust, all others must bring data" – W. Edwards Deming

"The truth is rarely simple and never pure." Oscar Wilde

"Romance should never begin with sentiment. It should begin with science and end with a settlement" - Oscar Wilde

"The least initial deviation from the truth is multiplied later a thousand fold"-Maya Angelou

"The biggest human temptation is to settle for too little"- Thomas Merton

"Only accountants can save the world - through peace, goodwill and reconciliations" - Anonymous

"A lack of transparency results in distrust and a deep sense of insecurity" – Dalai Lama

"Numbers have important story to tell. They rely on you to give them a voice" – Stephen Few

"And a step backward, after making a wrong turn, is a step in the right direction." - Kurt Vonnegut, (Piano Player)

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete" - R. Buckminster Fuller

सत्येन् धर्यते पृथ्वी सत्येन् तप्ते रविः
सत्येन् वति वयुस्ट्च्ह सर्व्म् सत्ये प्रतिस्ट्थितम् ॥- चाणक्य नीति
[The earth is supported by Truth; by Truth the Sun radiates heat; by Truth the air blows; everything is established in Truth.]

समानी वः आकूतिः समाना दयानि वः |
समानम् अस्तु वो मनः यथा वः सुसहा असति ||
यथा वः सुसहा असति ||- ऋग्वेद
[Let your conclusions be ONE (or be alike), Let your hearts be the same (or be alike)]

Implementation Aspects of DSM and F&S framework at state level

FOR Technical Committee Meeting

15-Jul-2016

Agenda

- State level F&S framework - Comparative Analysis and Key Objections
- Implementation Aspects
  - Qualified Coordinating Agency (QCA)
  - Operationalisation of Virtual Pool and De-pooling Mechanism
  - Funding the deficit in State Imbalance Pool
  - Metering arrangement
  - Treatment for Inter-State RE transactions of State Entities
- Way forward

Comparison of State level F&S Framework – 1/3

Sr. No.	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)
1	**Applicability**	Wind and solar generators selling power within or outside the state	Wind generators combined capacity 10 MW and above. Solar generators capacity 5 MW and above within or outside the state	Wind and solar generators selling power within or outside the state	Wind and solar generators selling power within the state	Wind and solar generators selling power to discoms/third party sale/captive consumption through OA: >5MW connected to state grid
2	**Forecasting Responsibility**	Wind and solar generator or by QCA Or forecast by SLDC to be accepted	Wind and solar generator or QCA or aggregator Alternatively through REMC	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted
3	**Scheduling Responsibility**	Wind and solar generator or by QCA	Wind and solar generator or QCA or aggregator. Alternatively through REMC	Wind and solar generator or by QCA	Wind and solar generator or by QCA	Wind and solar generator or by QCA
4	**Computation of Error Formula**	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator

In addition, JSERC (Jharkhand) and JtERC (Manipur & Mizoram) have also published draft F&S Regulations in line with FOR Model.

Comparison of State level F&S Framework – 2/3

Sr. No.	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)
5	**Tolerance Band for DSM**	10% new wind and solar generator. < = 15% existing wind and solar generator	± 15% for wind and solar generators	< = 10% new wind and solar generator , < = 15% existing wind and solar generator	< = 10% for wind generators. < = 5% for solar generator	± 15% for wind and solar generators
6	**Scheduling Requirement**	Weekly and day-ahead with maximum 16 revisions during a day	Weekly, day-ahead and intra-day with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day
7	**Reference point for DSM**	Pooling station	Pooling station/ Aggregator Level	Pooling station	Pooling Station	Pooling station
8	**Apportion of Energy Deviations & DSM Charges among RE generators at a pooling S/S**	In proportion to actual generated units or available capacity	No provision	In proportion to actual generated units or available capacity	In proportion to actual generated units or available capacity	In proportion to actual generation units

