

# First Report of FOR Technical Committee on Implementation of Framework for Renewables at the State Level

(Covering proceedings: December 2015 – November 2017)

Volume-II

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**ANNEXURE-1** 



# Report

on

# Scheduling, Accounting, Metering

and

# Settlement

of

# **Transactions in Electricity**

# (SAMAST)

July 2016



# केन्द्रीय विद्युत विनियामक आयोग CENTRAL ELECTRICITY REGULATORY COMMISSION



Gireesh B. Pradhan Chairperson

### Foreword

As of 31<sup>st</sup> December, 2013, India has achieved 'One Nation – One Grid – One Frequency'. While grid reliability and management has improved significantly along with the frequency profile, several building blocks of a developed grid are yet to be put in place. One of them is a comprehensive Accounting and Settlement system that streamlines trade and exchange of power across state/regional boundaries.

The activity assumes greater importance with the growing penetration of the Renewable Energy Sources (RES) / Distributed Energy Resources (DER) coupled with manifold increase in the intra-state, inter-state, interregional and transnational in bulk electrical energy transactions. The bulk energy transactions whether from renewable or conventional would ultimately require scheduling, measurement of physical delivery, book keeping, settlement and clearing in energy as well as in financial terms. Considering the overarching objectives of reliable 24x7 power and one market, it is essential that the adopted systems and procedures at various Load Despatch Centres should be compatible with each other.

The Electricity Act entrusts the Load Despatch Centres with the responsibility of ensuring reliability, economy and efficiency of the power system. This inter-alia requires forecasting of load and RE generation; ensuring load-generation balance in real-time as well as compilation and analysis of the Energy Balance Sheets, Deviation Statements and Transmission Loss at the grid level for every time-block. Further, these energy statements should have all the attributes of 'understandability', 'relevance', 'reliability', and 'comparability' as enumerated in the accounting standards.



# केन्द्रीय विद्युत विनियामक आयोंग CENTRAL ELECTRICITY REGULATORY COMMISSION



# Gireesh B. Pradhan Chairperson

This report on Scheduling, Accounting, Metering And Settlement of Transactions in electricity, or 'SAMAST', discusses all the above issues in great detail. It is a matter of satisfaction that the report was prepared under the guidance of the Technical Committee of the Forum of Regulators (FOR) after exhaustive consultations with the State, Regional and National Load Despatch Centres. It provides a roadmap for implementing a robust, scalable and dispute-free scheduling, metering, accounting and settlement system in the States. The report lays down the basic framework and governance structure for SAMAST including the IT infrastructure and human resources required for Market Operations function discharged by the State Load Despatch Centre.

The report was adopted by the Technical Committee in its 5<sup>th</sup> meeting and <sup>\*</sup> accepted by the Forum of Regulators in its 55<sup>th</sup> meeting held on 22<sup>nd</sup> July 2016. Implementation of the recommendations of this report in a time bound manner by all the State Load Despatch Centres / State Transmission Utilities under the oversight of the respective State Electricity Regulatory Commissions would go a long way in streamlining the SAMAST pan India. This framework would act as a foundation for several other regulatory interventions that are impending for strengthening power sector ecosystem and operations in India.

Com Prodan

(Gireesh B. Pradhan)

# TECHNICAL COMMITTEE OF FORUM OF REGULATORS RESOLUTION

Technical Committee of Forum of Regulators (FOR) was formed under the chairmanship of Member CERC, Shri A.S.Bakshi, comprising of Technical Members of State Commissions of renewable rich States viz. Tamil Nadu, Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka and Madhya Pradesh. The Technical Committee has been mandated to evolve a roadmap for implementation and ensure timely action on deployment of framework on forecasting, scheduling and deviation settlement of wind & solar generating stations at the state level, implementation of Availability Based Tariff (ABT) framework at the State level, introduction of Ancillary Services and Reserves at the State level and implementation of Automatic Generation and primary control within States.

The Technical Committee in its 2<sup>nd</sup> meeting dated 08 Jan., 2016, constituted a Sub-Committee with Terms of Reference (TOR) inter-alia to evolve detailed action plan with time-lines for implementation of ABT/DSM at State level, suggest modification of all technical and accounting procedures as may be necessary for rolling out ABT/DSM framework, assist in drafting of requisite State regulations, or amendments to existing regulations, as the case may be.

The Sub-Committee undertook visits and interacted with several State Load Despatch Centres to study the prevailing set-up of energy scheduling, metering, accounting and settlement system in the States.

The interim draft report of the Sub-Committee was deliberated during the 4<sup>th</sup> meeting of the Technical Committee held on 01 Jun., 2016. The Sub-Committee after incorporating the suggestions submitted its final report titled "Report on Scheduling, Accounting, Metering and Settlement of Transactions in Electricity" (SAMAST).

The Technical Committee hereby adopts the 'Report on SAMAST' in its 5<sup>th</sup> meeting on 15<sup>th</sup> of July, 2016 and endorses it to the Forum of Regulators for acceptance.

JE Chief (RA) CERC

P. Corros - Croz Member ERC Andhra Pradesh

lember

ERC Karnataka

CEO POSOCO

Member ERC Maharashtra

Member ERC Madhya Pradesh

Member, CERC Chairman of the Technical Committee

Member ERC Gujarat

NIG

Member ERC Rajasthan

Chairperson

ERC Tamil Nadu

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## **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, <u>Scheduling, Accounting, Metering and Settlement of Transactions in electricity (SAMAST) is indispensable as it solves the puzzle -"Who" pays to "Whom" and for "What?"</u>

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 are 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 report was to assimilate the available experience at the interstate/intrastate level and evolve 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. Responses from 28 SLDCs were received. The finding of the survey and the recommendations were discussed and with all the SLDCs, RLDCs and NLDC in the 16<sup>th</sup> and 17<sup>th</sup> 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

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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 in the third and fourth meeting of the Technical Committee held on 10 Feb 2016 and 01 June 2016 respectively. The Minutes of the 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 17<sup>th</sup> meeting held on 22 June 2016. The Minutes of the FOLD 16<sup>th</sup> and 17<sup>th</sup> FOLD meeting are collectively enclosed as Appendix-10. The brief details of the report on SAMAST 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. Fig-1 and Fig-2 provide a glimpse of the prevailing infrastructure of metering and the framework for energy accounting and settlement system in various States. 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.



Figure 1: Metering Infrastructure at the Intra State level



Figure 2: Status of intra State Deviation Settlement as on 31.03.2016

## 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, Jharkhand, Bihar, Odisha, Goa, UT Dadra Nagar Haveli, Damodar Valley Corporation, Chattisgarh 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 16<sup>th</sup> and 17<sup>th</sup> meeting of the Forum of Load Despatchers.

The sub-committee is indebted to the professionals working in operation, logistics, energy accounting, commercial and finance functions at various SLDCs, RLDCs and NLDC, who shared their varied experiences and insights. The list of all the 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.

15.07.2016

S.K. Soonee Chairman of the Sub-committee

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# Acronyms

ABT	Availability Based Tariff
AMI	Automatic Metering Infrastructure
BBMB	Bhakra Beas Management Board
CERC	Central Electricity Regulatory Commission
CGS	Central Generating Stations
СРР	Captive Power Plant
СТ	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
FSI	Electric Supply Industry
EOLD	Eacum of Load Despatchers
FOIR	Forum of Indian Regulators
FOR	Forum of Regulators
Conco	Constating Company
IEM	Interface Energy Mater
	Interface Energy Meter
INSIS	Intra State Transmission System
IFF ISO	Independent Producer
15U 16TC	Independent System Operator
1515	Inter State Transmission System
LIA	Long Term Access
NTOA	Know Your Customer
MIOA	Netium Term Open Access
NLDU	National Load Despatch Centre
	Potential Transformer
QCA	Qualified Coordinating Agency
KEA DEC	Regional Energy Account
KES	Renewable Energy Sources
RLDC	Regional Load Despatch Centre
RPC	Regional Power Committee
RRAS	Reserve Regulatory Ancillary Services
RIA	Regional Transmission Account
RIDA	Regional Transmission Deviation Account
SAMASI	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

## **1.0 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 (CERC) notified the 'Framework on Forecasting, Scheduling & Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar) on 07 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 outline 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 50<sup>th</sup> meeting held on 01 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 13 August 2015 at the interstate level. Vide its order dated 13 October 2015 in the Sue 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 02 Nov 2015 for issuing advisory to the States on the following issues

- o Execution of detailed Energy Accounting of all intra State entities
- o Creation of Intra State Deviation Mechanism pool at the State level
- o Implementation of Availability Based Tariff for intra State generators
- o 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 2<sup>nd</sup> 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
- 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 was 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.

# 2.0 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 of the 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 accountable for private) that had to be the business of electricity purchase/sale/transmission/distribution. Thus, scheduling, dispatching and accounting of electricity transmitted through the State Grid have 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 7<sup>th</sup> Annual General Meeting held on 15 June, 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"

S No.	State / UT	Existing	Envisaged	Envisaged
		capacity	Solar by 2022	Wind by 2022
		as on Feb 2016	(as per MNRE)	(as per MNRE)
		(as per CEA)		
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	

Table	1:	Existina	and	envisaaed	RES	capacity
i abic	<b>-</b> .	Exasting	ana	chrisagea	1120	capacity

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."



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 21<sup>st</sup> 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.
## 3.0 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 is 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. Tunical Number	of Intra Stata Entitios	whoco schoduling i	coordinated by S	IDC
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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 is 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 28 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.

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		11				12
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 D-T: Tie lines between Distribution & Transmission Grid   RES -T : Tie lines between RES & State Transmission System (at pooling point) D-T: Tie lines between Distribution & Transmission Grid   InSTS - ISTS : Tie lines between Intra State Transmission System Arransmission Grid   Inter State Transmission System O-T: Tie lines between Distribution & Transmission Grid   O-T: Tie lines between Distribution & Transmission Grid O-T: Tie lines between HT consumer & Transmission Grid								

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

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

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

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 Grids 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.

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%

Table 5: Typical Energy Interchange at the Intra State lev
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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 carry out weekly settlement of deviations.

S	State/UT/Control	Settlement System	Settlement system	Whether
No	Area	Status	for all Intra State	unbundling
•			Entities w.e.f.	has been done
1	Andhra Pradesh	Partial		Yes
2	Arunachal Pradesh	-	-	-
3	Assam	-	-	Yes
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	-	-	Yes
18	Meghalaya	Partial	-	Yes
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	-	-	Yes
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	-	-	-

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



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.

S No.	SLDC	Deviation Account for Week/Month	Over Generation + Under Drawal	Under Generation + Over Drawal	Payable by members <u>to</u> Deviation Pool A/C	Receivables by Members <u>from</u> 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 MU	Under Generation + Over Drawal MU	Payable by members <u>to</u> Deviation Pool A/C Rs. Lakh	Receivables by Members <u>from</u> Deviation Pool A/C Rs. Lakh	Revenue Realization in Pool A/C within the due date 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.



#### 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-factocustodians 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.

S N 0.	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

Table 9: Arch	ival and Utilization of Energ	y Data	

# 4.0 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 thirteen (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
- betection of time drift from frequency code of the block (since average frequency remains 50 Hz most of the time)
- 1. 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

# 5.0 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 16<sup>th</sup> meeting of the FOLD. Expert Audit Groups of Metering and Settlement in POSOCO were consulted. 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.



### 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 conform to the CEA document on "Functional Requirement of Advanced Metering Infrastructure". General Guidelines on the technical specifications is enclosed as Appendix-6.

Sl.	Stages	Position of Main Meter	Position of	Position of Standby Meter	
No.			Check Meter		
1	Generating	On all outgoing feeders	On all	High voltage (HV) side of	
	Station		outgoing	Generator Transformers	
			feeders	High voltage side of all	
				station Auxiliary	
				Transformers	
2	Transmission	At one end of the line	-	There shall be no separate	
	and	between the substations of		standby meter. Meter	
	Distribution	the same licensee, and at		installed at other end of the	
	system	both ends of the line		line in case of two different	
		between substations of two		licensees shall work as	
		different licensees, Meters		standby meter.	
		at both ends shall be			
		considered as main meters			
		for respective licensees.			
3	Inter-	High voltage side of inter-	-	Low voltage side of Inter-	
	connecting	connecting Transformer		connecting Transformer	
	Transformer				
The 1	The placement of the Main, Check and Standby Meter for the following case shall be as decided by				
the A	Appropriate Commi	ission			
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 co	onnected to distribution system	and permitted	open access by the	
	Appropriate Com	mission			
	Or				
	Any other system not covered above				
·					

Table 10: Metering Philosophy as per CEA Regulations

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 was 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 price is 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

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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 price 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 neverending 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 makes 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 performs 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 Guarantee 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	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.	<ul><li>Preparation of energy account statements requires the use of professional judgment in the adoption of regulatory provisions</li><li>There should be one pair of eyes for making the accounts and another pair of eyes for checking.</li><li>Post facto administration of transmission losses to be avoided</li></ul>
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.

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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 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

- 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.

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## 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.
- 1. 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

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- 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
- 1. 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

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# 6.0 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 analyze 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 updating. 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 are 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
- 1. 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 are 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 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





#### 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 are 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, eprocurement, 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 Technology 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, and 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 Dispatching.

# 7.0 Recommendations - Human Resource

## 7.1 Organizational structure

The Committee on 'Manpower, Certification, and Incentives for System Operation and Ring-fencing Load Despatch Centres' (Pradhan Committee) had estimated a total requirement of 60-70 persons for each State Load Despatch Centre in Aug 2008. The committee had grouped all the activities of SLDCs under four major divisions namely -System Operation, Market Operation, System Logistics (system data acquisition, Energy Management, communication, IT systems) and Establishment Services. Annex-IX of the above report had provided a department wise breakup of the human resources which indicated 22 persons under the Market Operation division. The system size and the scale of operations has significantly increased over the last 8 years mainly due to STOA and RES penetration. It is likely to become more complex in the near future. Thus the subcommittee felt that there is a need to re-assess the requirement.



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

After the discussions with the SLDCs, RLDCs and NLDC, it was noted that the activities of Market Operation division had expanded to cover the following areas:

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

The Figure-22 provides envisaged organization structure for the Market Operation Function only. Table-11 provides the break-up of activities covered under this department/division along with the HR requirement.

S.	Position /Function	Section	No. of
110.			reisons
1	Divisional Head	Market Operation	1
2	Chief Coordinator	Schoduling	1
2	Chief Coordinator		1
	Chief Coordinator	Metering	1
- + 5	Chief Coordinator	Accounting	1
6	Chief Coordinator	Sattlement & Clearing	1
7	Chief Coordinator		1
/	Chief Coordinator	Fees & Charges	1
0			
8	Same day scheduling (assuming 5-Shift Groups)	S als a dealine a	2
9	Day anead scheduling	Scheduling	2
10	Reconciliation, Implemented scheduling, MIS		Δ
11	Short Term Open Access Bilateral		1
11	Short-Term Open Access Collective		1
12	Short-Term Open Access Accounting	Open Access	1
13	Open Access-Compliance NOC & e-bidding		1
11	open necess compliance, noo e e blading		1
15	Metering architecture & Logistics		1
16	Meter Data Collection & Processing	Metering	1
17	Weekly Accounts		1
18	Transmission Loss Administration	Accounting	1
19	Monthly Accounts		1
20	Disbursal & settlement of pool accounts		1
21	Financial Settlement	Settlement & Clearing	1
23	Statutory, Regulatory and Legal Compliances		1
24	User Registration	Food & Charges	1
25	SLDC Fees & Charges	rees & Charges	1
	Total		30

#### 7.2 Human Resources – Market Operation

The Pradhan Committee had assessed a requirement of 22 persons for Market Operation (MO) division out of the total 70 persons assessed for a typical State Load Despatch Centre. However considering the expanded scope of activities of MO function, it may be inferred that the strength of HR in MO needs to be augmented to 30 persons. The above requirement does not cover System Operation, System Logistics and Establishment Services. 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. Certification linked incentives may be given as recommended in the Pradhan Committee.

## 7.3 Human Resources – IT services

The envisaged requirement of IT support personnel is enumerated below

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

Table 12: In house IT support personnel

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.

## 7.4 Recommendation

It may be seen that roughly around 30 persons are required to be deployed exclusively to discharge the Market Operation functions with the help of appropriate IT tools. The survey of SLDCs revealed that the number of persons deployed in MO division are highly inadequate. It is recommended that adequate persons may be deployed in the MO division. The HR expenses would be covered under SERC approved fees and charges of the SLDC and would not be a financial burden on the State Government.

SAMAST

# 8.0 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 <u>Accounting Metering and Settlement of Transactions in</u> electricity (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
- 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 timeline
- 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 transactions through LTA/MTOA/STOAbilateral/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 multibuyer, 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 circular reference, 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
- 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 interstate 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/Shortterm 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
- 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
- 1. 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 multipart 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)

SAMAST

S No.	Activity	Duration
		in days *
1	Identification of Intra State Entities	7
2	Demarcation of Interface boundary for each Intra State Entity	14
3	Assessment of Meters - Main, Check and Standby	21
4	Assessment of Automatic Meter Reading logistics requirement	30
5	Assessment of IT infrastructure (Hardware and Software) requirement	45
6	Preparation of Bill of Quantities (considering logistics already in place)	60
7	Preparation of Detailed Project Report and completion of first stakeholder workshop	90
8	Approval of the State-specific SAMAST scheme by SERC	120
9	Commencement of Load Forecasting by SLDC	120
10	Commencement of Interchange Scheduling by SLDC for all the Intra State Entities	120
11	Formation of a State Power Committee for preparation of Account	120
12	Establishment of State Regulatory Pool Account	120
13	Application for funding from Central Government/PSDF	150
14	Inviting tenders	150
15	Placement of Award	210
16	Adequacy of Human Resources in SLDC as approved by SERC	210
17	Implementation of the recommended IT infrastructure-Hardware	225
18	Completion of boundary metering and AMR system (as per DPR)	240

# 9.0 Checklist for Implementation of SAMAST in SLDC

19	Implementation of the recommended IT applications- Software	300
20	<ul> <li>a. User Registration</li> <li>b. Short term Open Access Processing</li> <li>c. Scheduling</li> <li>d. Meter Data Processing and Validation</li> <li>e. Accounting</li> <li>f. Settlement</li> <li>g. Billing and Clearing</li> <li>h. Data Archival and Retrieval</li> <li>i. Management Information System</li> <li>j. SLDC Website</li> </ul>	
20	Computation of transmission losses for each 15-min by SLDC	330
21	<ul> <li>Preparation of Energy Accounts by SPC/SLDC and Publication of the following on SPC/SLDC website</li> <li>a. Process document (SAMAST handbook) for the State</li> <li>b. At least four weekly deviation accounts for all intra State Entities</li> <li>c. At least one monthly State Energy Account (SEA)</li> <li>d. List of tie lines for each Intra State Entity with Intra STS</li> <li>e. List of Interface Energy Meters to be used in accounting</li> <li>f. CT/PT ratios to be used in accounting</li> <li>g. Formula to be used for computation of Injection / Withdrawal</li> <li>h. Implemented Schedule – DC, Entitlement, Injection Schedule, Withdrawal Schedule, STOA schedule, Scheduled Losses, Interchange with Regional Grid</li> <li>i. Deviation Rates as notified by SERC</li> <li>j. Comparative plot of Actual Interchange computed from SCADA and from Energy Meter data of each Intra State Entity for at least four weeks</li> <li>k. Plot of measured Transmission Losses for at least four weeks</li> </ul>	345
22	Clearing of Pool A/c Credit / Debit for at least four weeks and its reconciliation	345
23	Two stakeholder workshops by SLDC on SAMAST system	345
24	Quarterly Reconciliation Certificate from all State Pool members	
25	Annual 'Peer review' of SAMAST by any SLDC/RLDC	365

\* from the Zero Date (-zero date being August 1 to August 31, 2016)

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SAMAST

## Appendix - 1: Terms of Reference of the Sub-Committee

#### FORUM OF REGULATORS (FOR) C/o CENTRAL ELECTRICITY REGULATORY COMMISSION (CERC) 3<sup>rd</sup> & 4<sup>th</sup> Floor, Chandralok Building, 36, Janpath, New Delhi 110 001 **T**: 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 16<sup>th</sup> 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 8<sup>th</sup> 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, 23<sup>rd</sup> 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 subgroup prior to these meeting dates.

Mur-

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

To:

(i) Sh. A.S. Bakshi, Member, CERC	<u></u>	Chairman
(ii) Member (Technical), TNERC	-	Member
(iii) Member (Technical), GERC	-	Member
(iv) Member (Technical), RERC	-1	Member
(v) Member (Technical), MERC	. <del></del>	Member
(vi) Member (Technical), APERC	344	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 the First meeting held on 16-12-2015

- 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 <u>Annexure-III</u>.

## Discussion

- 4. The Chairman requested the state representatives to briefly summarize the status of implementation of ABT and DSM in their respective states.
- 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 31<sup>st</sup> 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.
- 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;
  - 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

- 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 <u>Annexure-I</u>.
- 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 (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 & learnings in 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 <u>Annexure-II</u>. Shri A B Bajpai (MPERC) informed that Draft Forecasting regulations have been issued and hearing is due on 19 January 2016.
- 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 <u>Annexure-III</u>.

- 8. Shri Venkatesan (SLDC, Tamil Nadu) presented the current status of ABT implementation in Tamil Nadu. A copy of the presentation is attached as <u>Annexure-IV</u>.
- 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 <u>Annexure-V</u>.
- 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 <u>Annexure-VI</u>.
- 11. SLDC Gujarat sent their presentation via email, though no representative was able to attend (attached as <u>Annexure-VII</u>).
- 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 Committee 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

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 10<sup>th</sup> February 2016. Mr. Bakshi welcomed all the members and appreciated the hard work done by the sub-groups.

 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**

- 2. Mr. S.K. Soonee, CEO, POSOCO presented the experience and learning of the sub group's visit to SLDC-Kalwa on 23<sup>rd</sup> January, 2016 and SLDC-Chennai on 30<sup>th</sup> 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.
- 3. 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.
- 4. 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.
- 5. Mr. Deepak Lad, Member, MERC, assured that MERC will issue the DSM regulation after analyzing 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.
- 6. 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 utilized. 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 equipment has been placed.

- 7. Mr. A. B Bajpai, Member, MPERC informed that MP has already issued draft Ancillary Services regulations in January 2016 and stakeholder comments has been invited.
- 8. 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**

- 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.
- 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 15<sup>th</sup> 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.
- 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.
- The next meeting of the Committee shall be held on 18<sup>th</sup> 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

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 1<sup>st</sup> 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**

- 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).
- 2. 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.
- 3. 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.
- 4. 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.
- 5. 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.

- 6. 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.
- 7. 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.
- 8. Mr. D. B. Manival Raju (Member, KERC) informed that KERC has issued final Regulations on Scheduling, Forecasting and Deviation Settlement of RE sources.

#### **Decisions**

- It was agreed that States shall give their feedback and comments on the draft report within 15 days.
- Interaction of Sub-Committee with SLDCs in West Bengal, Rajasthan, Meghalaya is expected to be complete by 15<sup>th</sup> 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.

#### 2. SLDC Maharashtra- 23.01.2016

The sub-committee visited SLDC-Kalwa on 23<sup>rd</sup>January 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 to extending this arrangement to generating station are as follows:
- Settlement of deviations is done on weighted average system marginal price in Maharashtra in order to ensure proper economic signal to market participants.
- Distribution licensees and the transmission open access users (subject to fulfillment of certain qualification criteria) operating within electricity 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, deviation son transactions will be accounted at the consumer end as in case of distribution 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 linked Intra-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 improving the BSM after ensuring successful implementation of Phase-I.

### 3. SLDC Tamil Nadu – 30.01.2016

The sub-committee visited the SLDC Chennai on 30<sup>th</sup> 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 15minute block in consultation with TANGEDCO (Sole DISCOM). Scheduling of 63 numbers 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

# 4. SLDC Karnataka- 15.02.2016

The sub-committee visited the SLDC Bengaluru on 15<sup>th</sup> 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 up to 11kV feeders
- All generators [excluding wind and mini hydel] 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:
  - o All ESCOMs and Hukeri Society
  - $\circ~$  All State owned generating stations –25 MW & above
  - IPPs of 25 MW & above
  - o 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
  - o 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.
  - o Power Exchange /IEX purchases of ESCOM s
  - o 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 are 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.
  - 0 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.

#### 5. SLDC Delhi – 10.03.2016

The sub-committee visited the SLDC Delhi on 10<sup>th</sup> 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 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. 01<sup>st</sup> 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 01<sup>st</sup> 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 place 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 three intra-state STOA customers (of > 1 MW) in the State. 18 new intrastate 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.
- Coarse Optimization: Shortage-Surplus settled within the State first. PX rate minus 10 paise being 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.

- 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 indisciplined discom. 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. Therefore Implementation of "Causer pays principle" in true spirit is desirable for bringing accountability in entities
- 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

# 6. SLDC Gujarat – 10.05.2016

The sub-committee interacted with the Chief Engineer, SLDC Gujarat through Video Conference on 10<sup>th</sup> 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

# 7. SLDC Madhya Pradesh – 12.05.2016

The sub-committee interacted with the Chief Engineer, SLDC Madhya Pradesh through Video Conference on 12<sup>th</sup> 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.

### 8. 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.

# 9. 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 1<sup>st</sup> 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 comparison, 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 agreed 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 Certification. 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)

# 10. 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 with 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
  - o Conventional generators are being scheduled by SLDC;
  - Scheduling of RE generators are being done on trial basis;
  - o 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
  - o 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.
  - o 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.

# 11. 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

# 12. 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

# 13. 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.
- <u>Metering Task Force:</u> 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, & 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
  - o 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:**

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- "Cluster Analysis of Smart Metering Data" by Research Center for Information Technology Karlsruhe Germany.
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- "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
- PJM Manual 01 " Control Center and Data Exchange Requirements" Revision: 31 Effective Date: November 18, 2015

## Appendix - 5: Settlement & 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, interutility 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.
- 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  $0^{\circ}$  to  $360^{\circ}$ .
- 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.

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- 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.
  - 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	
	IEM-1234	5678-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. 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 VT's 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:
  - 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),
  - 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  $\pm 10\%$  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 IEMs 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.

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# Appendix-7: Automatic 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). Preliminary validation is to be inbuilt in central data collection system (CDCS)

## 2. 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.

### 3. 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.

#### 4. Central Data Collection System

A Central Data collecting system provided at respective SLDC 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 built in data collection software.

#### 5. 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 a location then any other efficient means of communication.

#### 6. Interface Converter Unit

Each energy meter to be included in AMR system has an optical interface (as per IEC 1107) and also provided with 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.

## **Appendix - 8: Interstate Metering Accounting and Settlement**

#### 1. Evolution of Multi-part Settlement at interstate level

The State grids were integrated to form the regional grid however due to chronic shortages of capacity in the Indian Power Sector the opportunity to exchange power and energy was very limited. In the 80s- 90s there were no accepted guidelines for pricing interstate /interregional exchanges of power. The energy exchange between the neighboring States connected with tie lines used to be settled mutually. Monthly joint meter readings of energy meters on each of the tie line was taken and the net import or export on each of the tie line was separately settled generally at mutually agreed rate called emergency exchange rate. This rate was derived annually and it typically used to be the highest marginal cost of generation. The practices in various regions were different and also varied from time to time. For instance in Northern Region the emergency exchange rate adopted was the cost of generation of the Badarpur Thermal Power Station while in Eastern region it used to be the cost of generation of the Bandel TPS. Often the balance used to be carried over for years in terms of energy with chronic payment defaults. With the increase in the number of interconnections between the States leading to meshed network, the settlement of exchanges between States became complicated due to the wheeling and loop flows. The quantum of diversity exchanges between predominant hydro generation system and thermal dominant system also increased. The shared Central Sector projects were the driving force for a centralised system then famous as Global accounting coordinated by the erstwhile Regional Electricity Boards.

The global accounting last for almost three decades with variants in different regions, some booking as per descending order and some regions going for same landed cost. Several attempts were made to establish guiding principles to price power exchanges (Venugopal Committee, Rajagopal Committee and CEA Guidelines). However none of the implemented practices could facilitate energy trades or encourage good operational behaviour let alone causing economy. As a result, interconnected operation and integrated operation remained elusive. With a view to reduce or eliminate the problems caused by the original "one part tariffs" for sale of power from the Central Sector generating units to SEBs and, also, to resolve disputes arising in the settlement of tariffs between NTPC/SEBs for bulk supply, the Department of Power constituted a Committee headed by K.P. Rao. This committee submitted its report in June 1990, which was adopted in its entirety by the Government of India (GOI). The K.P. Rao Committee recommended

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two-part tariff, merit order operation, exploitation of hydro power for optimization and penalties for overdrawal/underdrawal. Subsequently, the GOI appointed ECC as consultants to undertake a Study of Bulk Power and Transmission Tariffs and Transmission regulations. The ECC report was submitted in Feb 1994, wherein it recommended Availability Based Tariff and proposed three Options for formal market mechanisms viz-Option-A, B and C. The National and Regional Task Forces constituted for implementation of the ECC recommendations. All these developments and a series of Grid incidents culminated in the Central Electricity Regulatory Commission (that created in 1998) notifying, in 2002, the implementation of Availability Based Tariff and the frequency linked Unscheduled Interchange Mechanism for settlement of deviations from schedule at the interstate level. The ABT/UI mechanism introduced multi-part settlement that paved way for the evolution of the bulk electricity market at the interstate level.

#### 2. 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

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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.

#### 3. 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 (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

#### 4. 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.

### 5. 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	Week Day	Activity
	of Accounting period		
W	0	Monday to	Scheduling and Delivery of the contract
		Sunday	
W+1	2	Monday-	Meter Data Collection for the previous
		Tuesday	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 -	Clearing the outstanding to pool
		Monday	debtors by RLDC from the available
			funds in the pool account
			(within 2 days of the receipt of amount in
			pool)

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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.

#### 6. 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.

#### 7. 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 are 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.

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	209	94	70	395
7	STs & ICTs Interface with ISTS	106	20		73	58	675
8	RES - T Interface	10	0	6	0	0	16
9	ISTS-InSTS Interface	98	10	57	260	52	505
10	CTU-STU Interface	159	53	548	42	192	1490
11	CTU-IPP Interface	26	0		16	82	180
12	Total Interface	449	93	820	485	454	3261
13	Make of Energy meter	L&T Secure Elster	L&T Secure Elster	L&T Secure Elster	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	0.25	0.25	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	3.0
27	Active Energy Settlement System in the Region	Net	Net	Net	Net	Net	
28	Deviation Account Administrator	ERLDC	NERLDC	NRLDC	SRLDC	WRLDC	

8.	Salient features	SAMAST	at the	Regional	level ar	e tabulated bel	low:
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S No.	Particulars	ER	NER	NR	SR	WR	All India
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	Yes	Yes	Yes	
33	Reactive Energy Interchange Settlement	Yes	Yes	Yes	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 <u>to</u> 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
38	Total Recovery in Deviation Pool A/C within due date (Rs. Lakh)	88	173	814	1385	1823	4283
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 2002	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 Commercial & Finance functions	11	7	15	10	10	53
50	Annual RLDC fees & Charges for 2014-15 (in Rs. Lakh) (Provisional)	4375	2238	4024	4306	4750	22160

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

The common metering errors are listed below:

- a. Non-availability of all 3 phases PT/CVTs at all locations.
- b. Non recording of data in meters on transformers at one location during bus shutdown if bus change over switch is not utilities.
- c. Usage of PTs/CVTs and CTs of opposite side of the Delta-Star transformers causing 30 degree phase change resulting in wrong data recording.
- d. Errors due to Current Transformer (CT)/ Potential Transformer (PT)/ Voltage Transformer (VT) or Capacitive Voltage Transformer (CVT) connection errors
- e. Wrong polarity connection of CTs (P1-S1) resulting in sign reversal of the data recorded
- f. Under-recording due to polarity reversal in few phase
- g. 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.
- h. 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.
- 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)
- j. Non communication of change in CT ratio changes or wrong CT ratio to the control center and thus wrong computation of energy accounts as well as losses.
- k. Meter and Meter Reading Instrument (MRI)/ Data Collecting Device (DCD) related:
- 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.
- m. Non-charging of DCD and thus issues in timely data down loading.
- n. Meter not responding to DCD commands: In most cases reason being lead connecting Optical Connector and DCD being faulty. In some cases meter being faulty and need to be replaced.
- Non charging of meters kept in store and therefore clock drifting by very high time difference.

- p. 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.
- q. High time drift in meters
- r. 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)
- s. Non filling of zero data in remaining time blocks wherein feeder/line was under shutdown and data down loaded through use battery backup.
- t. 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.

## 10. Process for troubleshooting Metering Errors

#### Addressing problems at site regarding SEMs



## 11. Meter Certification

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

	Certificate No. : 14871	ELECTRICAL RESEARCH ( According by the National Accorditation B ERDA Road, Makaspura Industrial Est EPABX: : +01 (0255) 2642942, 26429 Fax : +01 (0255) 2638382 E-mail : enda @ enda.org Web : http://www.enda.org	AND DEVELOPMENT / conflor Testing and Calibration Late arte, Vadodara-390 010, India, 364, 2642377, 3043128 / 29 / 30	ASSOCIATION resorties, Govt. of Redist
		TEST R	EPORT	SHEET 1 OF 6
	NAME & ADDRES	SS OF CUSTOMER	REPORT NO.:	RP-1516-050831
			DATE:	25/03/2016
	POWERGRID CORI	PORATION OF INDIA LTD.	CUSTOMER REF	P.O. No.: 5100001508
	NORTHERN REGIO	N-1, HEADQUARTERS,	No.:	
	B-9, QUTAB INST	ITUTIONAL AREA,	Dtd.:	29/07/2015
	KATWARIA SARAI		DATE OF SAMPLE	DATE OF
	NEW DELHI-1100	16.	RECEIPT	TESTING
			25/03/2016	25/03/2016
	SAMPI	LE DESCRIPTION	SAMPLE ID	ENTIFICATION
1	3 Phase 4 Wires	System Electronic	SI. No.	ERDA SAMPLE CODE
٩.	Type/Model :	ERBOOR	NP-1250-A	W0-1516-10312/416
	Voltage/Ereg :	2×63 5U / 50H+	in the second	110-1010-100120410
	Current :	-/14 (Th: 14 Tmay: 1.24)	-	
	Buloo sato u	FO/unit (We Mode)	-	
	Clase :	0.25		
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	COCUCION:	Main Meter		
	TEST DETAI	LS	TEST SPECIFIC	ATION
	1 Tests of accura	cy requirements Cl.No.8.	0 of IEC: 62053-22, 23	8 & 62052-11-2003
	1.1 Limits of error	due to variation Cl.No.8.	1 of IEC: 62053-22, 23	& 62052-11-2003
	of current			
С.	1.2 Test of startin	g condition Cl.No.8.	.3.1 & 8.3.3 of IEC:620	53-22,23 8 62052-
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	T*2 Lear 0LU0-109	a condition clinicia.	3.2 01 100: 02033-22r	23 8 02052-11-2005
	WITNESS BY:	Mr. Vikas Khare, Manager, N	ITPC; Unchahar	
	NOTE: 1) Only t	he tests asked by the custom	her have been carried o	ut.
	2) Meter (	was tested considering class 2	2 for reactive mode as	per Customer request.
	3) After T	esting seal fixed on meter be	aring ERDA Seal No.: 0	304698.
	REMARK -The at	sove energy meter conforms	to the requirements in	respect of the tests
	carrie	d out.		
	HR.		bart	Dentite !
P-s		and the second s		Dr. Vinod Gupta
ice.	PREPARED BY	CHEC	KED BY	APPROVED BY
TF 19232	2. This report relates onl 2. This report cannot be 3. Publication of this report 4. Only the basts asked f 5. In case of any dispute <b>Caution:</b> IRDA is not re- IRDA, provide	y to the particular sample received in greproduced in part under any circumsta ort requires prior permission in writing f or by the Customer have been carried o , Vedodars will be the exclusive jurisdic sponsible for the authenticity of photocc support to Customers for verification of	ood condition and bested at site most. from Director, IERDA, sut. tion & shall be construed as wh spied or reproduced best report of authenticity of the test report	ere the second of the second o



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No.	fests & Cl. No.	siecific	cation		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	'	Active Ener	9¥	Heter No. :	Conforms
	(CI.No. 8.1 of IEC: 62053-22.8.231	with loads	balanced	3phase	NP-1259-A	
		Current	C0597	Limit	Obtained Werror	
		0.00Im	1.0	±0.4	-0.02	
		0.02th	1.0	+0.4	-0.05	
		0.05in	1.0	#0.2	-0.08	
		0.11n	1.0	±0.2	-0.07	
		0.21h	1.0	+0.2	-0.08	
		0.5In	1.0	40.2	-0.05	
	1	1.0In	1.0	±0.2	-0.03	
		Jimaor	1.0	+0.2	-0.03	
		0.02In	0.5ind.	±0.5	+0.02	
1.1		0.05ln	0.5ind.	+0.5	-0.08	
		0.11n	0.Sind.	±0.3	-0.10	
		0.21n	0.5ind.	#0.3	-0.08	
		9.51n	0.5ind.	+0.3	-0.07	
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		Dimage 1	0.5md.	+0.3	+0.04	
		0.02in	0. Ecap.	±0.5	-0.07	
L		0.05th	D.Bcap.	#0.5	-0.09	
		0.116	0.8cap.	+0.3	-0.04	
		0.21n	D.Scap.	±0.3	-0.07	
L		0.516	D.Bcap.	+0.3	-0.08	
		1.01n	0.8cap.	+0.3	0.06	
		LITHIC .	D. Scap.	10.3	-0.05	



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PREPARED BY

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CHECKED BY -Albert



Figure 24: Metering Infrastructure at ISTS level

SAMAST
#### 15.07.2016

# Appendix-9: List of Contributors

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# Appendix- 10: Minutes of 16th and 17th FOLD Meeting

Forum of Load Despatchers (FOLD) Secretariat: C/o National Load Despatch Centre, New Delhi B-9 Qutab Institutional Area, New Delhi-110016 Tel: 011-26536915/26536832/26524522 Fax: 011-26524525/26536901 Website: www.forumofld.in Email: <u>foldsectt@gmail.com</u>



# MINUTES OF THE 16th MEETING OF FORUM OF LOAD DESPATCHERS (FOLD) HELD ON 2<sup>nd</sup> March 2016 at NRLDC, POSOCO, New Delhi

1. The 4<sup>th</sup> Certificate Conferment Ceremony for System Operators was held on 2<sup>nd</sup> 2016 NRLDC, New Delhi. The occasion March at was graced bv Sh. Gireesh B. Pradhan, Chairperson, Central Electricity Regulatory Commission (chief guest), Ms. Jyoti Arora, Joint Secretary (Power), and Shri I. S. Jha, Chairman & Managing Director, POWERGRID, CEO POSOCO and other officials from RPCs, SLDCs, RLDCs and NLDC. The Certificate was conferred by the Chairperson CERC to the successful system operators.

List of participants is enclosed at Annexure -I.

- CEO, POSOCO gave the welcome address and gave presentation on the Journey of FOLD which inter-alia highlighted the efforts being made for addressing various issues pertaining to LDCs.
- Power Atlas of India', and Report on 'Flexibility Requirement in Indian Power System' was released by the Chairperson CERC, JS MoP, CMD POWERGRID, CEO, POSOCO and ED, NLDC.
- 4. A brief presentation was given by NLDC regarding successful candidates in the examination conducted by PSTI/NPTI. Subsequently, the Chairperson, CERC distributed the Certificates to the certified system operators.
- 5. <u>16th meeting of the FOLD</u> was held subsequent to the Certificate Conferment Ceremony. After introductions by participants, CEO, POSOCO welcomed all members of FOLD and gave a brief overview of the agenda points of the last meeting and action taken on the same. Thereafter, the agenda items were taken up for discussions. A copy of the agenda for 16<sup>th</sup> meeting is enclosed at Annexure-II.

i. Agenda item no. 1 - Survey Validation - Manpower, Infrastructure, Learning and Development and related issues

In the 15<sup>th</sup> meeting of the FOLD the importance of Key performance indicators (KPI), benchmarks for measurement of progress, standards, policies, and manpower template was discussed. All participants suggested that a committee may be formed to (a) Study of present infrastructure, KPIs, Manpower template, policies etc. be conducted by forwarding a questionnaire to all LDCs, (b) benchmarks for standards, infrastructure, policies, manpower template etc. Accordingly, a committee was formed and a survey was circulated to all LDCs.

NLDC representative informed that 20 out of 40 LDCs have forwarded their responses of the survey. NLDC representative presented the findings of the survey forwarded by SLDCs/RLDCs and requested the concerned SLDCs/RLDCs to validate the responses of the survey. Further, NLDC representative requested that all LDCs may forward their responses along-with the best practices followed at SLDCs, so that the committee may undertake in-depth analysis of the findings of the survey and give recommendations for improvement in the functioning of the LDCs.

In this regard, ED (NLDC) stated that the survey along with the responses received shall be circulated again to all LDCs for furnishing of information / validation of already furnished information in the survey. A copy of the presentation, survey to be filled and responses received till date are enclosed at Annexure II.

Representative of MP SLDC and Odisha SLDC suggested that executives from SCADA department should also be posted in all shifts to take care of SCADA and communication system failures and assisting the system operating engineer during the shift. Further, MP SLDC and Delhi SLDC also suggested that before appearing in the basic level / specialist level Certificate examination all candidates must undergo the mandatory training at NPTI.

Further, GM, NLDC informed that separate LAN for wifi and separate LAN for official purpose has been installed at NLDC and the same may also be followed at LDC level to strengthen the cyber security of the SCADA system. CEO POSOCO also stated that best practices with regard to cyber security and password policy may also be followed in all LDCs.

CEO, POSOCO emphasized the need of the excellent communication skills for system operators, as communication exchanged during real time operation may also be used in the adjudication process. Therefore, clarity of thought along with excellent

communication skills are required for the system operators of the 21st Century. Accordingly the extensive training programs may be designed and conducted as per the global practices followed by National Grid Company (NGC), California ISO etc.

CEO, POSOCO also requested SLDCs to help in the preparation of the committee report and stated that the draft report should be ready before 17<sup>th</sup> FOLD meeting. The final report shall be shared with the Regulators. Subsequently, Regulators may take the informed decision with regard to strengthening of the Manpower, Infrastructure, training needs etc. in the LDCs.

A copy of the presentation, survey to be filled and responses received till date are enclosed at Annexure II.