Comparison of State level F&S Framework – 3/3

Sr. No.	Particulars	FOR Model F&S	KERC (final)	MPERC (draft)	TNERC (draft)	RERC (draft)
9	Telemetry and Communication Requirement	Data relating to power system output and weather	Data relating to power system output and weather, turbine availability	Data relating to power system output and weather	Data relating to power system output and weather	Data relating to power system output and weather
10	Responsibility of Providing Telemetry and Communication	Generator	Wind and solar principal generator/QCA/ Aggregator	Generator	Generator	Wind and solar principal generator/QCA
11	Procedure for Data Telemetry and Communication	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC
12	DSM For Sale Outside State Specified	Yes	No	Yes	No	No (stipulates that charges for DSM as per CERC DSM Regulations,2014)
13	Meeting Shortfall of DSM Pool	PSDF and NCEF	No provision	PSDF and NCEF	No provision	No provision

Key objections/suggestions received

Operational Issues

- **Clarity on Qualifying criteria and Governance structure of QCA**
- **F&S framework should be implemented subject to implementation of Intra state ABT**
- **Metering and data collection shall be the responsibility of STU**
- Data Telemetry at pooling S/S level instead of turbine/inverter level
- Standardisation of hardware and software required for forecasting and scheduling
- Grid code regulations be aligned with scheduling requirements
- **Provisions for inter-state sale of RE power in line with F&S regulations**

Strategic Issues

- Effective date to be fixed after 6 to 12 months
- Tariff to be revised to recover investments in in data telemetry/SCADA
- Tolerance band to be liberalised
- Applicability to cover only New Projects

Clarifications required in F&S framework

Role of QCA and it's eligibility criteria	Operation-alisation of Virtual pool within the state imbalance pool	Mechanism of deviation settlement at pooling S/S level	Funding deficit of the state imbalance pool	Diverse sets of metering practises being followed across states	DSM mechanism for RE Gen. connected to STU with inter-state transactions
a) Regulatory oversight of QCA in appropriate regulations b) Technical &Financial Criteria of QCA c) Governance mechanism of QCA d) Model Term sheet	a) Mechanism of Operation of virtual pool. b) Entity responsible for operating the virtual pool	a) Principles of de-pooling of deviation charges b) Between RE generators at the pooling S/S	a) Dependence on national level funds for long term and its sustainability. b) Need for creation of state level funds for funding deficit	a) Need for creating standardised metering points in all states b) Devising Uniform metering and energy accounting policy	a) Treatment for RE Generators with multiple transactions at Pooling S/S level

Implementation of Intra-state DSM mechanism, Adopting Standardised IT/communication protocol, Enhanced visibility of RE generators at SLDC Level will provide a facilitative mechanism to the above

Issue-1: Role of QCA (as per FOR Model F&S framework)

- **Provide schedules with periodic revisions** on behalf of all the Wind/Solar Generators connected to the pooling station(s),
- **Responsible for** metering, data collection/transmission, communication, coordination with DISCOMS, SLDC and other agencies.
- **Undertake commercial settlement** of all charges on behalf of the generators, including payments to the State UI pool accounts through the concerned SLDC.
- **Undertake de-pooling of payments** received on behalf of the generators from the State UI Pool account and settling them with the individual generators
- Undertake commercial settlement of any other charges on behalf of the generators as may be mandated from time to time.

Key considerations for QCA

Nos. of QCAs operating at a pooling S/S

a. Single or Multiple QCA at a pooling S/S.
b. Mechanism for selection and appointment of QCA (by RE Generators)
c. Recognition of QCA by State Agencies (SLDCs/REMC). Mapping of QCAs vis-a-vis Pooling S/S.
d. QCA to be single point of contact with the SLDC.
e. Role of REMCs and data/information exchange between QCA and REMC

Institutional and Governance Mechanism

a. Should QCA be a company or an association ?
b. Is it necessary to get QCA registered? If yes, whether registered with SLDC, NLDC,RLDC?
c. Can QCA be a Committee comprising of representatives of RE generators at the pooling S/S.
d. Should it be a generator franchisee?
e. Distinction of roles/responsibilities of QCA vis-à-vis Principal/Lead generator

Technical Criteria and Financial Criteria

a. Technical Criteria would be guided by the roles entrusted to QCA.
b. Should it be entrusted with the responsibility handling all commercial issues or only for Deviation settlement?
c. Analysis of desired skill set/capabilities of QCA
d. Assessment of QCAs ability to undertake financial transactions – Networth, Turnover, Solvency