#### ii. Agenda item no.2 - Automatic Generation Control & Spinning Reserves

Automatic Generation Control is well known to all system operators and has also been highlighted in the previous meetings of FOLD. NLDC gave a brief presentation on the AGC and Reserves. In the presentation, details of the roadmap to operationalise the reserves in the country were discussed. Further, in presentation, the expected quantum of Primary, Secondary and Tertiary reserves were discussed among the participants.

AGM, NLDC, also informed that workshop on AGC was organized on 19<sup>th</sup> & 20<sup>th</sup> Jan 2016 which was presided by Prof. Anjan Bose. The officials from CEA, CERC, NTPC and POSOCO participated in the workshop.

In the workshop, broad issues were discussed and broad areas of convergence were emerged in the workshop. A copy of the presentation is enclosed at Annexure III.

#### iii. Agenda item no.3 - Preparedness for implementation of Ancillary Services

CERC has notified the regulations on Ancillary Services in August, 2015. NLDC gave the presentation on ancillary Services regulations and role of Nodal Agency, RPC and Reserves Regulation Ancillary Services (RRAS) provider were discussed in the implementation of the proposed Regulations.

Detailed Procedure for operationalization of Ancillary services was submitted by POSOCO to CERC for approval. The Hon'ble Commission has approved the detailed procedure in March 2016.

Further, it was also requested that the SLDCs may provide the block wise daily forecast of demand on day-ahead basis considering the historical data, weather forecast data, and outage plan of units / transmission elements etc. to RLDCs and publish the same on their websites; this will help in the forecasting of Regional load / All India forecasts. A copy of the presentation is enclosed at Annexure IV.

iv. Agenda item no. 3- Implementation of Framework on Renewable at State Level NLDC representative gave a brief presentation on the FOR technical committee for the Implementation of Framework on Renewable at State Level. In the presentation, background, ToR of committee, recent initiatives, common challenges of LDCs were discussed.

Further, learning from interactions with SLDCs, wish list of frontline system operators, interim findings of the committee, way forward and challenges were also discussed in the meeting.

CEO, POSOCO stated that role of scheduling, metering and accounting is pre-requisite for robust settlement system. He also emphasized that the experience of LDCs should be cross-fertilised and replicated at appropriate level for the efficiency and effectiveness in the functioning of LDCs.

A copy of the presentation is enclosed at Annexure IV.

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

# <u>Minutes of the 17<sup>th</sup> Meeting of</u> <u>Forum of Load Despatchers (FOLD)</u> <u>Held on 22<sup>nd</sup> June 2016 At NRLDC, POSOCO, New Delhi</u>

 17<sup>th</sup> meeting of the Forum of Load Despatchers (FOLD) was held on 22<sup>nd</sup> June 2016 at Northern Regional Load Despatch Centre (NRLDC), New Delhi. Officials from NLDC, RLDCs, and SLDCs participated in the meeting.

List of participants is enclosed at Annexure -I.

- 2. The meeting was chaired by CEO, POSOCO. He, after introductions by participants, welcomed all Members of the FOLD and gave a brief overview of the agenda points of the last FOLD meeting and action taken /learnings /outcome on the same. He also congratulated all the system operators for achieving the best Frequency Variation Index (FVI) which was 0.025 on 19.06.2016. He appreciated the sustained efforts of all system operators for achieving and facilitating the lowest FVI, meeting of peak demand in range of 148 GW and energy met in the range of 3400 MUs. Further, he shared the success story of implementation of Ancillary services (launched on 12.04.2016), and explained how it had become a new tool in the hand of System Operators for reliable, secure, and safe Grid Operation.
- **2.1** It was observed that most of the SLDCs were connected through Video Conferencing (VC) resulting in increased participation of the Members from respective LDCs, however, it emerged that representation of few SLDCs was missing due to other on-going meetings/ activities. The representation of every LDC, in the FOLD meeting(s), was emphasised and the RLDCs were further requested to ensure connectivity with each of the constituent SLDC, through VC, irrespective of SLDC(s) representatives joining FOLD meeting(s) at RLDCs. RLDCs were requested to confirm 100% connectivity, with each constituent SLDC, by next FOLD meeting.
- **2.2** The need for operational acquaintance of the VC logistics by every FOLD member was considered desirable. In this regard, respective IT personnel/ department are requested to prepare a brief on the steps to be taken for operational connectivity of VC with LDCs and make arrangement for a workshop/ presentation, if required. This facility can be of great help under emergency situations in the grid also.

 Thereafter, the following agenda items of the 17<sup>th</sup> meeting were taken up for discussions: (The copy of the presentation which includes the agenda items discussed in the previous meeting, agenda for 17<sup>th</sup> meeting and System Operation highlights is enclosed at Annexure-II).

 V. Agenda item no. 1 - Implementation of Framework on Renewable at State Level-Recommendations on Energy Metering Accounting and Settlement System (E-MASS)

POSOCO representative gave a brief presentation on the recommendations of the Forum of Regulators (FOR) sub-committee on Energy Metering Accounting and Settlement System (E-MASS of India). A copy of the presentation is enclosed at **Annexure III**. He apprised the status of the FOR sub-committee draft report to FOLD Members. He elaborated on the Policy, Statutory and Regulatory provisions for Intra-State accounting and settlement system. Subsequently, he highlighted the findings of the committee with regard to present status of the intra-state EMASS which inter-alia included: the <u>level of coordination</u> by SLDCs/sub-SLDCs with entities, <u>status of installation of interface energy meters</u> in different control areas, <u>Pool account administration</u>, <u>Energy accounting</u>, <u>data in public domain</u>, <u>data archival</u> and its use in forecasting etc.

Further, he highlighted the findings of the committee with regard to challenges faced by the system operators. In order to address various challenges, FOR Technical subcommittee has suggested a roadmap which inter-alia covers the following:

- Adequate Interface Metering
- Ex-Ante Scheduling
- Uniform Energy Accounting System
- Principles of Accounting
- Robust, Scalable, Dispute-Free Settlement System
- Robust Infrastructure for IT
- STOA registry and clearing agency
- Human resource
- Transparency
- Integrity and probity of accounts
- Real-time generation dispatching
- Other recommendations

FOLD Members appreciated the efforts of the sub-committee and endorsed their findings and recommendation for Intra-State EMASS.

Further, way forward, preparation of DPR for States by the Consultant appointed by FOR, funding from PSDF, roll out of model regulations etc. were also discussed in the meeting.

CEO, POSOCO stated that role of scheduling, metering and accounting is pre-requisite for robust settlement system. The robust EMASS will lead to behavioural changes in the stakeholders with regard to - who will pay what, dispute free commercial settlement, adoption of improved forecasting methods etc. He emphasized that clarity in regulations, adherence to basic accounting principles, appropriate skill set of the human resource; sustained efforts for institutional capacity building etc. are required for efficient and effective functioning of the LDCs.

Representative from Maharashtra congratulated the sub-committee for the EMASS report, and he requested that the Consultant may give inputs on what is required in each state, and accordingly prepare a responsibility chart for effective and efficient implementation of EMASS report. He also emphasized that the support of CERC/SERC/FOR/POSOCO is required to achieve the desired results. It was agreed by the Members that roles and responsibilities of all stakeholders should be included in the report to be prepared by the Consultant.

Representative from Gujarat SLDC stated that revision(s) of account require more time and effort than the preparation of account itself; therefore, LDCs should explore the methods to streamline the process of revision of accounts. He also informed that few Generators defaulted on the due payments, and SLDCs were unable to take any action against them because they are no longer in the business of generation, so statutory/ Regulatory provisions are required to initiate the legal action on the defaulters. It was agreed that automation is the key to handle the process of revision of accounts and Know Your Customer (KYC) documents may be collected by all LDCs to pin down the defaulting entity. Representative from UP SLDC informed that requirement of AMR should be made mandatory. At all levels in UP, the meters are not installed, therefore, partial verification and partial reconciliation are being done. Responding to UP representative, it was stated that RLDCs/SLDCs are responsible for accounting as per Electricity Act 2003. Therefore, it is the responsibility of the LDC to ensure that meters are installed as per CEA standards. In case any of the connected entity is not following the standards / provisions of the Regulations, then concerned LDC must file a petition before concerned Regulatory Commission. It was agreed that full-fledged institutional arrangement with integrity and probity is required for behavioural changes in the concerned stakeholder(s).

Representative from TN SLDC informed that the process has been initiated for adoption of web based scheduling by floating a tender for the same. Other FOLD Members appreciated the efforts of TN SLDC and desired that success story of the web based scheduling should also be shared with them.

Representative from DVC SLDC stated that manpower deployed are not commensurate with the responsibilities allotted to SLDCs. He also stated that any policy/Statute/ regulations/ directive have a bearing on the functioning of the SLDCs. Therefore, minimum standards for SLDCs should be framed and manpower survey which was circulated by FOLD should be finalised soon. In this regard, POSOCO informed that Pradhan Committee Report may be referred for manpower requirement and concerned SLDC should write to the Appropriate Regulatory Commission for the increase in manpower, if required. Meanwhile, the collated manpower and infrastructure findings on the survey template circulated by the FOLD will be finalised soon and shared with all the Members. It was further informed by POSOCO, that manpower requirement in RLDCs/NLDC for 2014-19 period has clearly been spelt out in the petitions filed by RLDCs/NLDC under the RLDC Fee and Charges Regulations 2015, therefore, on similar line; concerned SLDC may also approach the SERC for the same.

Representative from Odisha SLDC informed that transfer of trained manpower from SLDC is a serious concern. He also informed that OERC has advised SLDC to increase manpower for performance of assigned duties. In this regard, CEO, POSOCO stated that SLDC should appraise the situation to the higher management to reduce the transfer

of personnel from SLDC, and increase in manpower may be dealt with the filing of a petition in the concerned Regulatory Commission.

#### vi. Agenda item no.2 - Grid Integration Studies by GIZ

GIZ representative gave presentation the overview of the Green Energy Corridors (GEC) project which included brief of work done and major findings, recommendations, REMC, human capacity development at REMC/ LDC level, etc. A copy of the presentation is enclosed at **Annexure IV**. He informed that GEC scope includes the four work packages (WP): WP1- Forecasting, REMC and Balancing; WP2- Market design; WP3- Grid code and regulatory aspect; WP4- Short term studies.

GIZ representative emphasised on the need of the separate REMC and the skill set required to effectively handle the challenges of RE integration. He explained the concept of REMC and the present status of REMC.

Further, he explained the functionalities of the forecasting tool which includes the external forecasting (by FSPs) and Internal forecasting (by LDC) to be used at REMC. Further, he discussed the recommendations for the forecasting tool to improve the forecast, sample inputs required for FSP, sample output, key functionalities, functionalities of analysis module etc. He further informed that presently in REMC, only data communication between Pooling Station (owned by State utility) to REMC, and REMC to SLDC control room envisaged, and communication between Pooling Station (owned by developer) to Pooling station(owned by State utility) has not been envisaged in the current scheme.

GIZ representative explained the scope of the scheduling tool of REMCs. Further, he gave a detailed presentation on the personnel requirement in REMCs. He shared the initial thoughts with regard to human resource which included - sustainability-scope-occurrence chart, potential topics for training, possible interventions at system level/LDC level etc.

Further, he highlighted the issues like availability of static data of wind/solar projects, weather data for internal forecasting tool, pooling station level forecasts, etc. He further informed that Communication from RE projects to SS / LDC / REMC is not envisaged

in the current scheme as this is not covered under REMC grant, and responsibility to provide data rest with the concerned State authorities.

The Members of FOLD appreciated the efforts of GIZ with regard to various studies and subsequent recommendations.

Representative from Gujarat SLDC and Maharashtra SLDC informed that presently responsibility is on State to provide Data; however, the responsibility should be on concerned RE developer/ generator to provide data to REMC. Representative of Maharashtra SLDC Stated that communication of data from developer's Pooling Station to Pooling Station (owned by State utility), Pooling Station (owned by State utility) to REMC, and REMC to SLDC is prerequisite for achieving the optimum result from REMCs.

In this regard, representative of MP SLDC informed that data communication from developer's PS to PS and PS to SLDC has been made mandatory before Injection of Energy into the grid, and all RE generators/developers are following the guidelines of SLDC.

POSOCO representative stated that we must ensure that data communication from developer as per the requisite provisions of the IEGC and the related CERC Regulations. It was further stated that as a system operator, the implementable solutions for RE integration need to be worked on including the assessment of the likely situation, load forecasting, generation forecasting, portfolio balancing, flexing of conventional generation and short-term forecast.

#### vii. Other Agenda items proposed by Gujarat SLDC

- Incentives to personal employed in System Operation and who have been awarded Certificates under various Certifications – CEO, POSOCO stated that performance link incentives to be linked with the Certifications and can be included in the respective SLDC's Fee and Charges Regulation.
- Weather forecasting Agency for forecasting wind / solar generation Gujarat SLDC requested that solar related data, as required, is not available with

IMD. It was informed that POSOCO will take-up the matter with IMD/ NCMRWF. Meanwhile, it was informed that IMD has its presence at all levels and accordingly the LDCs can take up with the respective offices of IMD.

• Deployment of reversible pump mode operation in existing Hydro plants-

In this regard, CEO, POSOCO informed that a committee is under constitution by Govt. of India to look into the deployment of pumped storage systems as an alternative to handle the high variability and intermittency of RE generation. It is expected that committee may also look into the issue raised by Gujarat SLDC.

On conclusion of the meeting, CEO, POSOCO thanked all the Members present in the meeting.

# 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 वयुस्ह्च्ह सर्व्भ् सत्ये प्रतिस्ह्थितम् ॥- 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 व आकूतिः समाना ह्रदयानि वः। समानमस्तु वो मनो यथा वः सुसहासति।।- ऋग्वेद

[Let your aim be one and single, Let your hearts be joined as one; United be your thoughts, at peace with all; May you be together in harmony]



# FORUM OF REGULATORS

# Model Regulations on Forecasting, Scheduling and Deviation Settlement of Wind and Solar Generating Stations at the State level

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#### (State) ELECTRICITY REGULATORY COMMISSION

No. ---/xERC

Dated: ....,2015

#### NOTIFICATION

**No.---/--/xERC.-** In exercise of the powers conferred under Section 181 of the Electricity Act, 2003 (36 of 2003), and all other powers enabling it in this behalf, and after previous publication, the (State) Electricity Regulatory Commission hereby makes the following regulations, namely:

#### 1. Short title and commencement

- (1) These regulations may be called the (State) Electricity Regulatory Commission (Forecasting, Scheduling, Deviation Settlement and Related Matters of Solar and Wind Generation Sources) Regulations, 2015.
- (2) These regulations shall come into force on x.x.2015.

#### 2. Definitions and Interpretation

(1) In these regulations, unless the context otherwise requires,-

(a) **'Absolute Error'** means the absolute value of the error in the actual generation of wind or solar generators with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation– Scheduled Generation] / (AvC);

(b) **'Act'** means the Electricity Act, 2003 (36 of 2003);

(c) **'actual drawal'** in a time-block means electricity drawn by a buyer, as the case may be, measured by the interface meters;

(d) 'actual injection' in a time-block means electricity generated or supplied by the

seller, as the case may be, measured by the Interface meters;

(e) 'Available Capacity or AvC' for wind or solar generators means the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block;

- (d) **'beneficiary**' means a person purchasing electricity generated from a generating station;
- (e) **'buyer'** means a person, including beneficiary, purchasing electricity through a transaction scheduled in accordance with the regulations applicable for short-term open access, medium-term open access and long-term access;
- (f) **'CERC'** means the Central Electricity Regulatory Commission referred to in subsection (1) of section 76 of the Act;
- (g) 'deviation' in a time-block for a seller means its total actual injection minus its total scheduled generation and for a buyer means its total actual drawal minus its total scheduled drawal;
- (h) **'gaming'** in relation to these regulations, shall mean an intentional misdeclaration of available capacity or schedule by any seller in order to make an undue commercial gain through Charge for Deviations;
- (i) **'Grid Code'** means the Grid Code specified by (State Regulatory Commission) under clause (h) of sub-section (1) of Section 86 of the Act;
- (j) 'IEGC' means the Grid Code specified by CERC under clause (h) of sub-section (1) of Section 79 of the Act;
- (k) 'interface meters' means interface meters as defined by the Central Electricity Authority under the Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006, as amended from time to time;
- (1) **'Pool Account'** means state account for receipts and payments on account of deviation by buyers or sellers including wind and solar generators;
- (m) 'pooling station' means the sub-station where pooling of generation of individual wind generators or solar generators is done for interfacing with the next higher voltage level:
   Provided that where there is no separate pooling station for a wind / solar generator and the generating station is connected through common feeder and terminated at a sub-station of distribution company/STU/CTU, the sub-station of distribution company/STU/CTU shall be considered as the pooling station for such wind/solar generator, as the case may be;
- (n) 'Qualified Coordinating Agency or QCA' means the agency coordinating on

behalf of Wind/Solar Generators connected to a pooling station. QCA may be one of the generators or any other mutually agreed agency for the following purposes:

- Provide schedules with periodic revisions as per this regulation 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.

QCA shall be treated as a State Entity.

- (o) '**scheduled generation**' at any time or for a time block or any period means schedule of generation in MW or MWh ex-bus given by the concerned Load Despatch Centre;
- (p) '**scheduled drawal**' at any time or for a time block or any period time block means schedule of despatch in MW or MWh ex-bus given by the concerned Load Despatch Centre;
- (q) **'seller'** means a person, including a generating station, supplying electricity through a transaction scheduled in accordance with the regulations applicable for short-term open access, medium-term open access and long-term access;
- (r) **'State Commission'** means (State) Electricity Regulatory Commission established under sub-section 1 of Section 82 of the Act;
- (s) **'State Entity'** means an entity which is in the SLDC control area and whose metering and energy accounting is done at the state level;
- (t) 'State Load Despatch Centre or SLDC' means Load Despatch Centre of the State, established under sub-section (1) of Section 31 of the Act, responsible for coordinating scheduling of the state entities in accordance with the provisions of the State Grid Code;
- (u) '**time-block**' means a time block of 15 minutes, for which specified electrical parameters and quantities are recorded by special energy meter, with first time block starting at 00.00 hrs;

(2) Save as aforesaid and unless repugnant to the context or the subject-matter otherwise requires, words and expressions used in these regulations and not defined, but defined in the Act, or the Grid Code or any other regulations of this Commission shall

have the meaning assigned to them respectively in the Act or the Grid Code or any other regulation.

#### PART – 1 GENERAL

#### **1.1 Objective**

The objective of these regulations is to facilitate large-scale grid integration of solar and wind generating stations while maintaining grid stability and security as envisaged under the Grid Code, through forecasting, scheduling and commercial mechanism for deviation settlement of these generators.

#### **1.2 Applicability of the Regulations**

a. All wind and solar generators connected to the State grid, including those connected via pooling stations, and selling power within or outside the State.

#### PART – 2 FORECASTING AND SCHEDULING CODE

- 2.1. This code provides methodology for day-ahead scheduling of wind and solar energy generators which are connected to the State grid and re-scheduling them on one and half hourly basis, and the methodology of handling deviations of such wind and solar energy generators. Appropriate meters shall be provided for energy accounting. Telemetry/communication system & Data Acquisition System shall also be provided for transfer of information to the concerned SLDC.
- 2.2. Wind and Solar generators, represented via Qualified Coordinating Agencies (QCAs), shall mandatorily provide to the concerned SLDC, in a format as prescribed by SLDC, the technical specifications at the beginning and whenever there is any change. The data relating to power system output & parameters and weather related data as applicable shall also be mandatorily provided by such generators to the concerned SLDC in real time.
- 2.3. Forecasting shall be done by wind and solar generators connected to the State grid, or by QCAs on their behalf. The concerned SLDC is also mandated to undertake forecasting of wind and solar power that is expected to be injected into the State grid, by engaging forecasting agency(ies) if required. The forecast by the concerned SLDC shall be with the objective of ensuring secure grid operation by planning for the requisite balancing resources. The forecast by the QCA or wind and solar generator, as the case may be, shall be generator centric. The QCA or wind and solar generators will have the option of accepting the SLDC's forecast for preparing its schedule or provide the

SLDC with a schedule based on their own forecast. The QCA shall coordinate the aggregation of schedules of all generators connected to a pooling station and communicate it to the SLDC.

- 2.4. The QCA or the wind and solar generator shall submit a day-ahead and weekahead schedule for each pooling station or each generating station, as the case may be. Day-ahead schedule shall contain wind or solar energy generation schedule at intervals of 15 minutes (time-block) for the next day, starting from 00:00 hours of the day, and prepared for all 96 time-blocks. Week-ahead schedule shall contain the same information for the next seven days.
- 2.5. The schedule of wind and solar generators connected to the State grid (excluding collective transactions) may be revised by giving advance notice to the SLDC. Such revisions shall be effective from 4<sup>th</sup> time block, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day.
- 2.6. The plan for data telemetry, formats of forecast submission and other details in this regard shall be provided in the Detailed Procedure to be prepared by SLDC and approved by the State Commission.
- 2.7. Any commercial impact on account of deviation from schedule based on the forecast shall be borne by the wind and solar generator, either directly or transacted via the representing QCA.

#### PART – 3 COMMERCIAL AND DEVIATION SETTLEMENT

- 3.1. (a) The wind or solar generators connected to the State grid and selling power within the State shall be paid by the buyer as per actual generation.(b) The wind or solar generators connected to the State grid and selling power outside the State shall be paid by the buyer as per scheduled generation.
- 3.2. The wind and solar generator or the QCA, as the case may be, shall have the option of accepting the concerned SLDC's forecast for preparing its schedule or provide the concerned SLDC with a schedule based on its own forecast, and such schedule shall be used as reference for deviation settlement.
- 3.3. The QCA shall undertake all commercial settlement on behalf of the generator(s) connected to the respective pooling station(s).
- 3.4. In the event of actual generation of a generating station or a pooling station, as the case may be, being less or more than the scheduled generation, the deviation charges for shortfall or excess generation shall be payable by the wind and solar generator or the QCA, as the case may be, to the State DSM Pool, as given in Table – I below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 10%	None
2	>10% but <=20%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 10% and upto 20%
3	>20% but <=30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for balance energy beyond 20% and upto 30%
4	> 30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for shortfall or excess energy beyond 20% and upto 30% + Rs. 1.50 per unit for balance energy beyond 30%

 Table – I: Deviation Charges in case of under or over-injection, for sale of power within the State

Provided that the deviation charges payable for under or over injection by the wind or solar generator or the QCA, which has been commissioned prior to the date of effect of these regulations, shall be as under:

Table – II: Deviation Charges in case of under or over-injection for wind or solar generators commissioned prior to the date of effect of these regulations, and selling power within the State:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	None
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 15% and upto 25%
3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for balance energy beyond 25% and upto 35%

4	> 35%	At Rs. 0.50 per unit for the shortfall or
		excess energy beyond 15% and upto
		25%
		+ Rs. 1.0 per unit for shortfall or excess
		energy beyond 25% and upto 35% +
		Rs. 1.50 per unit for balance energy
		beyond 35%

Provided that deviation charges for under or over injection by wind or solar generator connected to the State grid and selling power outside the State shall be payable or receivable as per the framework provided in Appendix – I. The accounting for this purpose shall be done by the SLDC.

- 3.5. The QCA shall also de-pool the energy deviations as well as deviation charges to each generator using one of the following options:
  - (a) In proportion to actual generated units for each time-block for each generator
  - (b) In proportion to available capacity of each generator
- 3.6. The State shall maintain separate records and account of time-block wise schedules, actual generation and deviations for all generators, including wind and solar generators.
- 3.7. Once the accounting procedures as above are put 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 above for wind and solar generators.
- 3.8. Annual accounts as mentioned above shall be prepared by the SLDC. The illustration in this regard is at Appendix II to these regulations. In case there is deficit in the overall pool at the end of the year, the SLDC may approach the National Funds such as PSDF or NCEF to cover such deficit.

# PART – 4 MISCELLANEOUS

#### 4.1 Power to Relax

The Commission may by general or special order, for reasons to be recorded in writing, and after giving an opportunity of hearing to the parties likely to be affected by grant of relaxation, may relax any of the provisions of these regulations on its own motion or on an application made before it by an interested person.

#### 4.2 Power to issue directions

If any difficulty arises in giving effect to these regulations, the Commission may on its own motion or on an application filed by any affected party, issue such directions as may be considered necessary in furtherance of the objective and purpose of these regulations.

> ( ) Secretary

# Appendix –I

# Framework for deviation charges for under or over injection by generator connected to the State grid and selling power outside the State

The wind or solar generators connected to the State grid and selling power outside the State boundary shall be paid as per schedule.

a) In the event of actual generation being less than the scheduled generation, the deviation charges for shortfall in generation shall be payable by such wind or solar generator, or the QCA on their behalf, to the State DSM Pool as given in Table – 1 below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	At the Fixed Rate for the shortfall energy for absolute error upto 15%
2	>15% but <= 25%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for the shortfall energy for absolute error upto 15% + 110% of the Fixed Rate for balance energy beyond 15% and upto 25% + 120% of the Fixed Rate for balance energy beyond 25% and upto 35% + 130% of the Fixed Rate for balance energy beyond 35%

# Table – I: Deviation Charges in case of under injection

Where the Fixed Rate is the PPA rate as determined by the Appropriate Commission under section 62 of the Act or adopted by the Appropriate Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective SLDC supported by copy of the PPA.

Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as determined by CERC from time to time.

b) In the event of the actual generation being more than the scheduled generation, the Deviation Charges for excess generation shall be payable to the wind or solar generator, or the QCA on their behalf, from the State DSM Pool as given in Table – II below:

Sr. No.	Absolute Error in the 15- minute time block	Deviation Charges payable
1	<= 15%	At the Fixed Rate for excess energy upto 15%
2	>15% but <= 25%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25%
3	>25% but <=35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy beyond 25% and upto 35%
4	> 35%	At the Fixed Rate for excess energy upto 15% + 90% of the Fixed Rate for excess energy beyond 15% and upto 25% + 80% of the Fixed Rate for excess energy

#### Table – II: Deviation Charges in case of over injection

beyond 25% and upto 35%
+ 70% of the Fixed Rate for excess energy
beyond 35%

Where the Fixed Rate is the PPA rate as determined by the Appropriate Commission under section 62 of the Act or adopted by the Appropriate Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to respective SLDC supported by copy of the PPA.

Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as determined by the CERC from time to time.

c) In reference to clauses (a) and (b) as above, for balancing of deemed renewable purchase obligation (RPO) compliance of buyers with respect to schedule, deviations by all wind and solar generators which are selling power outside the State boundary shall first be netted off for the entire pool on a monthly basis and any remaining shortfall in renewable energy generation must be balanced through purchase of equivalent solar and non-solar Renewable Energy Certificates (RECs), as the case may be, by SLDC by utilising funds from the Pool Account. For positive balance of renewable energy generation, equivalent notional RECs shall be credited to the State DSM Pool and carried forward for settlement in future.

# Appendix –II Metering, Energy and Deviation Accounting

Separate metering, schedule preparation, accounting of actual generation/drawl, accounting of energy deviations and deviation settlement shall be undertaken for different types of entities in the State. The complete accounting process will be operationalized in the following manner:



# 1. Metering:

Interface Metering for intra-state entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM).

# 2. Energy Accounting

Every intra-State grid connected entity shall be metered with a Special Energy Meter (SEM), and the energy accounting for each such entity shall be done in the following manner:-



# 3. Deviation Settlement

Deviation settlement for the State shall be governed by the following provisions:

#### **Stage – 1: Transitional Arrangement**

#### 3.1 Computation of Deviation Charge

Deviation charges shall be computed in the following manner:-

- 3.1.1. Deviation Charge (D) payable/receivable for the State as a whole at the State periphery shall first be computed.
- 3.1.2. Deviation charge (R1) from the pooling stations/RE generators based on these regulations, shall be collected and pooled in the State DSM Pool.

#### 3.2 Settlement of deviation charge

Deviation charge as above shall be allocated to different grid connected entities in the following manner:-

- 3.2.1 Deviation charge shall be allocated (D) amongst the distribution companies/OA consumers/conventional generators/RE generators in proportion to their respective deviation viz., C1/C2/C3/C4
- 3.2.2 For RE generators, assuming (i) the share out of State level deviation charge as D4 and (ii) receipt of deviation charge from RE generators (Pooling station) based on the charges for deviation as per the model regulation, as R1 actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

This amount (D4 - R1 if greater than zero) can be refunded to the State DSM pool from PSDF/NCEF.

#### Stage – 2: Long-Term Arrangement:

### 3.3 Computation of Deviation Charge

- 3.3.1 Compute Deviation Charge (D) payable/receivable for the State as a whole at the State periphery
- 3.3.2 Implement Deviation Settlement Mechanism(DSM) for conventional generators on lines of CERC DSM or any other variant, that is, determine in advance the deviation charge payable/receivable by all grid connected entities within the state
- 3.3.3 Implement DSM mechanism for RE generators on lines of model regulation and collect in the State DSM pool, deviation charge (R1) from the pooling stations/RE generators based on the said model

# 3.4 Settlement of deviation charge

- 3.4.1 Compute for the distribution companies / OA consumers / conventional generators, the deviation charges payable/receivable by them in proportion to their respective deviation viz., C1/C2/C3 (this should be as per State level DSM)....(assume net balance as D1)
- 3.4.2 In respect of RE generators, collect deviation charge from the RE generators (Pooling station) based on the charges for deviation as per the model regulation (assume as R1)
- 3.4.3 Actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

# If D is greater than (D1+R1), the differential be made good from the PSDF/NCEF.

# **EXPLANATORY MEMORANDUM**

#### 1. Background

The Central Electricity Regulatory Commission published the Framework on Forecasting, Scheduling and Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar) on 7<sup>th</sup> August, 2015. This framework is applicable for solar and wind generators that are regional entities, that is, their scheduling and settlement is handled by the respective Regional Load Dispatch Centre (RLDC). The framework is constituted of amendments to Grid Code and the DSM Regulations:

- Central Electricity Regulatory Commission (Indian Electricity Grid Code) (Third Amendment) Regulations, 2015.
- Central Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) (Second Amendment) Regulations, 2015.

This framework envisages that bulk of wind and solar capacity expected to come online over the next 7 years, in alignment with Government's target of 100 GW solar and 60 GW wind by 2022, shall be inter-state in nature. That is, these generating stations shall sell power within as well as outside the host state, and connect directly to the CTU grid. This will become essential as a few states are rich in solar and wind resources, whereas the Renewable Purchase Obligations (RPOs) shall ensure that the whole country takes advantage of renewable power, while marching towards the national goal of *universal electrification*. This Framework has opened up the countrywide market to such solar and wind generators that shall be under RLDC's jurisdiction.

However, presently all of the existing wind and solar generating stations are directly connected to the State grid, and thus fall under operational control area of the respective State Load Dispatch Centres (SLDCs). Presently, (....) MW of wind and (....) MW of solar is installed in the State of (....). The proposed regulations seek to address the grid integration aspects related to such wind and solar generators directly connected to the State grid.

# 2. Objective & Scope

The objective of these regulations is to facilitate large-scale grid integration of solar and wind generating stations while maintaining grid stability and security as envisaged under the Grid Code, through forecasting, scheduling and commercial mechanism for deviation settlement of these generators.

It is essential that the grid operator has visibility into how much renewable energy (RE) is expected to be injected into the grid. This is especially critical for variable and uncertain sources such as wind and solar. Forecasting and scheduling of these generators is critical to anticipate balancing requirements and procure requisite reserves to maintain load-generation balance and grid reliability. At the same time, due to the intermittent nature of these sources, special provisions must be made so that the generators are not unduly penalized.

These regulations are intended to cover all wind and solar generators connected to the State grid, directly or via pooling stations. Majority of these generators are selling power within the State. Additionally, some wind and solar generators are connected to the State grid but selling their power wholly outside the State, or partly within the State and partly outside the State boundary. All solar and wind generators connected to the State grid fall under the purview of these regulations, irrespective of nature of transactions.

#### **3. Proposed Framework**

#### **3.1. Introduction of Aggregators**

The fragmented nature of the industry which is evident from the large number of owners of wind turbines poses a challenge of direct interaction of these generators with the respective SLDCs. This process can quickly become unwieldy due to the sheer number of turbine owners. Secondly, benefits of aggregation on forecasting accuracy are well documented. Keeping in view the above reasons, the Commission proposes to formalize a new aggregator entity, termed as Qualified Coordinating Agency or the QCA. This aggregator or the QCA shall coordinate all forecasting, scheduling and commercial settlement processes for all wind or solar generators connected to a pooling station. The QCA might aggregate one or more pooling stations, and several QCAs may come together to aggregate even at the State level for leveraging maximum benefit of aggregation. The QCAs shall interact with the SLDC (or RLDC, if required) on behalf of the generators. This significantly cuts down the complexity both for small generators as well as the SLDC, which now has to interact with a few number of agencies instead of thousands of generators.

The QCA might be a Principal Generator, as recognized in the Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Mediumterm Open Access in inter-State Transmission and related matters) (Third Amendment) Regulations, 2013, or a third party. The proposed functions of the QCA are as follows:

- Provide schedules with periodic revisions as per this regulation on behalf of all the Wind/Solar Generators connected to the pooling station,
- Responsible for metering, data collection and 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.

The eligibility and empanelment of QCAs shall be outlined through a separate order.

It must be noted that this is not a compulsory requirement for the process. Some large solar or wind plants in future may encompass one or more pooling stations themselves. Such large generators may choose to interact directly with the respective SLDC, if desired.

# 3.2. Data Telemetry

Weather and power system data at the turbine or inverter level is essential for the grid operator to have accurate visibility into the availability and performance of RE stations connected to the grid. Metering and communication of real time data at the turbine/inverter level are mandated. This data shall also help the QCA for improving forecasting accuracy. Thus, special energy meters and communication infrastructure must be installed by all generators, and as such, this should be a requirement for approval of connectivity going forward. Special Energy Meters should also be installed at the pooling station level, to meter the power injected into the grid in every time-block.

The SLDC shall have to prescribe a format for accepting this data into their system, and define an internal process to assimilate and deploy this data. While SLDC may only receive data at the pooling station level, the QCA shall have to process data at the turbine level for improved forecasting and pooling/de-pooling of schedules/deviations.

# 3.3. Forecasting

Wind and solar sources are variable and uncertain in nature. Known variability such as high wind speeds during monsoon can be better predicted for large geographical areas, while uncertainty reduces closer to the time of injection. In fact, forecasting accuracy increases exponentially the closer it is to real-time.

Solar plants are now mandated to undertake forecasting. Notwithstanding the lack of indigenous experience, solar forecasting methodologies are quickly maturing worldwide and have higher accuracy levels than wind forecasting. While we are starting out and aiming for ambitious solar power targets, this is the opportune moment to ensure these plants connect to the grid in a sustainable and streamlined manner.

Forecasting should be done by wind and solar generators connected to the State grid, or by QCAs on their behalf. The concerned SLDC should also undertake forecasting of wind and solar power that is expected to be injected into the State grid, by engaging forecasting agency(ies) if required. The forecast by the concerned SLDC shall be with the objective of ensuring secure grid operation by planning for the requisite balancing resources. The forecast by the QCA or wind and solar generator, as the case may be, shall be generator centric.

The QCA or wind and solar generators will have the option of accepting the SLDC's forecast for preparing its schedule or provide the SLDC with a schedule based on their own forecast. The QCA shall coordinate the aggregation of schedules of all generators connected to a pooling station (or a cluster of pooling stations) and communicate it to the SLDC. Such schedule shall be used as reference for deviation settlement.

The wind and solar generator or QCA should submit a day-ahead as well as weekahead schedule for each generating station or each pooling station, as the case may be. In case the QCA is coordinating for several pooling stations, it should submit an aggregate schedule as well. Day-ahead schedule should contain wind or solar energy generation forecast at intervals of 15 minutes (time-block) for the next day, starting from 00:00 hours of the day, and prepared for all 96 time-blocks. Week-ahead schedule should contain the same information for the following seven days.

The accuracy of forecasting algorithm can be measured by computing the delta between scheduled and actual generation. Error may be defined as:

'Absolute Error' means the absolute value of the error in the actual generation of wind or solar generators with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation–Scheduled Generation] / (AvC);

where Available Capacity or AvC for wind or solar generators means the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block.

Mean Absolute Error or MAE can be determined by averaging the absolute error over a day or week or year, etc. MAE should be tracked over time to ensure that accuracy improves as more historical data is collected, and to benchmark against error % reported internationally.

The Central Commission, in the Statement of Reasons (SOR) accompanying the Framework on Forecasting, Scheduling and Imbalance Handling for Variable Renewable Energy Sources (Wind and Solar), has noted that the definition of error, calculated w.r.t schedule, does not adequately address instances such as low/no generation cases, such as during low wind season, where close to zero schedules would result in high numerical errors but with no real impact on grid. Additionally, incentives to generators for better forecasting must be aligned with the objective of grid management, which is to minimize actual MW deviations from schedule. As commercial impact on generators is directly proportional to the error percentage, forecasting models will be designed to minimize MW deviations only if the denominator is a constant (and not a variable such as 'schedule'). This will ensure that the error quantity corresponds to the physical MW impact on the grid, and the error definition holds valid in all seasons.

#### 3.4. Scheduling

Once the day-ahead schedule is submitted, flexibility must be accorded to the QCA (or generators) to revise it as the accuracy of forecasting improves closer to real time. Keeping this in mind, 16 revisions per day have been allowed, to provide maximum opportunity to minimize deviations from schedule, and hence limit the commercial burden on the generator.

Hence, the schedule of wind and solar generators could be revised by giving advance notice to the SLDC. Such revisions shall be effective from  $4^{th}$  time block, the first being the time-block in which notice was given. There may be one revision for each time slot of one and half hours starting from 00:00 hours of a particular day subject to maximum of 16 revisions during the day.

The plan for data telemetry, formats of forecast submission and other details in this regard should be provided in the Detailed Procedure to be prepared by SLDC and approved by the State Commission.

Any commercial impact on account of deviation from schedule based on the forecast would have to be borne by the wind and solar generator, either directly or transacted via the representing QCA.

#### **3.5. Deviation Settlement**

While forecasting accuracy increases over time with improved models and more reliable data, 100% accuracy is not possible to achieve given the uncertain nature of solar and wind sources. However, to incentivize investment in better forecasting methodologies and reliable data, deviation charges would be levied outside a tolerance band. Within this tolerance band, there will be no revenue impact on the

generator. However, outside this band, a graded deviation charge can be applied. This will provide incentive to forecast as accurately as possible, utilizing the schedule revisions, and communicate accordingly with SLDC.

Currently, all wind and solar generators are being paid as per actual generation. This could be continued in all cases of 'single seller-single buyer' model, and where power is being sold within the State.

The Central Commission, while proposing the DSM amendments for solar & wind regional entities, considered simulations and analytical inputs from agencies engaged in wind forecasting. For various sites across India, based on one year of actual data, the error normalized to capacity was simulated (pertaining to case where Available Capacity = Installed Capacity). The results were plotted in graphs, a few of which are reproduced from CERC's SOR document below:



Figure 1: Site A 25.5 MW




7.39%

Figure 2: Site B 24 MW



#### Figure 3: Site C 72 MW

The first two sets of graphs plot simulation results with 16 revisions, based on 50 weeks of actual recorded data, thus including both high wind and low wind seasons. The resulting accuracy is very high. The third plot is a real-world example of one year of forecasting algorithm that was run at the site based on previously allowed number of revisions, i.e. 8 per day. This pilot also reports a fairly high accuracy, with 87% of output energy within  $\pm -10\%$  error, and 94% within  $\pm -15\%$ .

The Central Commission, in view of simulation studies such as above, as well as international research reports on observed MAE, has put forth a framework for computing deviation charges based on error, with a tolerance band of 15% initially, which shall be tightened over time as the ecosystem gains experience. The State Commission proposes the following, with a structure in line with CERC's framework; however, a tighter tolerance band for new projects, as it is felt that with the framework of aggregator (QCA) at pooling station, 10% accuracy (defined w.r.t available capacity) is quite achievable. For existing generators, the framework is more liberal, so as to ensure minimal financial impact on existing PPAs. The COD (Commercial Operation Date) may be considered w.r.t. the date this regulation is notified, to categorize the generators as 'existing' (COD before regulation notification date) or 'new' (COD after regulation notification date).

In the event of actual generation of a generating station or pooling station being less or more than the scheduled generation, the deviation charges for shortfall or excess generation shall be payable by the wind and solar generator or the QCA, as the case may be, to the State DSM Pool, as given in Table -1 and Table -2 below:

Sr. No.	Absolute Error in the	Deviation Charges payable to State
	15-minute time block	DSM Pool
1	<= 10%	None
2	>10% but <=20%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 10%
3	>20% but <=30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for balance energy beyond 20% and upto 30%
4	> 30%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 10% and upto 20% + Rs. 1.0 per unit for shortfall or excess energy beyond 20% and upto 30% + Rs. 1.50 per unit for balance energy beyond 30%

 Table – 1: Deviation Charges in case of under or over-injection for New

 Generators

# Table – 2: Deviation Charges in case of under or over-injection for Existing Generators

Sr. No.	Absolute Error in the 15-minute time block	Deviation Charges payable to State DSM Pool
1	<= 15%	None
2	>15% but <=25%	At Rs. 0.50 per unit for the shortfall or excess energy for absolute error beyond 15% and upto 25%
3	>25% but <=35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for balance energy beyond 25% and upto 35%
4	> 35%	At Rs. 0.50 per unit for the shortfall or excess energy beyond 15% and upto 25% + Rs. 1.0 per unit for shortfall or excess energy beyond 25% and upto 35% + Rs. 1.50 per unit for balance energy beyond 35%

As in aggregation, the QCA should 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

RPO accounting can continue as per existing arrangement, and needs no change.

Symmetrical deviation charges around zero ensure that there is no perverse incentive for gaming or mis-declaration of schedule by the generator. Secondly, a tolerance band equivalent to 15% of installed capacity is quite wide, based on some simulations conducted by a couple of stakeholders on CERC's request. This is a good starting point to get the processes ironed out and get the ecosystem

disciplined. As experience is gained, this zero-impact band might be tightened in future.

It must be noted that taking cognizance of variable and uncertain nature of these sources, the solar and wind generators have been exempt from the frequency linked deviation charges. The State Pool might be surplus or deficit depending on instantaneous DSM rate when solar or wind generators deviate vis-a-vis the deviation rate applicable on them. The State may then approach a national fund such as PSDF or NCEF in case the State DSM pool goes into deficit due to these regulations. Accordingly, the State shall create accounting procedures to track schedules and actual generation of all generators, including wind and solar generators, as well as deviation charges of solar and wind generators under a separate head, as detailed in Section 4 below.