Issue-1 : Institutional structures for QCA -1/4

Option 1: Registered Entity with NLDC or concerned SLDC	Option 2: Generator Franchisee	Option 3: Committee
• Conditions/ Qualification/ Registration requirements for 'Registered Entities' to undertake scheduling and deviation settlement of variable power at Pooling S/S needs to be defined under Grid Code Regulations (CERC) and/or Procedures (NLDC)	• QCA will act as Generation Franchisee, for and on behalf of RE Generators connected to Pooling S/S	• Representatives from RE generators connected to the pooling S/S form a group/committee to carry out the functions of QCA

Issue-1 : Institutional structures for QCA -2/4

Key Features	Option1: Registered entity with NLDC	Option2: Generator Franchisee	Option3: Committee of RE Generators
Eligibility Criteria	• Compliance to Technical and Financial Criteria for getting registered with NLDC to be laid down by CERC	• Technical capabilities and financial credentials to be decided by RE Generators	• All RE generators connected to the pooling S/S form a Committee
Constitution and Composition	• Regulatory oversight through SLDC • Managed/ Guided by Technical Experts from the industry with understanding of the technical functions, financial credentials of handling large fund transactions, computational capabilities	• Responsibility of selection RE Generators • Experts in the field of forecasting, scheduling having capabilities to undertake large financial transactions and settlement form an entity that acts as a franchisee to the RE generators	• Representatives from each constituent RE generators to be member of Committee to undertake the role of QCA • Composition in the form of loose association or Group with business rules/charter of operations.
Mandatory Roles	1. Provide schedules and revisions at pooling S/S 2. deviation settlement 3. Coordination With NLDC, SLDC 4. Provide turbine/generator data to SLDC	1. Provide schedules and revisions at pooling S/S 2. deviation settlement 3. Coordination With NLDC, SLDC 4. Provide turbine/generator data to SLDC	1. Provide schedules and revisions at pooling S/S 2. deviation settlement 3. Coordination With NLDC, SLDC 4. Provide turbine/generator data to SLDC

Issue-1 : Institutional structures for QCA -3/4

Key Features	Option1: Registered entity with NLDC	Option2: Generator Franchisee	Option3: Committee of RE Generators
Participation Fees	• As stipulated by NLDC	• Decided by generators	• NIL
Default and Remedy Measures	• Financial Penalty both by SLDC and RE generators for commercial implications • Disputes to be resolved by SERCs • Blacklisting by NLDC in case of major errors/ frauds	• Financial penalty by RE generators and SLDC • Disputes to be resolved in terms dispute resolution or arbitration mechanism outlined under Franchisee Agreement.	• Financial penalty by SLDC • Disputes among Generators to be resolved through negotiations. Committee cannot sue or cannot be sued unless separate structure as cooperative society or /association is formed.
Revenue Model	• QCA and RE Generators to mutually decide Professional charges for scheduling & Deviation Settlement in INR/MWh or MW	• **QCA and RE Generators to mutually decide Professional charges for scheduling & Deviation Settlement in INR/MWh or MW**	• Not applicable • Organised on the principle of Cost sharing
Contractual Agreement	• Multilateral between all RE generators and QCA • Conditions for Registration/ Empanelment to guide SLDC & QCA	• Bilateral Agreement between lead generator and QCA • No agreement necessary between QCA and SLDC. Governed by Regulations/Procedure	• Agreement among all RE generators to form a committee • Agreement between committee and SLDC

Issue-1 : Institutional structures for QCA -4/4

	Company	Association of Persons	Cooperative society
Registered Entity with NLDC	Yes	No	Yes
Generator Franchisee	Yes	No	No
Committee	No	Yes	Yes

Potential Options for structuring QCAs:

1. *Option-1: Company registered with NLDC*
2. *Option-2: Co-operative society registered with NLDC*
3. *Option-3: Company which acts as a generator franchisee*
4. *Option-4: Committee formed with association of persons*
5. *Option-5: Committee formed which is a cooperative society*

- Option-1 as Company registered with NLDC/SLDC is most tenable institutional structure.
- This Institutional structure is amenable to better control, regulatory oversight, scalable and accountability