#### **3.5.1.** Case of generator selling power outside the State

The generators connected to the State grid, even if selling power outside the State, will remain under SLDC's jurisdiction. IEGC sub-clause 6.4(1) clearly demarcates responsibilities and control areas:

"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, [meter data processing], collections/disbursement of UI payments, outage planning, etc. The following clause gives the criteria for demarcation of control area jurisdiction."

Additionally, sub-clause 6.4(2)c(ii) states:

"If a generating station is connected only to the State transmission network, the SLDC shall coordinate scheduling, except for the case as at (a) above."

Thus, IEGC clearly specifies control area jurisdiction for different types of entities. Generators connected to the State network are monitored, metered and controlled by SLDC, even though nature of transaction might change over time (intra-state, inter-state, open-access etc).

For generators connected to the State grid and selling power outside the State, payment shall be made by the buyer as per schedule, in alignment with existing energy accounting practices at the regional level. This will ensure that wind and solar generators can seamlessly participate in the national market, which

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would benefit them in the long run. A brief summary of the deviation settlement rules is provided in the Appendix. The Commission underscores that the accounting shall be undertaken by State Load Dispatch Centre, and settlement shall be done with the State Pool. It should be noted that even though payment is made as per schedule, the settlement with the State Pool would effectively provide payment as per actual to the generators. Additional deviation charges shall be applicable if the error is outside the tolerance band.

Additionally, in schedule based payment, RPO is deemed complied on the basis of schedule. However, in case of under-injection for example, there would arise a need for balancing actual RE generation with RPO. This necessitates procurement of equivalent RECs for shortfall in RE generation. Similarly over-injection necessitates crediting REC towards such excess generation. As in the regional framework, all RE shortfalls and over-injections can be netted off (on a monthly basis) for the entire State pool first. In case of RE shortfall, RECs will be purchased by the nodal agency SLDC from exchange by using funds from the State DSM pool and the RECs so purchased shall stand extinguished. In case of RE surplus, notional RECs will be credited to the DSM pool as carry forward for the next cycle.

#### 4. Metering, Energy and Deviation Accounting

While integration of solar and wind generating stations presents unique challenges to grid management, several other mechanisms must be put in place to create a strong foundation for a reliable grid. Separate energy accounting, both for injection schedule as well as drawl schedule, is essential for ensuring grid discipline from all grid-connected entities, such as DISCOMs, open access consumers, conventional and renewable generators. To achieve this objective, separate metering, schedule preparation, accounting of actual generation/drawl, accounting of energy deviations and deviation settlement shall be undertaken for different types of entities. The complete accounting process will be operationalized in the following manner:



## 4. Metering:

Interface Metering for intra-state entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM).

## 5. Energy Accounting

Interface Metering for intra State entities shall be undertaken on an urgent basis. Every entity must be metered with a Special Energy Meter (SEM), and the energy accounting for each such entity shall be done in the following manner:-



As seen from the flowchart above, separate accounting shall be done for schedule, actual and deviations of all grid-connected entities. This will enable SLDC to

accurately distribute the State boundary energy deviations (and associated commercial charges to RLDC) among different categories of generators and drawl entities.

# 6. Deviation Settlement

Deviation settlement for the state shall be governed by the following provisions:

# Stage – 1: Transitional Arrangement

# 3.1 Computation of Deviation Charge

Deviation charges shall be computed in the following manner:-

- 6.1.1. Deviation Charge (D) payable/receivable for the State as a whole at the State periphery shall first be computed.
- 6.1.2. Deviation charge (R1) from the pooling stations/RE generators based on these regulations, shall be collected and pooled in the State DSM Pool.

# 3.2 Settlement of deviation charge

Deviation charge as above shall be allocated to different grid connected entities in the following manner:-

- 3.3.1 Deviation charge shall be allocated (D) amongst the distribution companies/OA consumers/conventional generators/RE generators in proportion to their respective deviation viz., C1/C2/C3/C4
- 3.3.2 For RE generators, assuming (i) the share out of State level deviation charge as D4 and (ii) receipt of deviation charge from RE generators (Pooling station) based on the charges for deviation as per the model regulation, as R1 actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

This amount (D4 - R1 if greater than zero) can be refunded to the State DSM pool from PSDF/NCEF.

# Stage – 2: Long-Term Arrangement:

# 3.4 Computation of Deviation Charge

- 3.3.1 Compute Deviation Charge (D) payable/receivable for the State as a whole at the State periphery
- 3.4.4 Implement Deviation Settlement Mechanism(DSM) for conventional generators on lines of CERC DSM or any other variant, that is, determine in advance the deviation charge payable/receivable by all grid connected entities within the state

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3.4.5 Implement DSM mechanism for RE generators on lines of model regulation and collect in the State DSM pool, deviation charge (R1) from the pooling stations/RE generators based on the said model

# 3.5 Settlement of deviation charge

3.4.1 Compute for the <u>distribution companies/OA consumers/conventional</u> generators,

the deviation charges payable/receivable by them <u>in proportion to their</u> respective deviation viz., C1/C2/C3 (this should be as per State level DSM)....(assume net balance as D1)

- 3.5.2 In respect of RE generators, collect deviation charge from the RE generators (Pooling station) based on the charges for deviation as per the model regulation (assume as R1)
- 3.5.3 Actual commercial impact for the State as a result of deviation of RE generation would be D4-R1

If D is greater than (D1+R1), the differential be made good from the PSDF/NCEF

The Commission directs the Staff to prepare relevant regulations, or amendments to existing regulations, to put in place procedures described above latest by April 1<sup>st</sup>, 2016.

# 5. Conclusion

The proposed framework deals with operational and commercial aspects of running wind and solar generating units on the grid. This regulation is a big first step for the State grid operator to be able to manage the variable power effectively. The Central Government's initiative towards facilitating centralized forecasting through establishment of Renewable Energy Management Centres (REMCs), co-located with SLDCs, is expected to help in capacity building at SLDCs, as well as development of better forecasting and more accurate scheduling methods.

Notwithstanding the issue of forecasting accuracy that is feasible, the next natural issue to address is that of balancing. The deviation from schedule is inevitable for RE generators as 100% accuracy is not possible to achieve, even with frequent revisions. To manage these uncertain deviations in real time, the grid operator must have access to reserves. The Commission directs its staff to work on Ancillary Services Regulations, including spinning reserves. Both primary and secondary reserves will assist the SLDC to maintain load-generation balance, and ensure grid reliability. Fast ramping resources such as pumped hydro or natural gas plants are natural options to be deployed for balancing. Backing down of thermal units will also be necessary.

As stated above, the State shall create accounting and settlement procedures to keep records of time-block wise schedules, actual generation and deviations for all generators, including wind and solar generators. Once this is put in place, all RE generators can 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 above for wind and solar generators. This aggregation at the State level will be advantageous, reducing the impact on the State as well as the generators.

Annual accounts as mentioned above shall be prepared by the SLDC. In case there is deficit in the overall pool at the end of the year, then the SLDC may approach the National Funds such as PSDF or NCEF to cover such deficit. This facility of support from the National level fund for meeting the deficit is expected to be available till 31.3.2019 as recommended by the Forum of Regulators.

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# Appendix: Framework for deviation settlement of wind or solar generator, or QCA on their behalf, connected to the State grid and selling power outside the State boundary

The wind or solar generator, or QCA on their behalf, shall be paid as per schedule for a time-block. The error shall be defined w.r.t Available Capacity (AvC). If there is a deviation from schedule, the deviations shall be settled as below:

- If the Absolute (Abs) Error is less than 15%: no deviation charge shall be applicable on the generator. If the generator has under-injected (vs schedule given), the generator shall return to the State pool amount equivalent to (no. of units under-injected) x (PPA rate). On the other hand, if the generator has over-injected (vs schedule given), the generator shall receive from the State pool an amount equivalent to (no. of units under-injected) x (PPA rate). Thus, the net revenue of the generator within this tolerance band is equivalent to revenue as per actuals.
- If the Abs Error is greater than 15% but less than 25%: the generator shall settle the difference with respect to schedule, with the State pool at its PPA rate, as above. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

Deviation charge (I) = (no. of units outside 15% of AvC) x (10% of PPA

rate)

If the Abs Error is greater than 25% but less than 35%: the generator shall settle the difference with respect to schedule with the State pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

Deviation charge (I) =  $(10\% \text{ of AvC}) \times (10\% \text{ of PPA rate})$ 

Deviation charge (II) = (no. of units outside 25% of AvC) x (20% of PPA rate)

Total deviation charge in this case = Deviation Charge (I) + Deviation Charge (II)

If the Abs Error is greater than 35%: the generator shall settle the difference with respect to schedule with the State pool at its PPA rate. In addition to this settlement, the generator would pay a deviation charge calculated as follows:

Deviation charge (I) =  $(10\% \text{ of AvC}) \times (10\% \text{ of PPA rate})$ 

Deviation charge (II) =  $(10\% \text{ of AvC}) \times (20\% \text{ of PPA rate})$ 

Deviation charge (III) = (no. of units outside 35% of AvC) x (30% of PPA rate)

Total deviation charge in this case = Deviation charge (I) + Deviation charge (II) + Deviation charge (III)

Pictorially, this framework can be represented as follows (AvC: Available Capacity):

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The PPA rate mentioned above which shall be used for the purpose of Deviation Settlement shall be the PPA Rate as determined by the Appropriate Commission under Section 62 or as adopted under Section 63 of the Electricity Act 2003 through a separate order.

In case the RE generator has multiple PPAs at different rates, then the weighted average PPA rate shall be used for the purpose of Deviation settlement.

On the issue of Settlement for Open Access (OA) users and Captive Power Plants (CPPs), it has been felt that Settlement of OA (REC projects) and CPP poses a challenge, particularly for CPP where there is no PPA rate. All deviations from schedule by these entities must be settled at National APPC rate, as determined by CERC from time to time.

#### MODEL DSM REGULATIONS AT STATE LEVEL (DRAFT) \_\_\_\_\_(STATE)ELECTRICITY REGULATORY COMMISSION

#### \_\_March, 2017

#### NOTIFICATION

**No.**\_/\_/2016/xERC.- In exercise of the powers conferred under Section 181of the Electricity Act, 2003 (36 of 2003), and all other powers enabling it in this behalf, and after previous publication, the \_\_\_\_\_[*State]*Electricity Regulatory Commission hereby makes the following regulations, namely:

#### 1. Short title and commencement

- 1. These regulations may be called the <u>[State]</u>Electricity Regulatory Commission (Deviation Settlement Mechanism and related matters) Regulations, 2017.
- 2. These regulations shall come into force from the date of notification in the official Gazette[\_\_\_\_\_\_\_, 2017].

#### 2. Definitions and Interpretation

- 1. In these regulations, unless the context otherwise requires -
- a. Act' means the Electricity Act, 2003 (36 of 2003);
- b. **'Actual drawal'** in a time-block means electricity drawn by a buyer, as the case may be, measured by the interface meters;
- c. **'Actual injection'** in a time-block means electricity generated or supplied by the seller, as the case may be, measured by the Interface meters;
- d. 'Available Capacity (AvC)' for wind or solar generators which are regional entities or state entities, as the case may be, is the cumulative capacity rating of the wind turbines or solar inverters that are capable of generating power in a given time-block.
- e. 'Buyer' means a person, including distribution licensee or open access consumer, purchasing electricity through a transaction scheduled in accordance with the regulations applicable for short-term open access, medium-term open access and long-term access;
- f. **'Connectivity Regulations'** means the \_\_\_\_*[State]*Electricity Regulatory Commission (Grant of Connectivity, Long Term Access and Medium Term Access in inter-State Transmission) Regulations as amended from time to time and shall include any subsequent amendment thereof.

- g. **'Commission'** means the \_\_\_\_\_[*State]*Electricity Regulatory Commission referred to in sub-section (1) of section 82of the Act;
- h. 'Deviation' in a time-block for a Seller means its total actual injection minus its total scheduled generation and for a Buyer means its total actual drawal minus its total scheduled drawal, and shall form part of the State Energy Accounts to be prepared by SLDC.
- i. **'Deviation-RE** (also termed as **Absolute Error'**) shall mean the absolute value of the error in the actual generation of wind or solar generators which are state entities with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation– Scheduled Generation] / (AvC)

- k. 'Existing RE Project' shall mean Wind Generating Project or Solar Generating Project that has been commissioned prior to date of notification of these Regulations and the term Existing Wind/Solar Generator shall be construed accordingly;
- I. 'Gaming' in relation to these regulations, shall mean an intentional misdeclaration of declared capacity by any seller in order to make an undue commercial gain through Charge for Deviations;
- I. '**Grid Code**' means the Grid Code specified by the Commission under clause (h) of sub-section (1) of Section 86 of the Act.
- m. 'Interface meters' means interface meters as defined by the Central Electricity Authority under the Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006, as amended from time to time.
- n. 'Interconnection Point' means the HV side of the pooling station (line isolator of the outgoing feeder of the HV side of the pooling S/S), which shall be the same level at which forecast and schedule need to be prepared by wind and solar generating stations for onward submission to SLDC.
- o. 'Load Despatch Centre' means National Load Despatch Centre, Regional Load Despatch Centre or State Load Despatch Centre, as the case may be, responsible for coordinating scheduling of the Buyers and the Sellers in accordance with the provisions of Grid Code;
- P. 'New RE Project' shall mean Wind Generating Project or Solar Generating Project that has been commissioned subsequent to date of notification of these Regulations and the term New Wind/Solar Generator shall be construed
   (*Final Draft Version V12.0 14March2017*)

accordingly;

- q. 'Open Access Regulations' means the \_\_\_\_[State]Electricity Regulatory Commission Open Access Regulations as amended from time to time and shall include any subsequent amendment thereof.
- q. 'Qualified Coordinating Agency (QCA)': means the agency coordinating on behalf of Wind/Solar Generators connected to a pooling station. QCA may be one of the generators or any other mutually agreed agency for the following purposes:
  - Coordinate for schedules with periodic revisions on behalf of all the Wind/Solar Generators connected to the pooling station(s).
  - •Responsible for coordination with STU/SLDC for metering, data collection/ transmission, communication.
  - Undertake commercial settlement on behalf of the generators of such charges pertaining to generation deviations only including payments to the Regional/State Deviation Pool Accounts through the SLDC.
  - Undertake de-pooling of payments received on behalf of the generators from the State Deviation Pool Account and settling them with the individual generators.

QCA shall be treated as a State Entity and shall be registered with SLDC.

- r. **'Scheduled Generation'** at any time or for a time block or any period means schedule of generation in MW or MWh ex-*bu*s given by the concerned Load Despatch Centre;
- s. 'Scheduled Drawal' at any time or for a time block or any period time block means schedule of despatch in MW or MWh ex-bus given by the concerned Load Despatch Centre;
- t. 'Seller' means a person, including a generating station, supplying electricity through a transaction scheduled in accordance with the regulations applicable for short-term open access, medium-term open access and long-term access;
- u. 'State Entity' means such person who is in the SLDC control area and whose metering and energy accounting is done at the state level
- "Time-Block" means a time block of 15 minutes, for which specified electrical parameters and quantities are recorded by special energy meter, with first time block starting at 00.00 hrs;
   Provided that time block shall be revised to 5 minutes from the date to be notified by Central Commission and [State] Commission.

(2) Save as aforesaid and unless repugnant to the context or the subject-matter otherwise requires, words and expressions used in these regulations and not

defined, but defined in the Act, or the Grid Code or any other regulations of this Commission shall have the meaning assigned to them respectively in the Act or the Grid Code or any other regulation.

#### 1. Objective

The objective of these regulations is to maintain grid discipline and grid security as envisaged under the Grid Code through the commercial mechanism for Deviation Settlement through drawal and injection of electricity by the users of the grid.

#### 2. Scope

These regulations shall be applicable to Seller(s) and Buyer(s) involved in the transactions facilitated through short-term open access or medium-term open access or long-term access in intra-state transmission or distribution of electricity (including inter-state wheeling of power), as the case may be.

#### 3. Pre-conditions for participation in Deviation Settlement Mechanism:

These Regulations aim to govern the functioning of the various State Entities in a way that discipline is maintained with regards to the injection and drawal of energy by such State Entities and the reliability and integrity of power system is maintained.

In order to meet these objectives, necessary preconditions and covenants for participation by State Entities shall be as under:

- (A) All State Entities shall have equal and non-discriminatory treatment as regards the 'Deviation Settlement mechanism as specified in these Regulations.
- (B) The State Entities shall inform the SLDCs of all contracts they have entered into for exchange of energy.
- (C) SLDC shall take all decisions with regard to the despatching of stations after evaluating all possible network parameters, constraints, congestions in the transmission network and in the eventuality of any such network aberration, the instructions by the SLDC with regard to despatch and drawal shall be binding on all State Entities.
- (D) State Entities shall operate their equipment and loads in a manner that is consistent with the provisions of the Indian Electricity Grid Code and the State Grid Code.
- (E) State Entities shall enter into BPTA (Bulk Power transmission agreement) and Connection Agreement with the concerned transmission licensee, which shall specify the physical and operational requirements for a reliable operation and gain physical access and connection to the intra-State transmission system (InSTS) or enter into Connection and Use Agreement with concerned Distribution Licensee for use of distribution

system, as the case may be.

- (F) SLDC shall publish all such information as required for all other State Entities to be aware of the energy exchanges taking place within the pool as well as exigency conditions, if any.
- (G) All State Entities shall make necessary arrangements for putting up suitable meters, capable of recording energy flows at 15-minute intervals, at the points of injection and drawal.

#### 4. Principles for Operationalising Deviation Settlement Mechanism:

The framework for Deviation Settlement Mechanism shall cover the following key design parameters, viz. (a) Scheduling period (b) Operating range of frequency (c) Deviation (d) Settlement period (e) Measurement unit for State Deviation Pool (f) Deviation Pool Price Vector (g) Deviation Volume Limit (h) Premise for least cost despatch (i) Premise for allocation of losses.

(A) Scheduling Period: The scheduling period shall comprise of 96 time blocks, each of 15-minute duration starting from 00:00 hours (IST) ending with 24:00 hours (IST). The first time block of scheduling period shall commence from 00:00 hours (IST) to 00:15 hours (IST), second time block of scheduling period shall commence from 00:15 hours (IST) to 00:30 hours (IST) and so on.

Provided that from the date to be notified by Commission, the scheduling period shall be revised to 288 time blocks, each of 5-minute duration starting from 00:00 hours (IST) ending with 24:00 hours (IST). Accordingly, the Interface Metering, Energy Accounting and Deviation Settlement should be capable to undertake transactions with 5-minute duration. All future resource planning, IT and communication system requirement and infrastructure development shall be undertaken to cater to this requirement.

(B) Based on the availability schedule forecasted by generating stations (Sellers) and load requirement forecasted by Buyers, the SLDC shall draw up the least cost despatch schedule on Day Ahead basis for the State Entities in accordance with the merit order principles approved by State Commission from time to time;

Provided that wheeling transactions of captive users and open access consumers shall be despatched as contracted subject only to transmission constraints and system emergency conditions.

(C) Operating Range for Frequency: The normal operating range for average grid frequency for time block shall be in line with range stipulated under IEGC and [State] Grid Code from time to time (viz. 49.90 Hz to 50.05 Hz). While normal operating range of average frequency as per IEGC has been stipulated as 49.90 Hz to 50.05 Hz, the deviation price vector has been specified under Schedule-I for frequency range of 49.80 Hz to 50.05 Hz.

No over-drawal or under-injection shall be allowed when grid frequency is below 49.80 Hz and no under-drawal or over-injection shall be allowed when grid frequency is above 50.05 Hz.

- (D) Deviation: For the purposes of Deviation settlement amongst State Entities, the SLDC shall work out the 'Deviation Pool Accounts' comprising over-drawal/under-drawal and over-injection and under-injection for each State Entity corresponding to each Scheduling period in accordance with the principles outlined hereunder.
  - i. **'Deviation'** in a time-block for a Seller means its total actual injection minus its total scheduled generation and for a Buyer means its total actual drawal minus its total scheduled drawal.
  - ii. **'Deviation-RE** (also termed as **Absolute Error**') shall mean the absolute value of the error in the actual generation of wind or solar generators which are State Entities with reference to the scheduled generation and the 'Available Capacity' (AvC), as calculated using the following formula for each 15 minute time block:

Error (%) = 100 X [Actual Generation– Scheduled Generation] / (AvC)

- (E) Settlement Period: Preparation and settlement of 'Deviation Pool Accounts' shall be undertaken on weekly basis coinciding with mechanism followed for regional energy accounts.
- (F) Measurement Unit for Deviation Pool Account: The measurement unit for Deviation Pool Volume (Over-drawal/under-drawal and Overinjection/under-injection) preparation shall be kiloWatt hours (kWh). Measurement unit for Deviation Pool Value (Payable and Receivable) preparation shall be Indian Rupees (INR). The decimal component of the energy unit (kWh) and amount (INR) shall be rounded off to nearest integer value.
- (G) Deviation Pool Price Vector: The charges for Deviation shall be in accordance with the Deviation Price Vector to be notified by the Commission from time to time. Separate treatment for pricing of Deviation of Buyers/Sellers and Wind/Solar Generators, as stipulated under Regulation 6 shall be applicable. Further, additional condition for a change in sign of the deviation shall be met once every 6 time blocks by Buyer/Seller except for Wind or Solar Generator(s),failing which additional charges @10% of the deviation charges applicable shall be levied for the duration of continuance of violation.
- (H) **Deviation Volume Limit**: In order to ensure grid discipline and grid security, conditions for Deviation Volume Limit and consequences for exceeding such Deviation Volume Limit by way of levy of Additional

Deviation Charges as specified under Regulation 7 shall be applicable.