Issue-1 : Eligibility Criteria for QCA

Technical Criteria

- Capability to handle real time communication with SLDC 24X7
- Demonstrable IT capabilities : IT Resources (database, manpower, licenses) and Infrastructure (hardware and software)
- Experience (at least 2 yrs) of Metering, Billing, Consumer in any domain
- Manpower requirement: Qualified professionals in min. 3 yr experience in power systems or renewable energy systems – planning or development or operations.
- Code of Conduct – adherence to statutory compliances/registrations

Financial Criteria

- Networth of the Entity to be related to monetary value of state imbalance pool and/or Capacity at Pooling S/S and state level
  - *Networth requirement of INR 1,00,000/- per MW*
  - *(Est. for Pooling S/S 100 MW with annual generation of 200 MU. Deviation volume estimated @10% 20 MU @ deviation charge Rs 3 pu = Rs 60 p.a. or Rs 5 Mn/month for 100 MW i.e. Rs 50000/MW per month. Networth equivalent to at least 2 month Deviation Charge Volume = Rs 1,00,000/MW.)*
- Profitable Operations (past 2 yrs) – Avg. Annual Turnover (INR 5 Crore) and Positive Profit after Tax
- Total tangible and intangible assets requirements (Min GFA of INR 25 Lakh)

Operationalising Virtual Pool and De-pooling

- **Clause 3.7 (Virtual Pool)**: Once the accounting procedures as above are in place, all RE generators shall be treated together as a 'virtual pool' within the State Pool. Deviations for and within this virtual pool could be settled first at the rates and methodology stipulated for wind and solar generators.
- **Clause 3.5 (De-pooling):** The QCA shall also de-pool the energy deviations as well as deviation charges to each generator using one of the following options:
  - In proportion to actual generated units for each time-block for each generator;
  - In proportion to available capacity of each generator

Issue 2 – Computation of Deviation Charges at Pooling S/S

Pooling Station No	Available Capacity (MW)	Schedule (MW)	Actual Injection (MW)	Deviation (MW)	Deviation (%)	Dev. Charges payable by Individual Pooling Stations (F)
	(A)	(B)	(C)	(D)	(E)	
P.S. – 1	140	100	130	30	21%	4,500
P.S. - 2	320	200	210	10	3%	-
P.S. - 3	480	300	360	60	13%	-
P.S. - 4	360	200	190	-10	-3%	-
P.S. - 5	220	150	80	-70	-32%	26,000
Grand Total	**1520**	**950**	**970**	**180 (ABS) +20 (state)**	**12%**	**30,500**

a. Mechanism of operationalisation of the virtual pool within the state imbalance pool.
b. QCA to undertake settlement of only Deviation Charges at Pooling with State Imbalance Pool.
c. Settlement of Actual /Schedule injection directly between Buyer and Seller.

Issue 3 – De-pooling of Deviation Charges amongst RE Generators

Pooling Station No (PS-5)	Available Capacity (MW)	Schedule (MW)	Actual Injection (MW)	Deviation (MW)	Deviation (%)	Dev. Charges payable by RE Generators (F)
	(A)	(B)	(C)	(D)	(E)	
RE Gen – 1	20		-			-
RE Gen – 2	50		10			3,250
RE Gen – 3	60		30			9,750
RE Gen – 4	40		20			6,500
RE Gen – 5	50		20			6,500
Grand Total	**220**	**150**	**80**	**-70**	**-32%**	**26,000**

a. QCA to provide energy credit statement (monthly / weekly).

b. De-pooling of Deviation Charges amongst RE Generators on 'Actual' injection instead of 'Av. Capacity'

- Report for Energy Credit Statement with actual injection by each RE Generator is readily available.
- Average Available capacity over deviation settlement period (weekly or monthly) need to be ascertained.
- Certification of Available Capacity over settlement period would be challenge.