(I) **Premise for allocation of losses**: For the purpose of Deviation Pool accounting, intra-State transmission system losses as approved by the Commission shall be allocated amongst the State Entities in proportion to the actual drawal by each State Entity.

Provided that State Load Despatch Centre shall maintain account of actual intra-state transmission system loss for each time block and publish reconciliation statement of 52 weekly average loss vis-à-vis approved loss by the Commission on its website.

#### 5. Declaration, scheduling and elimination of gaming

- (A) The provisions of the State Grid Code and the \_\_\_\_[State)Electricity Regulatory Commission Open Access Regulations, as amended from time to time, shall be applicable for declaration of capacity, scheduling and elimination of gaming.
- (B) The generating station, as far as possible, shall generate electricity as per the day-ahead generation schedule finalized by the State Load Despatch Centre in accordance with the State Grid Code.

Provided that the revision in generation schedule on the day of operation shall be permitted, in accordance with the procedure specified under the Grid Code and \_\_\_\_[State]Electricity Regulatory Commission Open Access Regulations, as the case may be.

- (C) The wind and solar generator or the QCA, as the case may be, shall have the option of accepting the concerned SLDC's forecast for preparing its schedule or provide the concerned SLDC with a schedule based on its own forecast, and such schedule shall be used as reference for deviation settlement.
- (D) The QCA shall coordinate the aggregation of schedules of all generators connected to a pooling station and communicate it to the SLDC. The QCA shall undertake all commercial settlement on behalf of the wind or solar generator(s) connected to the respective pooling station(s).
- (E) The Commission, either suo-motu or on a petition made by SLDC, or any affected party, may initiate proceedings against any generating company or seller on charges of gaming and if required, may order an inquiry in such manner as decided by the Commission. When the charge of gaming is established in the above inquiry, the Commission may, without prejudice to any other action under the Act or regulations thereunder, disallow any Charges for Deviation received by such generating company or the seller during the period of such gaming.

#### 6. Charges for Deviations:

#### (A) <u>Deviation Charges for Sellers and Buyers other than the Wind and</u> <u>Solar Generators:</u>

(1) The charges for the Deviations for all the time-blocks shall be payable for over-drawal by the Buyer and under-injection by the Seller and receivable for under-drawal by the Buyer and over-injection by the Seller, other than the wind and solar generators which are State Entities, and shall be worked out on the average frequency of a timeblock at the rates in the table specified at <u>Schedule-I</u> and subject to conditions stipulated under clause (2) to (6) of this regulation:

Provided that a change in sign of the deviation shall be made once every 6 time blocks, failing which additional charges @10% of the deviation charges applicable shall be levied for the duration of continuance of violation.

- (2) The charges for the Deviation for the generating stations regulated by Commission using coal or lignite or gas supplied under Administered Price Mechanism (APM) as fuel, when actual injection is higher or lower than the scheduled generation, shall not exceed the Cap Rate to be determined by Central Commission from time to time <sup>1</sup>[303.04]Paise/kWh.
- (3) No cap rate shall be applicable with effect from [the date of revision of price of APM gas by the Government of India] on the charges for the Deviation for the generating stations regulated by [the Central Commission] using gas supplied under Administered Price Mechanism (APM) as the fuel.
- (4) The charges for the Deviation for the under-drawal by the Buyer in a time block in excess of 12% of the schedule or <sup>2</sup>[X]MW, whichever is less, shall be zero; wherein limit of [X]MW shall be determined as per

<sup>1</sup> Present Tariff Rate of imported coal as determined by Central Commission

<sup>2</sup> Volume Cap for Buyer may vary with profile mix and no. of pool entities (Buyers) in the state (*Final Draft Version V12.0\_14March2017*)

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methodology specified under Clause (1) of Regulation 7 of these Regulations;

- (5) The charges for the deviation for the over-injection by the Seller in a time block in excess of 12% of the schedule or <sup>3</sup>[10] MW, whichever is less, shall be zero, except in case of injection of infirm power, which shall be governed by clause (7) of this regulation:
- (6) The Charges for Deviation may be reviewed by the State Commission from time to time and as and when Deviation Price Vector is revised by Central Commission and shall be re-notified accordingly.
- (7) The infirm power injected into the grid by a generating unit of a generating station during the testing, prior to COD of the unit shall be paid at Charges for Deviation for infirm power injected into the grid, consequent to testing, for a period not exceeding 6 months or the extended time allowed by the Commission in the \_\_\_\_[State]Electricity Regulatory Commission Open Access Regulations, as amended from time to time, subject to ceiling of Cap rates corresponding to the <sup>4</sup>[main fuel] used for such injection as specified below:

Domestic coal/ Lignite/Hydro	- [1.78] / kWh sent out
APM gas as fuel	- [2.82]/ kWh sent out up to the date of revision of price of APM gas by Government of India and thereafter, a the rate to be notified by the Commission separately
Imported Coal	- [3.03] / kWh sent out
RLNG	- [8.24] / kWh sent out

(B) <u>Deviation Charges for Wind and Solar Generators:</u>

<sup>4</sup> Present rates of main fuel as determined by Central Commission

<sup>&</sup>lt;sup>3</sup> Volume Cap for Seller may vary with no. of pool entities (Sellers) in the state

(1) The charges for deviation for wind and solar generators which are state entities undertaking inter-state or intra-state transactions, shall be governed as per the provisions outlined under sub-clauses (1) to (9) of this regulation.

Wind/Solar Generators	Under-injection	Over-injection
Inter-State transaction(s)	Refer Table-I of	Refer Table-II of
	Schedule-II	Schedule-II
Intra-State transaction(s) of New Wind/Solar Generators	Refer Table-III of Sch	nedule-ll
Intra-State transaction(s) of Existing Wind/Solar Generators	Refer Table-IV of Sch	nedule-ll

- (2) The wind or solar generators which are state entities undertaking interstate transactions shall be paid as per schedule generation.
  - In the event of actual generation being lesser than the scheduled generation, the deviation charges for shortfall in generation shall be payable by such wind or solar generator which are state entities into State Deviation Pool Account as given in <u>Table –I of</u> <u>Schedule-II</u>
  - ii. In the event of the actual generation being more than the scheduled generation, the Deviation Charges for excess generation shall be payable to the wind or solar generators which are state entities undertaking inter-state transactions from State Deviation Pool Account as given in *Table II of Schedule-II*:
- (3) The wind or solar generators which are state entities undertaking intrastate transactions shall be paid as per actual generation.
  - iii. In the event of actual generation of a generating station or a pooling station, as the case may be, being less or more than the scheduled generation, the deviation charges for shortfall or excess generation shall be payable by the wind and solar generator or the QCA, as the case may be, to the State Deviation Pool Account, as given in <u>Table III or Table-IV of Schedule-II</u>, as the case may be.
- (4) In case of wind or solar generators as state entities undertaking intrastate transactions and inter-state transactions shall be allowed provided that such generators are connected to separate feeders at LV side of the Pooling Substation and metering, scheduling, energy

accounting and deviation settlement account for such wind or solar generators are maintained separately.

- (5) Where the Fixed Rate referred under <u>Table-I and Table-II of</u> <u>Schedule-II</u> is the PPA rate as determined by the Commission under section 62 of the Act or adopted by the Commission under section 63 of the Act. In case of multiple PPAs, the weighted average of the PPA rates shall be taken as the Fixed Rate. The wind and solar generators shall furnish the PPA rates on affidavit for the purpose of Deviation charge account preparation to concerned SLDC supported by copy of the PPA.
- (6) Fixed Rate for Open Access participants selling power which is not accounted for RPO compliance of the buyer, and the captive wind or solar plants shall be the Average Power Purchase Cost (APPC) rate at the National level, as may be determined by the Central Commission from time to time through a separate order.
- (7) With regard to inter-state wheeling transactions of Wind and Solar Generating stations as State Entities, for balancing of deemed renewable purchase obligation (RPO) compliance of buyers with respect to schedule, deviations by all wind and solar generators which are state entities shall first be netted off for the entire pool on a monthly basis and any remaining shortfall in renewable energy generation must be balanced through purchase of equivalent solar and non-solar Renewable Energy Certificates (RECs), as the case may be, by SLDC by utilising funds from the Pool Account. For positive balance of renewable energy generation, equivalent notional RECs shall be credited to the DSM Pool and carried forward for settlement in future.
- (8) State Load Despatch Centre [or the Secretariat of State Power Committee, as the case may be] shall maintain separate records and account of time-block wise schedules, actual generation and deviations for all generators, including wind and solar generators.
- (9) Once the accounting procedures as above are put in place, all Wind and Solar generators shall be treated together as a virtual pool within the State Deviation Pool Account. Deviations for and within this virtual pool could be settled first at the rates and methodology stipulated above for wind and solar generators.

#### 7. Limits on Deviation volume and consequences of crossing limits

- (A) The over-drawal or under drawal of electricity by any Buyer during a time block shall not exceed 12% of its scheduled drawal or [X] MW, whichever is lower, when grid frequency is between range of '49.80 Hz and above to below 50.05 Hz.'
- (B) The Volume Limit of **[X] MW** for distribution licensee(s) and Buyers shall be determined as under:

- Minimum of (12% of schedule, (Peak Demand of Distribution Licensee or Buyer / ∑NCPD) x State Volume Limit)
   Where NCPD (Non-Coincident Peak Demand) represents the sum of Peak Demand of Distribution Licensee(s) and Buyer(s) subject to condition stipulated under following sub-clause (iii).
- ii. State Volume Limit shall be linked to Volume Limit (L) applicable to the State as per CERC DSM Regulations and its amendments thereof
- Where Peak Demand of the Distribution Licensee shall be recorded Peak Demand in the previous Financial Year or Projected Peak Demand of Buyer in ensuing Financial Year, whichever is higher;

Provided that no over drawal of electricity by any buyer shall be permissible when grid frequency is "below 49.80 Hz" and no under drawal of electricity by any buyer shall be permissible when grid frequency is "50.05 Hz and above".

- (C) The under-injection or over-injection of electricity by Seller shall not exceed following when grid frequency is "49.80 Hz or above and below 50.05 Hz":
  - i. 12% of the scheduled injection or [10 ] MW, whichever is lower for a Seller

Provided that in case schedule of a Seller, in a time block, is less than or equal to [40] MW, under-injection / over-injection in a time-block shall not exceed [5] MW, when grid frequency is "49.80 Hz or above and below 50.05 Hz".

- (D) The limits on deviation volume and consequences for crossing these limits (including the additional charges for deviation) as stipulated under Regulation 7 shall not apply to wind and solar generators which are State Entities.
- (E) No under injection of electricity by a seller shall be permissible when grid frequency is "below 49.80 Hz" and no over injection of electricity by a seller shall be permissible when grid frequency is "50.05 Hz and above.
- (F) Any infirm injection of power by a generating station prior to COD of a unit during testing and commissioning activities shall be exempted from the volume limit specified above for a period not exceeding 6 months or the extended time allowed by the Commission in accordance with Connectivity Regulations.
- (G) Any drawal of power by a generating station prior to COD of a unit for the start up activities shall be exempted from the volume limit specified above when grid frequency is "49.80 Hz and above".

- (H) In addition to Charges for Deviation as stipulated under Regulation 5 of these regulations, Additional Charge for Deviation shall be applicable for over-drawal as well as under-injection of electricity for each time block in excess of the volume limit specified in Clause (B) and (C) of this regulation when average grid frequency of the time block is "49.80 Hz and above" at the rates specified in the <u>Table V of Schedule-II</u> in accordance with the methodology specified in clause (N) of this regulation:
- (I) Additional Charge for Deviation for under-injection of electricity, during a time-block in excess of the volume limit specified in clause (A) and (B) of this regulation when grid frequency is "49.80 Hz and above", by the generating stations regulated by the Commission using coal or lignite or gas supplied under Administered Price Mechanism (APM) as the fuel shall be at the rates specified in <u>Table VI of Schedule-II</u> in accordance with the methodology specified in clause (P) of this regulation;
- (J) Any drawal of power by a generating station prior to COD of a unit for the start-up activities shall be exempted from the levy of additional Charges of Deviation.
- (K) In addition to Charges for Deviation as stipulated under Regulation 5 of these regulations, Additional Charge for Deviation shall be applicable for over-injection/under drawal of electricity for each time block by a Seller or Buyer, as the case may be; when grid frequency is "50.05 Hz and above" at the rates equivalent to charges of deviation corresponding to the grid frequency of "below 50.01 Hz but not below 50.0 Hz".
- (L) State Load Despatch Centre shall develop and publish on its website Procedures and Methodologies for the computation of Charges for Deviation and Additional Charges for deviation for each State Entity for crossing the volume limits specified for the under-drawal /over-injection and for over-drawal and under-injection in clause (D) of this Regulation.
- (M) In addition to Charges for Deviation as stipulated under Regulation 5 of these Regulations, Additional Charge for Deviation shall be applicable for over-drawal or under-injection of electricity when grid frequency is "below 49.80 Hz" in accordance with the methodology specified in clause (O) of this Regulation and the same shall be equivalent to 100% of the Charge for Deviation as stipulated under Deviation Price Vector at Schedule-I [800Paise/kWh] corresponding to the grid frequency of "below 49.80 Hz".

Provided that Additional Charge for Deviation for under-injection of electricity by a Seller, during the time-block when grid frequency is "below 49.80 Hz", by the generating stations regulated by State Commission using coal or lignite or gas supplied under Administered Price Mechanism (APM) as the fuel in accordance with the methodology specified in clause

(O) of this Regulation shall be equivalent to 100% of the Cap Rate for Deviations of  $[303.04]^5$  Paise/kWh.

(N) The Additional Charge for Deviation for over-drawal and under-injection of electricity for each time block in excess of the volume limit specified in clause (B) and (C) of this Regulations when grid frequency is "49.80 Hz and above" shall be as specified by the [State Commission] as a percentage of the charges for the Deviation corresponding to average grid frequency of the time block with due consideration to the behavior of the Buyers and Sellers towards grid discipline:

Provided that the [State Commission] may specify different rates for additional Charges for Deviation for over drawals and under injections depending upon different % deviation from the schedule in excess of the volume limit specified in clause (B) and (C) of this Regulation.

(O) The additional Charge for Deviation for over-drawals and under-injection of electricity for each time block when grid frequency is "below 49.80 Hz" shall be as specified by the [State Commission] as a percentage of the charges for the Deviation corresponding to average grid frequency of the time block with due consideration to the behavior of the Buyers and Sellers towards grid discipline:

Provided that the [State Commission] may specify different rates for Additional Charges for Deviation for over drawls and under injections and for different ranges of frequencies "below 49.80 Hz".

(P) The Additional Charge for Deviation for under-injection of electricity during the time-block in excess of the volume limit specified in Clause (C) of this regulation when grid frequency is '49.80 Hz and above", by the generating stations regulated by SERC using coal/ lignite or gas supplied under Administered Price Mechanism (APM) as the fuel shall be as specified by the Commission as a percentage of the Cap Rate or the Charges for Deviation corresponding to the grid frequency of the time block, or both with due consideration to the behavior of the generating stations regulated by SERC towards grid discipline:

- (Q) In the event of sustained deviation from schedule in one direction (positive or negative) by any state entity, such State Entity (Buyer or Seller) shall have to make sign of their deviation from schedule changed, at least once, after every 6 time blocks. To illustrate, if a state entity has positive deviation from schedule from 07.30 hrs to 9.00 hrs, sign of its deviation from schedule shall be changed in the 7<sup>th</sup> time block i.e. 9.00 to 9.45 hrs from positive to negative or negative to positive; as the case may be.
- (R) Payment of Charges for Deviation under Regulation 5 and the Additional Charges for Deviation under Clauses (H) and (I) of this Regulation, shall be levied without prejudice to any action that may be considered appropriate by the Commission under Section 142 of the Act for contravention of the limits of over-drawal/ under drawal or under-injection /over-injection as specified in these regulations, for each time block or violation of provision of clause (Q) of these Regulations.
- (S) The charges for over-drawal/ under-injection and under-drawal/ overinjection of electricity shall be computed by the respective SLDCs [or State Power Committee, as case may be] in accordance with the methodology used for preparation of 'State Energy Accounts".
- (T) The State Load Despatch Centre shall, on monthly basis, prepare and publish on its website the records of the Deviation Accounts, specifying the quantum of over-drawal/ under-injection and corresponding amount of Charges for Deviation payable/receivable for each buyer and seller for all the time-blocks when grid frequency was "49.80Hz and above" and "below 49.80" Hz separately.

#### 8. Compliance with instructions of Load Despatch Centre

Notwithstanding anything specified in these Regulations, the sellers and the buyers shall strictly follow the instructions of the State Load Despatch Centre on injection and drawal in the interest of grid security and grid discipline.

#### 9. Accounting of Charges for Deviation

(A) A statement of Charges for Deviations including Additional Charges for Deviation levied under these Regulations shall be prepared by SLDC [or by the Secretariat of the State Power Committee, as the case may be] on weekly basis based on the data provided by SLDC by the Thursday of the week and shall be issued to all constituents by next Tuesday, for seven day period ending on the penultimate Sunday mid-night. (B) All payments on account of Charges for Deviation including Additional Charges for Deviation levied under these Regulations and interest, if any, received for late payment shall be credited to the funds called the "State Deviation Pool Account", which shall be maintained and operated by the concerned State Load Despatch Centre in accordance with provisions of these regulations.

Provided that -

- i. the [State Commission] may by order direct any other entity to operate and maintain the respective "State Deviation Pool Account":
- ii. separate books of accounts shall be maintained for the principal component and interest component of Charges for Deviation and Additional Charges for Deviation by SLDC [or by the Secretariat of the respective State Power Committee, as the case may be].
- (C) All payments received in the "State Deviation Pool Account" shall be appropriated in the following sequence:
  - i. First towards any cost or expense or other charges incurred on recovery of Charges for deviation.
  - ii. Next towards over dues or penal interest, if applicable.
  - iii. Next towards normal interest.
  - iv. Next dues towards Regional Deviation Pool Account
  - v. Lastly, towards charges for deviation and additional charges for deviation.

#### 10. Schedule of Payment of Charges for Deviation

- (A) The payment of charges for Deviation shall have a high priority and the concerned constituent shall pay the indicated amounts within 10 (ten) days of the issue of statement of Charges for Deviation including Additional Charges for Deviation by SLDC [or by the Secretariat of the State Power Committee, as the case may be] into the "[State] Deviation Pool Account".
- (B) If payments against the Charges for Deviation including Additional Charges for Deviation are delayed by more than two days, i.e., beyond twelve (12) days from the date of issue of the statement by the SLDC [ or the Secretariat of the State Power Committee, as the case may be], the defaulting constituent shall have to pay simple interest @ 0.04% for each day of delay.
- (C) All payments to the entities entitled to receive any amount on account of charges for Deviation shall be made within 2 working days of receipt of the payments in the "[State] Deviation Pool Account".

Provided that –

- i. in case of delay in the Payment of charges for Deviations into the [State] Deviation Pool Account and interest there on if any, beyond 12 days from the date of issue of the Statement of Charges for Deviations, the State Entities who have to receive payment for Deviation or interest thereon shall be paid from the balance available in the [State] Deviation Pool Account. In case the balance available is not sufficient to meet the payment to the State Entities, the payment from the [State] Deviation Pool Accounts shall be made on pro rata basis from the balance available in the Deviation Pool Account.
- ii. the liability to pay interest for the delay in payments to the "[State] Deviation Pool Account" shall remain till interest is not paid; irrespective of the fact that constituents who have to receive payments, have been paid from the "[State] Deviation Pool Account" in part or full.
- (D) All State Entities which had at any time during the previous financial year failed to make payment of Charges for Deviation including Additional Charges for Deviation within the time specified in these Regulations shall be required to open a Letter of Credit (LC) equal to 110% of its average payable weekly liability for Deviations in the previous financial year, in favour of the SLDC within a fortnight from the date these Regulations come into force.

Provided that -

- i. if any State entity fails to make payment of Charges for Deviation including Additional Charges for Deviation by the time specified in these Regulations during the current financial year, it shall be required to open a Letter of Credit equal to 110% of weekly outstanding liability in favour of State Load Despatch Centre within a fortnight from the due date of payment.
- ii. LC amount shall be increased to 110% of the payable weekly liability for Deviation in any week during the year, if it exceeds the previous LC amount by more than 50%.

**Illustration:** If the average payable weekly liability for Deviation of a State entity during [2016-17] is `2.0 crore, the State entity shall open LC for 2.2 crore in [2017-18]. If the weekly payable liability during any week in [2017-18] is `3.5 crore which is more than 50% of the previous financial year's average payable weekly liability of Rs 3.0 Crore, the concerned state entity shall increase the LC amount to `3.85 Crore (1.1\*3.50) by adding 1.65 Crore.

(E) In case of failure to pay into the "[State] Deviation Pool Account" within the specified time of 12 days from the date of issue of statement of charges for

Deviations, the SLDC shall be entitled to encash the LC of the concerned constituent to the extent of the default and the concerned constituent shall recoup the LC amount within 3 days.

#### 11. Governance Structure and constitution of [State] Power Committee

(A) Within three months from date of notification of these Regulations, the State Load Despatch Centre shall formulate Operating Procedures and Business Rules for constitution of [State] Power Committee, which shall be approved by the [State] Commission.

(B) The [State] Power Committee shall :

- i. Co-ordinate and facilitate the intra-state energy exchange for ensuring optimal utilisation of resources.
- ii. Review energy accounting and billing for inter-utility exchange of power
- iii. Ensure settlement of deviations amongst State Entities in accordance with these Regulations.
- iv. Monitor compliance of these Regulations by State Entities.

#### 12. Power to Relax.

The Commission may by general or special order, for reasons to be recorded in writing, and after giving an opportunity of hearing to the parties likely to be affected by grant of relaxation, may relax any of the provisions of these Regulations on its own motion or on an application made before it by an interested person.

#### 13. Power to issue directions:-

If any difficulty arises in giving effect to these Regulations, the Commission may on its own motion or on an application filed by any affected party, issue such directions as may be considered necessary in furtherance of the objective and purpose of these Regulations.

Average Frequen Block (Hz)	Charges for Deviation	
Below	Not Below	Paise/kWh
	50.05	0.00
50.05	50.04	50.00
50.04	50.03	100.00
50.03	50.02	150.00
50.02	50.01	200.00
50.01	50.00	250.00
50.00	49.99	277.50
49.99	49.98	305.00
49.98	49.97	332.50
49.97	49.96	360.00
49.96	49.95	387.50
49.95	49.94	415.00
49.94	49.93	442.50
49.93	49.92	470.00
49.92	49.91	497.50
49.91	49.90	525.00
49.90	49.89	552.50
49.89	49.88	580.00
49.88	49.87	607.50
49.87	49.86	635.00
49.86	49.85	662.50

# Schedule-I : Price Vector for Deviation Charges

Average Frequen Block (Hz)	Charges for Deviation	
Below	Not Below	Paise/kWh
49.85	49.84	690.00
49.84	49.83	717.50
49.83	49.82	745.00
49.82	49.81	772.50
49.81		800.00

(Charges for deviation for each 0.01 Hz step is equivalent to 50 Paise/kWh in the frequency range of 50.05-50.0 Hz and in step of 27.50 Paise/kWh in the frequency range of 50.0-49.8 Hz)

#### Schedule-II : Deviation Charges for Wind/Solar Generating Stations

Table – I: Deviation Charges in case of under injection byWind/Solar Generating Stations as State Entities undertakingInter-state transactions

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable to</u> State Deviation Pool Account
1	<= 15%	At the Fixed Rate for the shortfall energy for absolute error upto 15%
2	>15% but <=25%	(At the Fixed Rate for the shortfall energy for absolute error upto 15%) + (110% of the Fixed Rate for balance energy beyond 15% and upto 25%)
3	>25% but <=35%	(At the Fixed Rate for the shortfall energy for absolute error upto 15%) + (110% of the Fixed Rate for balance energy beyond 15% and upto 25%) + (120% of the Fixed Rate for balance energy beyond 25% and upto 35%)
4	>35%	(At the Fixed Rate for the shortfall energy for absolute error upto 15%) + (110% of the Fixed Rate for balance energy beyond 15% and upto 25%) + (120% of the Fixed Rate for balance energy beyond 25% and upto 35%) + (130% of the Fixed Rate for balance energy beyond 35%)

# Table – II: Deviation Charges in case of over injection by Wind/Solar Generating Stations as State Entities undertaking Interstate transactions

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable from</u> State Deviation Pool Account
1	<= 15%	At the Fixed Rate for the excess energy upto 15%
2	>15% but <=25%	(At the Fixed Rate for the excess energy upto 15%) + (90% of the Fixed Rate for excess energy beyond 15% and upto 25%)
3	>25% but <=35%	(At the Fixed Rate for the excess energy upto 15%) + (90% of the Fixed Rate for excess energy beyond 15% and upto 25%) + (80% of the Fixed Rate for excess energy beyond 25% and upto 35%)

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable from</u> State Deviation Pool Account
4	>35%	(At the Fixed Rate for the excess energy upto 15%) + (90% of the Fixed Rate for excess energy beyond 15% and upto 25%) + (80% of the Fixed Rate for excess energy beyond 25% and upto 35%) + (70% of the Fixed Rate for excess energy beyond 35%)

<u>Table – III: Deviation Charges in case of under-injection or over</u> injection, by Wind/Solar Generating Stations commissioned after date of Notification of these Regulations for sale of power within <u>State</u>

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable to</u> State Deviation Pool Account
1	<= 10%	None
2	>10% but <=20%	(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 10% and upto 20%)
3	>20% but <=30%	<ul> <li>(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 10% and upto 20%)</li> <li>+ (At the Rs 1.00 per unit for balance energy beyond 20% and upto 30%)</li> </ul>
4	>30%	<ul> <li>(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 10% and upto 20%)</li> <li>+ (At the Rs 1.00 per unit for shortfall or excess energy beyond 20% and upto 30%)</li> <li>+ (At the Rs 1.50 per unit for balance energy beyond 30%)</li> </ul>

Table – IV: Deviation Charges in case of under-injection or over injection by Wind/Solar Generating Stations commissioned prior to date of Notification of these Regulations, for sale of power within State

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable to</u> State Deviation Pool Account
1	<= 15%	None

S. No.	Absolute Error in the 15-minute time block	Deviation Charges <u>payable to</u> State Deviation Pool Account
2	>15% but <=25%	(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 15% and upto 25%)
3	>25% but <=35%	<ul> <li>(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 15% and upto 25%)</li> <li>+ (At the Rs 1.00 per unit for balance energy beyond 25% and upto 35%)</li> </ul>
4	>35%	<ul> <li>(At the Rs 0.50 per unit for shortfall or excess energy for Absolute Error beyond 15% and upto 25%)</li> <li>+ (At the Rs 1.00 per unit for shortfall or excess energy beyond 25% and upto 35%)</li> <li>+ (At the Rs 1.50 per unit for balance energy beyond 35%)</li> </ul>

# TABLE – V : Additional Deviation Charge (for Seller/Buyer)

(A) When 12% of the Schedule is less than or equal to [10] MW			
1	For over-drawal of electricity by any Buyer in excess of 12% and upto 15% of the schedule in a time block	Equivalent to 20% of Charge for Deviation corresponding to average grid Frequency of the time-block	
2	For over-drawal of electricity by any Buyer in excess of 15% and upto 20% of the schedule in a time block	Equivalent to 40% of Charge for Deviation corresponding to average grid Frequency of the time-block	
3	For over-drawal of electricity by any Buyer in excess of 20% of the schedule in a time block	Equivalent to 100% of Charge for Deviation corresponding to average grid Frequency of the time-block	
4	For under-injection of electricity by any Seller in excess of 12% and upto 15% of the schedule in a time block	Equivalent to 20% of Charge for Deviation corresponding to average grid Frequency of the time-block	
5	For under-injection of electricity by any Seller in excess of 15% and upto 20% of the schedule in a time block	Equivalent to 40% of Charge for Deviation corresponding to average grid Frequency of the time-block	
6	For under-injection of electricity by any Seller in excess of 20% of the schedule in a time block	Equivalent to 100% of Charge for Deviation corresponding to average grid Frequency of the time-block	
(B) When 12% of the Schedule is more than [10] MW			
1	For over-drawal of electricity by any Buyer is above X MW and upto X+[10] MW in a time block	Equivalent to 20% of Charge for Deviation corresponding to average grid Frequency of the time-block	

(A) When 12% of the Schedule is less than or equal to [10] MW			
2	For over-drawal of electricity by any Buyer is above X+[10] MW and upto X + [20] MW in a time block	Equivalent to 40% of Charge for Deviation corresponding to average grid Frequency of the time-block	
3	For over-drawal of electricity by any Buyer is above X + 20 MW in a time block	Equivalent to 100% of Charge for Deviation corresponding to average grid Frequency of the time-block	
4	For under-injection of electricity by any Seller is above [10] MW and upto[20] MW in a time block	Equivalent to 20% of Charge for Deviation corresponding to average grid Frequency of the time-block	
5	For under-injection of electricity by any Seller is above [20] MW and upto [25] MW in a time block	Equivalent to 40% of Charge for Deviation corresponding to average grid Frequency of the time-block	
6	For under-injection of electricity by any Seller is above [25] MW in a time block	Equivalent to 100% of Charge for Deviation corresponding to average grid Frequency of the time-block	

# TABLE – VI : Additional Deviation Charge for Under-injection by Generating

# Stations regulated by the Commission using coal or lignite or gas supplied under Administered Price Mechanism (APM)

(A) When 12% of the Schedule is less than or equal to [10] MW			
1	For under-injection of electricity by any Seller in excess of 12% and upto 15% of the schedule in a time block	Equivalent to 20% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	
2	For under-injection of electricity by any Seller in excess of 15% and upto 20% of the schedule in a time block	Equivalent to 40% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	
3	For under-injection of electricity by any Seller in excess of 20% of the schedule in a time block	Equivalent to 100% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	
(A) When 12% of the Schedule is more than [10] MW			
1	For under-injection of electricity by any Seller is above X MW and upto X+[10] MW in a time block	Equivalent to 20% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	
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2	For under-injection of electricity by any Seller is above X+[10] MW and upto X + [20] MW in a time block	Equivalent to 40% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	
3	For under-injection of electricity by any Seller is above X + [20] MW in a time block	Equivalent to 100% of Cap Rate for Deviations of [303.04] Paise/kWh or charge for Deviation corresponding to average grid Frequency of the time-block, whichever is less.	

## First Meeting of Sub-Group for "Implementation of 5-Minute Scheduling, Metering, Accounting and Settlement" under FOR Technical Committee for Implementation of Framework on Renewables at the State Level

## Agenda Note

- 1.0 In the 11<sup>th</sup> Meeting of the "Technical Committee for Implementation of Framework on Renewables at the State Level" held at Chennai on 28<sup>th</sup> March 2017, it was decided to form a Sub-Group to examine the various aspects of migrating from 15-minute to 5-minute scheduling, metering, accounting and settlement at the inter-state level to facilitate large scale integration of renewables.
- 2.0 Accordingly, the Sub-Group has been constituted comprising of the following members:-
  - (a) Shri S.K. Soonee, Advisor, POSOCO
  - (b) Representative of all RPCs and NPC
  - (c) Representative of CEA
  - (d) Representative of POSOCO
  - (e) Representative of CTU
  - (f) Representative from one RE rich state each in NR, WR and SR

3.0 The broad terms of reference (TOR) for the Sub-Group are:-

*a)* Look at all pros and cons of moving to 5-Minute Scheduling, Metering, Accounting and Settlement

*b)* Identify all activities to move from 15-minute to 5-minute scheduling, metering, accounting and settlement

c) Identify changes required in various Regulations including Grid Code and suggest the required amendments

*d)* Suggest amendments required to the CEA Metering Regulations and assess the metering infrastructure required

e) Suggest any specific requirements in this context for cross border transactions

*f*) Infrastructure requirements in terms of hardware & software upgradation needed for scheduling, metering, accounting and settlement by the NLDC, RLDCs, SLDCs and RPCs/NPC

g) Detailed action plan for migration including phasing of activities if required

*h)* Time-frames for the implementation of identified activities and target date for migration to 5-minute scheduling, metering accounting and settlement

*i)* Information dissemination requirements to be identified

j) Capacity building measures required for all stakeholders

k) Any other suggestions related to above

4.0 In pre – Availability Based Tariff (ABT) era, there was practice of daily energy booking, Joint Meter Reading based monthly accounting, overlay accounts and frequency measurement from SCADA. This led to certain inadequacies such as no incentives for generators/utilities to respond for issues like frequency control, absence of merit order operation, grid indiscipline, no signal for power trading, perpetual operational & commercial disputes, poor supply quality and hence, overall economy was lost.

- 5.0 The introduction of ABT was recommended by Government of India (GoI) appointed ECC (Energy Conservation and Commercialisation) Inc. Consultant in its comprehensive report on Bulk Power Generation and Transmission Tariff in February 1994. It was also supported by NTF (National Task Force) & RTF (Regional Task Force) recommendations from 1995-98. In line with these recommendations, CERC introduced multi-part tariff through implementation of ABT Mechanism w.e.f 04th January, 2000 at inter-State level.
- **6.0** The ABT Mechanism comprising of 15-minute scheduling, despatch, metering, accounting and settlement along with deviation accounts at the ISTS level was implemented in different regions in a phased manner from 2002-2003. Under the ABT mechanism, a coordinated multi-lateral scheduling model has been adopted. Electricity Act, 2003 mandated open access in inter-state transmission which was introduced in May, 2004 and a beginning was made with Bilateral transactions with 15-minute trading in power and settlement. Subsequently, in 2008, Collective transactions through the Power Exchanges were also introduced with hourly bidding, clearing and settlement of trades (energy only). Subsequently w.e.f. 1st April 2012, the Power Exchanges also moved to a 15-minute price discovery in the Day Ahead Market (DAM). This shift aligned the Power Exchange markets with scheduling, despatch & settlement practice in India.
- 7.0 In recent developments, Ancillary Services were launched in April, 2016 to address the need for 'fast' / 'quick' response from generators (16 30 minutes). The amendments in Indian Electricity Grid Code(IEGC) in April, 2017 mandated primary response (within seconds). CERC has also laid down roadmap for Automatic Generation Control (AGC) (seconds to few minutes) for enabling Secondary Reserves on a regional basis in October, 2015. An AGC pilot project is being implemented in northern region (NTPC Dadri II TPS) and is expected to be operational in the next 3 months.

## 8.0 Imperatives for moving to 'Fast Markets'

## a. Learning from implementation of Ancillary Services in India

The main requirements for effective ancillary services is quick / fast response & turnaround time as for majority of the time the despatch is for short durations e.g. hour boundary changeover. The ancillary services are essential reliability services which are a costly resource and may be used in limited manner for system reliability. Therefore, increasing granularity would optimize the cost of ancillary services despatch. At present, the earliest possible implementation of ancillary services despatch instruction is 16 minutes which is similar to fast tertiary control at best.

## b. Re-scheduling of resources

At present, four time –blocks of 15-minutes (total 60 min) is provided for re-scheduling of resources. With the advent of new technologies and fast responding resources i.e. Smart Grids, Storage, Demand Response, Electric Vehicles, there is need for faster despatch to incentivise the participation of distributed resources, aggregators and neighbouring markets best able to contribute to system needs. Short despatch intervals and sub-hourly energy markets provide the economic signals for conventional generators and flexible generators to respond to short term fluctuations in load and variable generation. The relevant extract is quoted as below:

"...Scheduling rules that restrict generators to hourly movements artificially hobble the conventional generation fleet, resulting in lost opportunities for those generators and increased costs for all..." - Milligan and Kirby, Market characteristics for efficient integration of variable generation in the Western Interconnection, 2010

The suite of day-ahead, intraday, real-time (balancing) and ancillary services markets are the place where prices optimise the system in the short run, and reveal the value of electricity (and thus investments in the long run).

## c. Increasing RE penetration

Variable generation (VG) technologies such as solar and wind increase the level of variability and uncertainty in power grid operations; characteristics that are inherent of electric power systems. Faster markets will allow access to manoeuvring capability of the conventional generation to respond to fluctuations in load and variable generation. There may be a need for an additional ancillary service for supplemental ramping or load following when the generation fleet providing energy can't respond fast enough. Better alignment with the timescale of variable RE resources, enables better utilization of wind and solar forecasts and therefore, lead to reduced wind and solar curtailment.

## d. Lowering of Overall System Operating Costs

Short dispatch intervals allow more frequent re-dispatch of the whole systems, enabling deviations to be dealt with by adjustment of every market participant in the system as appropriate. Long dispatch intervals mean that deviations in load and variable generation from the central set point for the interval for be significantly larger, requiring larger regulation services. The timing of solar and wind variability occurs more in the sub-hourly to multiple-hour timeframe, not in the minute-to-minute timeframe for which regulation service (more expensive) is intended. The accuracy of RE forecasts is significantly higher the closer they get to dispatch. Consequently, the ancillary service requirements will also be lower Hence, faster dispatch leads to lower overall system operating costs with/without renewable generation.

## e. Ramping requirements

The effects of variability in demand are compounded by the variability of wind and solar power generation, which increases the volatility of the power system. At present, in the Indian system, typical ramp up/down of 200 – 250 MW/min for about an hour is observed during morning and evening peaks. However, when the granularity of the ramp is analyzed on minute to minute basis, it goes to as high as 600 MW/min for few minutes. Much of our ramping requirement is taken care through scheduling of fast acting hydro generation. Therefore, faster markets will introduce flexible ramping products to help take care of contingencies and improve the short-term operational flexibility of the electric grid.

## f. Recognizing flexibility as a requirement

The electric grid has always been somewhat flexible in order to meet variable electricity demand in every instant. But increasing variability and ramping requirements introduced by a cleaner, more modern power system means system flexibility is poised to become

more and more valuable. Many different resources are already available to deliver grid flexibility on both the short-term operational timeframe and the long-term planning timeframe. Flexibility can come from physical assets, such as batteries and fast-ramping natural gas plants, but it can also come from improved operations, such as shorter dispatch intervals and improved weather forecasting. Shortening dispatch schedules can allow the grid to respond more rapidly to changes in supply from variable renewables. Shortening dispatch intervals also creates value for flexible resources that are capable of responding in near-real-time by ramping up or ramping down easily.

## g. Implementation of Primary, Secondary (AGC) and Tertiary Reserves/Control

Currently, tertiary reserves ancillary services have been implemented at the ISTS level where actions at the power plant happen 16-30 minutes after the same is advised by NLDC. Secondary regulation services through Automatic Generation Control (AGC) are soon expected to be introduced with a pilot project for NTPC, Dadri Stage-II project scheduled to roll out in May 2017. This would necessitate moving to at least 5-minute settlement for the plants providing secondary regulation through AGC.

**9.0** The relevant extracts from the various policy guidelines and regulatory orders are quoted as below:

## a. Report of the Expert Group on 175 GW by 2022, NITI Aayog

Interventions to reduce overall system costs [Section 3.23(ii)] "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 15minute 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"

## b. CERC order dated 24-May-2011 in Suo Motu Petition No. 127/2011

".....Thereafter matter was discussed in the Central Advisory Committee (CAC) meeting held on 29th September, 2010 with the agenda "How to make power markets more efficient". The CAC recommended for modification in the bidding time block from one hour to fifteen minutes....."

## c. SAMAST Report, Technical Committee of the Forum of Regulators, 2016

"5.6.....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...."

"Apendix -6: ......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....."

**10.0** There is widespread international trend of adoption of faster despatch and settlement systems in the respective electricity markets. In Australia, "Scheduling and Despatch" has been decoupled with "Settlement" from 1998. The scheduling and despatch is at 5-minute interval and settlement at 30 minute interval using average of 5-minute prices in that interval. In recent development, in late 2016, Australia Energy Market Commission (AEMC) initiated stakeholder consultations to align both "scheduling & despatch" and "settlement" to five minute interval.

There are seven regional transmission organizations (RTOs) and independent system operators (ISOs) that manage parts of the electric grid in the United States. In ISOs like CAISO, NYISO and SPP, there is five minute despatch and settlement. There are also ISOs like ISO-NE, MISO and PJM where there is five minute despatch but hourly average settlement interval. The United States Federal Energy Regulatory Commission (FERC) in September 2016 ruled that all system operators under its jurisdiction must settle energy in their real-time markets at the same interval that those markets are dispatched (i.e. five minute settlement).

However, in major European electricity markets like UK product duration requirements for the Day-Ahead Market (DAM) and the Intra-Day Market (IDM) are typically set at 1 hour, with the exception of the Austrian DAM and the Austrian, German, and Swiss IDMs that facilitate trading of 15 minute products as well. This has proven to be an advantage where political circumstances do not facilitate the introduction of a single market design. They have been popular because they are not mandatory, are relatively inexpensive to implement and allow trade in electricity over large geographical areas. The drawback of this low-resolution approach is that the markets cannot manage network congestion, which then has to be dealt with separately. System operators take re-dispatching actions within price zones before gate closure, and this interacts with market prices. Consequently, low-resolution market design is likely to lead to increasing inefficiencies as more renewables are introduced into electricity systems and increase congestion.