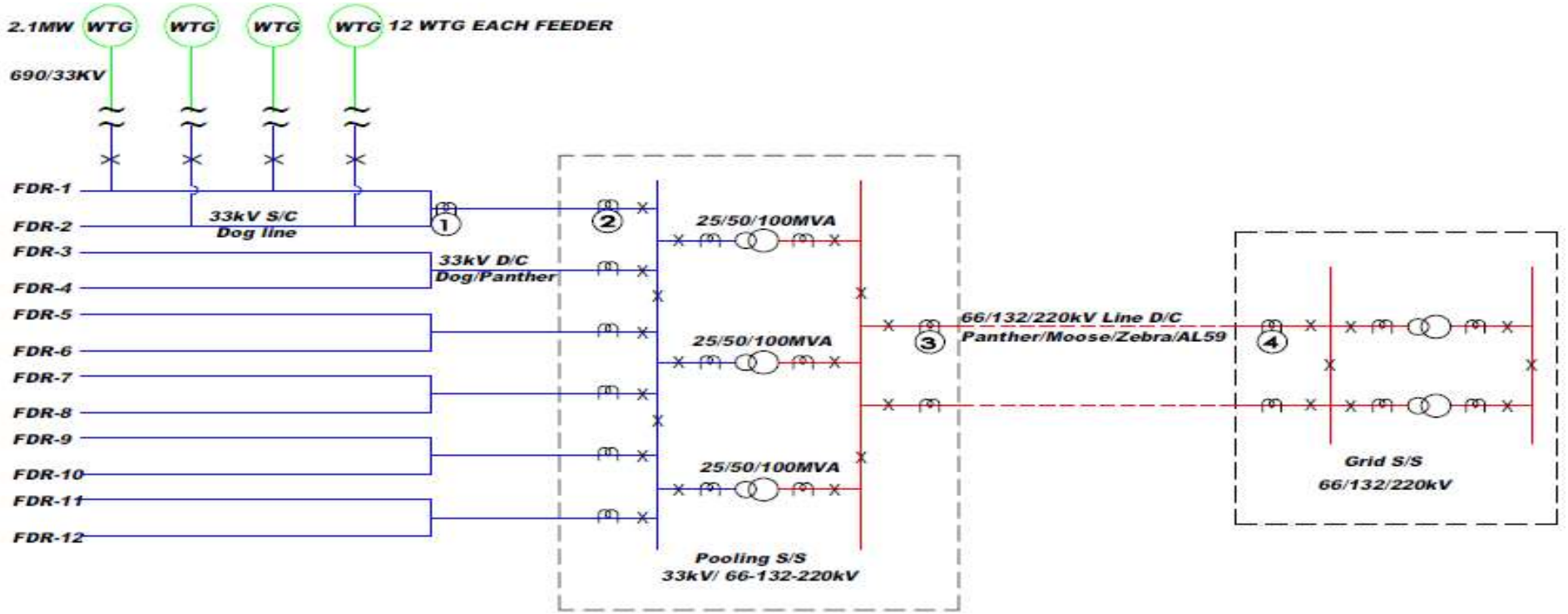
Issue-4 : Funding deficit in state imbalance pool

- **Clause 3.8** : For covering the deficit in the overall pool, at the end of the year the SLDC may approach the National Funds such as PSDF or NCEF

Discussion Points

- Whether meeting the deficit from PSDF/NCEF on a long term basis is sustainable?
- Designing of state level Imbalance Pool with 'Non-Zero Sum' features is crucial.
- Creating State level funding support mechanism to manage deficit
  - Levy of System Benefit charges (paise/MWh)
  - Regulatory charges for shortfall in RPO Compliance

Issue-5: Standard Metering and Accounting practices



State	AP	GJ	KN	MH	MP	RJ	TN
Billing Meters Position	3&4	3	4	2&3	1	2&4	0&1

- Uniform practice for Energy Accounting for DSM computations to be adopted. Model DSM Regulations to cover.

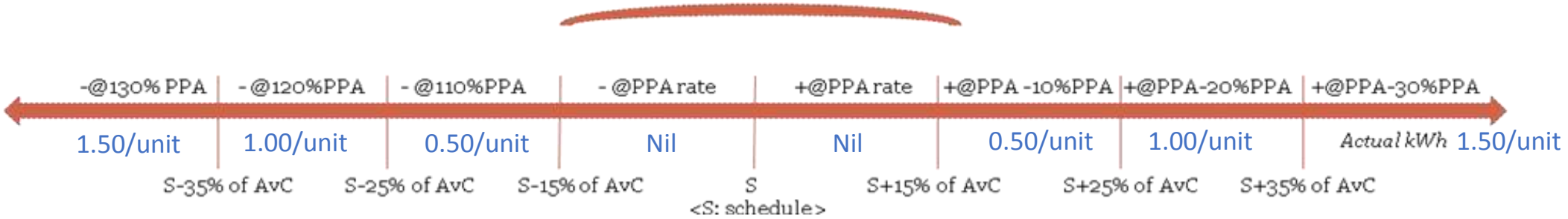
Issue-6 : Mechanism for DSM for inter-state transactions

- **Payments to RE Generators** are made on the following basis:
  - Inter-state transactions- Scheduled energy basis
  - Intra-state transactions- Actual energy basis

- **Rates for deviation settlement** for RE generators undertaking **inter-state transaction is based** percentage of PPA Rate or APPC (i.e. 90%, 80% and 70%) in steps**.**
- **Rates for deviation settlement** for RE generators undertaking **intra-state transaction** is based on fixed amount (Rs 0.50, Rs 1.00 and Rs 1.50/kWh) in steps

- **Deviation Charge settlement** on the following basis:
  - Inter-state transactions:
    - For Over-injection – Receipt from DSM Pool
    - For Under-injection – Payment into DSM Pool
  - Intra-state transactions:
    - For Over-injection – Payment into DSM Pool
    - For Under-injection – Payment into DSM Pool

Issue-6: Mechanism for DSM for intra/inter-state transactions



- Error definition: [(Actual generation – Scheduled generation)/Available Capacity] x 100
- Payment as per schedule @PPA Rate
- Deviation Settlement within tolerance band (+/- 15%):
  - Receipt from/payment to pool @PPA rate (i.e. in effect, payment as per actuals)
- Beyond 15%, a gradient band for deviation charges is proposed as follows:

Abs Error (% of AvC)	***Deviation Charge***	***Deviation Charge***
15%-25%	110% or 90% of PPA rate	0.50/unit
25%-35%	120% or 80% of PPA rate	1.00/unit
>35%	130% or 70% of PPA rate	1.50/unit

- 16 revisions allowed, one for every one-and-half-hour block, effective from 4th time-block.

Issue-6: Illustration for DSM for inter-state transactions – 1/3

	Example 1: (Within tolerance band of +/- 15%)		
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	Scenario I: Intra-state wheeling	Scenario II: Inter-State wheeling
	Actual Generation	110	110
	% Absolute Error	10%	10%
	Buyer Pays	5*110*1000 = 550,000 (on actual basis)	5*100*1000 = 500,000 (on schedule basis)
	Seller Receives	550,000	500,000
Seller to DSM	Add: Seller Receives from DSM Pool or pays into pool for Deviation upto 15%	None	5*(110-100)*1000 =50,000
Seller to DSM	Add: Deviation Charge @ Rs 0.50/unit or @ 90% of Fixed rate for Deviation Between 15%-25%	-	-
Seller to DSM	Add: Deviation Charge @ Rs 1.00/unit or @ 80% of Fixed rate for Deviation Between 25%-35%	-	-
Seller to DSM	Add: Deviation Charge @ Rs 1.50/unit or @ 70% of Fixed rate for Deviation Beyond 35%	-	-
Seller to DSM	Total Receipt from/(payment to) Pool	(Nil)	50,000
	Net Revenue of Generator	550,000	550,000

Issue-6: Illustration for DSM for inter-state transactions – 2/3

Example 2: (For tolerance band > 35%)			
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	**Scenario I: Intra-state wheeling**	**Scenario II: Inter-State wheeling**
	Actual Generation	140	140
	% Absolute Error	40%	40%
	Buyer Pays	**5*140*1000 = 700,000 (on actual basis)**	**5*100*1000 = 500,000 (on schedule basis)**
	Seller Receives	700,000	500,000
Seller to DSM	**Add: Seller Receives from DSM Pool or pays into pool for Deviation upto 15%**	(None)	5*(115-100)*1000 =75,000
Seller to DSM	**Add: Deviation Charge @ Rs 0.50/unit or @ 90% of Fixed rate for Deviation Between 15%-25%**	(0.5)*10*1000 = (5000)	(5*90%)*10*1000 = 45000
Seller to DSM	**Add: Deviation Charge @ Rs 1.00/unit or @ 80% of Fixed rate for Deviation Between 25%-35%**	(1.00)*10*1000 = (10000)	(5*80%)*10*1000 = 40000
Seller to DSM	**Add: Deviation Charge @ Rs 1.50/unit or @ 70% of Fixed rate for Deviation Beyond 35%**	(1.50)*5*1000 = (7500)	(5*70%)*5*1000 = 17500
Seller to DSM	**Total Receipt from/(payment to) Pool**	**(22,500)**	**177,500**
	Net Revenue of Generator	**677,500**	**677,500**

QCA to settle

Issue-6: Illustration for DSM for inter-state transactions – 3/3

Example 3: (For tolerance band > - 35%)			
	Schedule (MWh)	100	
	PPA Tariff (Rs/Unit)	5	
	Available Capacity (MWh)	100	
	Scenario	**Scenario I: Intra-state wheeling**	**Scenario II: Inter-State wheeling**
	Actual Generation	60	60
	% Absolute Error	-40%	-40%
	Buyer Pays	**5*60*1000 = 300,000 (on actual basis)**	**5*100*1000 = 500,000 (on schedule basis)**
Seller to DSM	**Seller Receives**	3,00,000	5,00,000
Seller to DSM	**Add: Seller Receives from DSM Pool or pays into pool for Deviation upto 15%**	(None)	5*(85-100)*1000 = (75,000)
Seller to DSM	**Add: Deviation Charge @ Rs 0.50/unit or @ 110% of Fixed rate for Deviation Between 15%-25%**	(0.5)*10*1000 = (5000)	(5*110%)*(-10)*1000 = (55000)
Seller to DSM	**Add: Deviation Charge @ Rs 1.00/unit or @ 120% of Fixed rate for Deviation Between 25%-35%**	(1.00)*10*1000 = (10000)	(5*120%)*(-10)*1000 = (60000)
Seller to DSM	**Add: Deviation Charge @ Rs 1.50/unit or @ 130% of Fixed rate for Deviation Beyond 35%**	(1.50)*5*1000 = (7500)	(5*130%)*(-5)*1000 = (32500)
Seller to DSM	**Total Receipt from/(payment to) Pool**	**-22,500**	**-2,22,500**
	Net Revenue of Generator	**2,77,500**	**2,77,500**

QCA to settle

Issue-6 : Mechanism for DSM for inter-state transactions – 1/2

Key Issues for Discussion

- Some RE generators connected to a particular pooling S/S may undertake intra-state transaction while others may wish to undertake inter-state transactions
- As schedules are prepared at pooling S/S level, carrying out deviation settlement poses challenge.
- Rules for Treatment for such transactions needs to be defined.

Issue-6 : Mechanism for DSM for inter-state transactions – 2/2

Potential Solution

- All inter-state transactions at a pooling S/S to be allowed if connected through separate feeder.
- Deviations for Inter-State and Intra-State transactions at Pooling S/S to be accounted for separately.
- Virtual Pool Accounting at State level to exclude such Deviation Accounting for inter-State transactions
- SLDC/State Energy Account to provide separate Energy/DSM accounts for inter-State and intra-state transactions to QCA.
- QCA to separately settle Deviation Charges with RE Generators for inter-State and intra-State transactions.
- In case of shortfall in amount at QCA level or for variation in weekly/monthly cycle, QCA may set rules for pro-rata settlement of inter-State and intra-state transactions of RE Generator(s).
- Reference rate for Deviation Charge computation of inter-State transactions may be APPC of host State.

Way forward

- Addressing implementation aspects of F&S Framework is crucial from operationalising F&S for variable RE.
  - **Institutional aspects of QCA** to be recognised through suitable amendments in IEGC and State Grid Code. *(QCA as Registered Entity)*
  - **Model DSM Framework/Regulations** at State level to be formulated (*To address rules for virtual pool operationalisation, de-pooling arrangement, clarity on rules/treatment for intra-State and inter-state wheeling transactions of State Entities)*
  - **Clarity on Procedures/Rules** for claiming shortfall in State DSM Pool due to RE *(Treatment for funding deficit in state level DSM Pool or Amendment to existing Regulations to create State level funding support)*
  - **Model Procedures /Code for** Metering, Communication, Energy Accounting for RE to accomplish uniformity across states. *(To address Energy Accounting, Communication, Data telemetry, Metering and Loss accounting)*
- Action Plan and Timelines to be finalised

Thank You