- **11.0** Issues to be discussed and actions needed for implementation of Fast Markets in India are as follows:
  - a. Forecasting (Both Load and Renewables)
  - b. Scheduling & Despatch
  - c. Markets
    - i. 5-minute OTC (bilateral) markets;
    - ii. Power Exchanges 5 minute price discovery

- d. Deviation Settlement 5-minute prices in DSM
- e. Commercial interface metering
- f. Settlement system energy accounting, financial settlement
- g. Changes in various CERC/SERC Regulations
- h. Gate closure provisions
- i. Changes in CEA Metering Standards
- j. Replacement of meters
- k. Software upgrade at the RLDCs/SLDCs scheduling, meter data processing, accounting, settlement
- I. Software upgrade at the RPCs
- m. Holding workshops, dissemination, stakeholder capacity building

## 12.0 References

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- b. The Future of Wholesale Electricity Market Design, Brattle Group, <u>http://www.brattle.com/system/publications/pdfs/000/005/359/original/The\_Future\_of\_Wholesale\_Electricity\_Market\_Design.pdf?1475081019</u>
- c. Melbourne Energy Institute Submission to the AEMC Five Minute Settlement consultation paper, June 2016 <u>http://www.aemc.gov.au/getattachment/1d460acc-dbe2-45ea-bb4e-1903161d90f1/Melbourne-Energy-Institute.aspx</u>
- d. IEA Report on Re-powering Markets: Market design and regulation during the transition to low-carbon power systems
   <u>https://www.iea.org/publications/freepublications/publication/REPOWERINGMARKE</u> <u>TS.PDF</u>
- e. Grid Flexibility: Methods for Modernizing the Power Grid, Sonia Aggarwal and Robbie Orvis, March 2016 <u>http://energyinnovation.org/wp-content/uploads/2016/05/Grid-</u> <u>Flexibility-report.pdf</u>
- f. Big, Fast, and Flexible: Grid Operations for Efficient Variable Renewable Integration, Michael Milligan, NREL <u>https://cleanenergysolutions.org/sites/default/files/documents/big-fast-flexible-webinar-final-10oct2016.pdf</u>
- g. CE Delft and Microeconomix (2016): Refining Short-Term Electricity Markets to Enhance Flexibility. Study on behalf of Agora Energiewende. <u>https://www.agora-</u> <u>energiewende.de/fileadmin/Projekte/2015/Penta\_EOM/Agora\_Penta\_Refined\_ST\_M</u> <u>arkets\_and\_Flexibility.pdf</u>
- h. US DoE Solar Energy Technologies Program The Role of Electricity Markets and Market Design in Integrating Solar Generation <u>https://dx.doi.org/10.2172/1013270</u>

**ANNEXURE-5** 

## Proposed implementation plan for roll out of smart meters

1. Meter manufacturers, ISGF, DISCOMs, industry experts were invited for meetings on 19.7.2017 and 31.7.2017 at CERC to discuss various issues involved. The discussions were held with regard to basic features which are mandated as per Indian Standards, utility of these features and the likely cost of smart meters in case of large scale roll out.

## 2. Provisions under Tariff Policy dated 28.1.2016

(a) The clause 8.2.1 (b) of the Tariff Policy in the context of AT&C

losses in distribution system provides as follows:

"The SERC shall undertake independent assessment of baseline data for various parameters for every distribution circle of the licensee. The SERC shall also institute a system of independent scrutiny of financial and technical data submitted by the licensees.

As the metering is completed up to appropriate level in the distribution network, it should be possible to segregate technical losses. Accordingly technical loss reduction under MYT framework should then be treated as distinct from commercial loss reduction which requires a different approach."

(b) The Clause 8.3 of tariff Policy dated 28.1.2016 provides further

that

"5. Metering of supply to agricultural/rural consumers can be achieved in a consumer friendly way and in effective manner by management of local distribution in rural areas through commercial arrangement with franchisees with involvement of panchayat institutions, user associations, cooperative societies etc. **Use of smart meters may be encouraged as a cost effective option for metering in cases of "limited use consumers" who are eligible for subsidized electricity."** 

(c) The Clause 8.4 of tariff Policy dated 28.1.2016 provides as under

"3. The Appropriate Commission may provide incentives to encourage metering and billing based on metered data, particularly for consumer categories that are presently unmetered to a large extent. The metered tariffs and the incentives should be given wide publicity. Smart meters have the advantages of remote metering and billing, implementation of peak and off-peak tariff and demand side management through demand response. These would become essential in future for load-generation balancing due to increasing penetration of intermittent type of generation like wind and solar power.

Appropriate Commission shall, therefore, mandate smart meters for:

- (a) Consumers with monthly consumption of 500 units and more at the earliest but not later than 31.12.2017;
- (b) Consumers with monthly consumption above 200 units by 31.12.2019.

Further, two-way smart meters shall be provided to all consumers, who also sell back electricity to the grid as and when they require."

3. Combined reading of above provisions makes it amply clear that tariff

policy emphasises on metering the consumption of each consumer for the purpose of billing with the intent of reducing the AT&C losses of discoms. Also, the use of Smart meters can help in remote metering and billing, implementation of peak and off-peak tariff and demand side management through demand response. It is expected that these attributes of smart meters would be useful in future for loadgeneration balancing when penetration of wind and solar power increases. The tariff policy also requires that Appropriate Commission shall mandate smart meters in a time-bound manner.

## 4. Features of Smart Meters

It is noted that the basic features of a Smart meter as per IS 15959(Part 2):2016 are Measurement of electrical parameters; Two way communication and provision for Remote Connect disconnect / load limiting features. These features are briefly stated below:

(a) Measurement of electrical parameters-This feature includes measurement of electrical parameters such as Voltage, phase current, neutral current, power factor, real time clock, frequency, apparent power (KVA), active power (KW), cumulative energy (KVArh and KW (import and export)), maximum demand (KW and KVA), cumulative tamper count, cumulative billing count. This feature also enables measurement of instantaneous values as well as cumulative values for the specified period. A utility can make use of instantaneous values for determining fault location or maximum demand but utility will require extensive control centre at remote location along with data management software to manage the quantum of data and put the data for logical and effective use.

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(b) Two way communication - The communication feature will enable meter reading from remote location and will do away with requirements of physical meter readers. Further two-way communication can be used by utility to set time-of-use tariff settings which may be dynamic and will enable setting differential tariff based on local peak/off-peak times. However this feature could be of any value and use only when following framework is put in place.

- Notification of Time of use(ToU) tariff or Time of day tariff (ToD) or dynamic pricing is most important requirement
- Installation of control centre with backbone communication system,
   SCADA, IT
- Training of manpower for advanced IT, communication system handling and data management
- Customer sensitisation on benefits of smart meter to make the scheme acceptable and successful.

The data of usage of electricity is highly sensitive information which reveals the absence/ presence of consumer at home. There may be privacy concerns and risks in case such data is mishandled or

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hacked. Hence appropriate cyber security measures need to be put in place before such data is collected.

It is observed thatIS 16444: 2015 provide both Radio frequency (RF) as well as GPS/GPRS as options for communication technologies. RF technology may require creation of parallel communication network as for mobile network and associated skilled manpower to maintain the same, with enhanced data security. A utility may be provided a choice of communication technology as per its own requirements, feasibility and cost involved. Providing all features or selective features has its own cost implications.

- (a) **Remote Connect disconnect / load limiting features** (load limit value (KW), Load limit function status, load switch status can be measured / set). The load limit switch can only be utilised if the framework of prepaid metering or ToU/ToD/dynamic pricing is put in place as follows:
  - **Prepaid metering:** In this case load automatically gets cut off on exhausting the balance on prepaid count.
  - **ToU/ToD/Dynamic pricing:** In this case customer enters into an agreement with Utility to control his load on specific request at preplanned time or pay extra charges as per the agreement. In this

case switch can be used for Supply capacity control and emergency supply capacity control. In supply capacity control there are two switches with each meter-one for essential load and other for nonessential load. Non-essential loads can be switched off in case of emergency as per agreement entered into between utility and customer. In this case if a customer wishes to continue the power supply he can press a button and its supply will be restored subject to payment of higher charges. A customer may also enter into an agreement for temporary disconnection to relieve him from payment of Maximum Demand charges, in case he is going out of station etc. In any case for DSM, large consumers or industrial and commercial would be more relevant at least initially.

In the absence of above features load limit switch may not be of much use and can be disabled. The cost for remote connect/disconnect feature (relay and switch) is about 10% of meter cost as indicated by meter manufacturers. This feature can be disabled through software or can be factory disabled. In that case, meters would have to be sent to factory to enable the switch in case it is desired to enable it at a later date. Accordingly either the switch be disabled or be dispensed with.

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5. It is observed that except Two-way Communication and Remote Connect disconnect / load limiting features, the basic features of electrical parameter measurements are already available in most of the electronic meters being installed currently or that are already installed, such as Voltage, current, power factor and energy. This data can be measured for each 30 minutes block for a limited period of 60 days due to memory constraints. Further, it is possible to make up to 4 registers for measurement of Time of use. i.e a day can be divided into 4 blocks according to time of use and can be charged time of use tariff. Automated Meter readers (AMR) installed under APDRP have facility of remote communication (one-way) of data from meter to control centre but the system has not been able to deliver results due to extensive communication channel requirement and meter data management system which is yet to be accomplished. It was clearly expressed by experts that Retro-fitting of existing electronic meter to have all the features of smart meter as per IS 15959 is not possible. Therefore, providing smart meters to all class of consumers would involve replacement of all existing electronic meters.

- 6. As per the tentative estimates of Smart Grid Forum, about 5 Crore smart meters would have to be provided at national level for all single phase consumers consuming more than 200 kWh of electricity during a month. This number would increase to about 25 Crore smart meters if all single phase consumers are to be provided smart meters.
- 7. On an enquiry with meter manufacturers regarding indigenous manufacturing capability for normal electronic meter, it was stated that approximately 2.5 Crore meters can be manufactured in a year. Further the actual deployment which is a must to make metering system functional is the associated communication infrastructure for which the industry experts have not specified any timeline stating that same is difficult to ascertain and would depend on willingness and capability of utility. However, foreign supplier can supplement the supplies. Considering the indigenous manufacturing capability, its expansion and time taken by utilities in placing orders, time required for installing smart meters would range between 3 to 10 years depending upon the quantum of smart meters to be installed.

8. On the other hand, utilities are somewhat apprehensive about the blanket coverage and full-fledged roll out of smart meters. They are of the view that smart meters may be installed in selected areas in phased manner after evaluating its utility. The Utilities have expressed their concerns over the use of a smart meter especially in rural, semi-urban areas where even the basic infrastructure of adequate transformer capacity, distribution network, metering of all points is not available. They have also expressed that it may be better to take up underground cabling in strategic locations to reduce theft.

## Utility and Cost Benefit of Smart meters

9. We could not come across an objective cost benefit analysis on utility of smart meters. However, certain intangible and qualitative benefits enumerated are; Remote metering and billing facilitating reduction in AT&C losses, Increased consumer interface and sharing of information on usage of a consumer bring much needed transparency, Providing net metering facility for injection from roof top solar of consumer, Facilitate introduction of ToU/ToD/Dynamic pricing and Creating demand elasticity, Flexibility in managing load and Demand side management by utilities, Early fault detection and faster recovery of system, improved supply, Reduction in forced outages due to informed outage planning and Reduction in O&M cost etc. As a result, it is likely that there would be overall reduction in retail tariffs for the consumers.

- 10. It is being stated that consumer may manage his load with real time information from meter in case time of use tariff is implemented. However elasticity of demand of consumers for such time of use tariff needs to be established through few pilot projects.
- 11. The smart meter may be of much use to a Utility since Meter reader manpower will reduce significantly as the data can be transferred remotely. However expert manpower for network management and IT infrastructure management will be required. Utility will get real time information of all points which will help utility to improve outage time since utility will get information of outage automatically. Hence it will reduce SAIDI and SAIFI (which are measures of reliability of distribution system). Utility will get exact consumer load profile and may be able to manage its load better. However whether utility will be able to make use of all data points due to its huge quantum needs to be seen. Remote meter reading can significantly cut down on corruption in the billing process, as no manual intervention would be possible. However, this assumes the meters are tamper-proof.

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## **Cost Implications**

12. The cost of smart meter awarded in recent past in a few states is around Rs.6000-8000 per meter (with communication technology specified as RF). The most recent award by EESL is at the cost of Rs. 2503 per meter (with communication technology specified as GPRS). Meter manufacturers have expressed that massive reduction in cost is not possible even with large scale roll out and the cost may not reduce below Rs. 2250/meter which is only 25% of total cost required towards metering. This may vary depending on number of meters procured. The total cost of metering includes associated communication infrastructure cost, IT cost, development of manpower skills to manage and make use of data available, security set up etc. The total cost for the comprehensive installation of meter may vary from Rs. 8000- 10000 per meter including cost of smart meters as per conservative estimates as expressed during the meeting by experts. Thus if 5 Crore meters are installed the total cost shall be of the order Rs.45000 Crore considering average metering cost of Rs. of 9000/meter. For 25 Crore smart meters this could be a whopping Rs 225000 Crore. This amount has to be paid by consumers either directly as meter rent or through retail tariffs. Meter manufacturers

informed that the guarantee period for a smart meter is 5 years although the meter may function for a period of 10-15 years.

## **Tackling of Electricity Theft**

13. There are two ways of Electricity Thefts prevalent in our country; (a) through tampering of meters and (b) by taking direct supply from overhead wires. The theft through meter tampering may be reduced in case of smart meter if they are designed to be tamper proof. This is however, possible to be done through current electronic meters also. The second kind of theft cannot be reduced through smart meters and can only be detected with metering at Distribution Transformer level. Hence to reduce theft, there is a need to get accurate information on on-going theft and can be detected if distribution transformer metering is completed in all respects.

## **Financing of Smart meters**

14. On the issue of financing Options for Smart meters, Utilities have suggested that capital expenditure may be provided as a grant from MoP or subsidised loan may be granted which could either be included in ARR of Utility or Charges can be billed directly to consumers at monthly EMI of approximately Rs 70/month for 6 years. This is only the cost towards the meter and not the associated

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communication infrastructure which needs to be included in ARR for DISCOM. Further operational expenditure shall also be added in ARR of DISCOMs. The benefits to the consumer are required to be clearly shown to avoid resistance which is likely to come from consumer end on such cost of meters.

## **Demand Elasticity and Demand Side management**

**15.** The Electricity Act and Tariff Policy have provided for introduction of time of use tariff for having elasticity of demand and load management in the wake of upcoming renewables. This can be achieved with existing meters with customer sensitisation and notification of time of use tariff. Time of use tariff is being implemented in many countries of the world. The experience shows that big industries may be sensitive to time of use tariff given high per-capita usage but small customers may not exhibit elasticity to time of use tariff. It is also unclear how ToU tariff design can be aligned with current usage-based-subsidy schemes for households.

## **Conclusion and recommendations**

16. In the light of above deliberations, following is recommended:

 (i) Installation of smart meters may be taken up in phased manner following a systematic and pragmatic approach.

- (ii) Dynamic pricing by way of Time of Use or Time of Day tariffs may be introduced.
- (iii) Initially few pilots may be conducted to establish cost benefits such as reduction in AT&C losses or overall reduction in tariff before taking up large scale roll out. Such pilots could be initiated in selected States supported by Govt grant or soft loans.
- (iv) An appropriate view regarding full scale roll out could be taken based on results of such pilots.
- (v) The remote connect/disconnect and load management may be disabled, to start with, in smart meters for the small consumers consuming less than 500 units.
- 17. EESL has already invited bids for 50 lakh smart meters (40 lakhs for UP and 10 Lakhs for Haryana). After assessing the cost of meters and performance of these meters over 1-2 years further investment may be planned.



# केन्द्रीय विद्युत विनियामक आयोग

CENTRAL ELECTRICITY REGULATORY COMMISSION



Gireesh B. Pradhan Chairperson & Chairperson Forum of Regulators

D.O. No. No.1/14/2015-Reg.Aff.(FSDS)/CERC Dated: 16<sup>th</sup> November, 2017

Dear Smi Blalla,

This has reference to interaction of Hon'ble Minister of Power on 22.7.2017 with Central and State Electricity Regulators on the issue of rolling out of Smart meters and its installation for all consumers. It was suggested that Technical Committee under FOR (Forum of Regulators) may carry out a detailed study with regard to **implementation plan for roll out of smart meters** and make suitable recommendations.

2. The Technical Committee invited prominent meter manufacturers, ISGF, DISCOMs and industry experts for meetings on 19.7.2017 and 31.7.2017 to discuss various issues involved. The discussions were held with regard to basic features which are mandated as per Indian Standards, utility of these features and the likely cost of smart meters in case of large scale roll out.

3. Based on the discussions, FOR Technical Committee prepared a report on **"Proposed implementation plan for roll out of Smart Meters"** (Attached as Annexure 1), which includes detailed analysis of various aspects, such as Features of Smart Meters, Provision of Time of Use Tariff, Benefits to Consumers & Utilities, Estimated Cost & Financing options, Total Requirement & Manufacturing Capacity, etc. The report was presented at the 15<sup>th</sup> Meeting of the Technical Committee on 30.10.2017 and the Committee members unanimously agreed that the roll-out of Smart Meters should be taken up in a phased manner.

4. It is requested that the suggestions of the Committee and the report prepared by FOR Technical Committee be included in the roll out plan of Smart Meters by the Government.

With bastragends,

Yours sincerely,

Cump D

(Gireesh B. Pradhan)

Encl : As above

Shri Ajay Kumar Bhalla Secretary Ministry of Power Government of India Shram Shakti Bhawan New Delhi – 110 001

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Draft-5\_22.09.2017



## Model Regulation for Tariff Determination & other related matters for Intra-State Hydro Generating stations

September 2017

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### (State) ELECTRICITY REGULATORY COMMISSION

No. ---/---/xERC

Dated: ....,2017

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### NOTIFICATION

No.---/xERC.- In exercise of the powers conferred under Section 181 of the Electricity Act, 2003 (36 of 2003), read with section 61 thereof and all other powers enabling it in this behalf, and after previous publication, the (State) Electricity Regulatory Commission hereby makes the following regulations, namely:

### 1. Short title and commencement:

- (a) These regulations may be called the (State) electricity Regulatory Commission (Intra-state Hydro Tariff & other related matters) Regulations, 2017.
- (b) These regulations shall come into force on x.x.2017.
- 2. Definitions
  - a. Additional capitalisation: Additional capitalisation means the capital expenditure incurred or projected to be incurred, after the date of commercial operation of the project and admitted by the Commission after prudence check;
  - b. Annual fixed cost: The fixed component of the tariff which is mainly dependent on the capital cost of the project so as to ensure that the power producer is able to recover the fixed expenses and earn a Return on Investment. The Annual Fixed cost of a Hydro generating station is determined by the Commission for each year of the Control period, based on the specified norms.
  - **c. Auxiliary energy consumption:** The quantum of energy consumed by auxiliary equipment of the generating station, and transformer losses within the generating station, expressed as a percentage of the sum of gross energy generated at the generator terminals of all the units of the generating station.
  - d. Bank Rate: 'Bank Rate' means the base rate of interest as specified by the State Bank of India from time to time or any replacement thereof for the time being in effect plus 350 basis points;
  - e. 'Black start' means the start-up of a generating unit or gas turbine or internal combustion (IC) engine based generating set without use of external power following a grid failure.

f. Cut-off Date: Cut-off Date means 31<sup>st</sup> March of the year closing after two years of the year of commercial operation of whole or part of the project, and in case the whole or part of the project is declared under commercial operation in the last quarter of a year, the cut-off date shall be 31<sup>st</sup> March of the year closing after three years of the year of commercial operation:

Provided that the cut-off date may be extended by the Commission if it is proved on the basis of documentary evidence that the capitalisation could not be made within the cut-off date for reasons beyond the control of the project developer;

- **g. Declared capability**: The capability to deliver ex-bus electricity in MW declared by such generating station in relation to any time-block of the day or whole of the day, duly taking into account the availability of fuel or water, and subject to further qualification in the relevant regulation;
- h. Debt-Equity Ratio: In case of all Generating stations, Debt–Equity ratio as on the date of commercial operation shall be considered as 70:30 for determination of tariff. However, if the Equity employed is more than 30%, the amount of Equity for determination of tariff would be limited to 30% and the balance amount shall be considered as the normative loan. Also, if the actual equity employed by the developer is less than 30%, the actual Debt and Equity would considered for determination of tariff.
- Design Energy' means the quantum of energy which can be generated in a 90% dependable year with 95% installed capacity of the hydro generating station;
- j. 'Design Pumping Efficiency' is the inverse of the ratio of energy consumed when operating as a pump and the energy generated out of the pumped water. The Design Pumping Efficiency shall be considered as.....P %.
- k. Hydro Electric Project: A power generation project meant for generation of hydro-electricity that includes all components of generating facility such as dam, intake water conductor system, power generating station and generating units of the scheme, as apportioned to power generation;
- I. Infirm Power: Electricity injected into the grid prior to the commercial operation of a unit or block of the generating station;
- **m. Installed Capacity**: The summation of the name plate capacities of all the units of the generating station or the capacity of the generating station (reckoned at the generator terminals), approved by the Commission from time to time;

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- n. Normative Plant Availability Factor: Normative annual plant availability factor (NAPAF) for Hydro generating stations is determined by the Commission as per the norms given at Regulation 10 of these regulations.
- o. Operation & Maintenance (O&M) Expenses: The expenditure incurred on operation and maintenance of the project, or part thereof, and includes the expenditure on manpower, repairs, spares, consumables, insurance and overheads.
- p. Plant availability factor (PAF): The average of the daily declared capacities (DCs) for all the days during that period expressed as a percentage of the installed capacity in MW reduced by the normative auxiliary energy consumption
- **q. 'Pumped storage hydro generating station'** means a hydro station which generates power through energy stored in the form of water energy, pumped from a lower elevation reservoir to a higher elevation reservoir;
- r. 'Run-of-River generating station' means a hydro generating station which does not have upstream pondage;
- **Kun–of-River generating station with pondage'** means a hydro generating station with sufficient pondage for meeting the diurnal variation of power demand;
- **Storage type generating station'** means a hydro generating station associated with large storage capacity to enable variation of generation of electricity according to demand;
- **Unit**' in relation to hydro-electric generating station, means generator or pump as the case may be with interconnected turbine and auxiliaries, operated as one single set or system to generate or absorb electric power.
- v. 'Useful life' : 35 years for hydro generating stations including Pumped storage type hydro plants
- w. The definition of Design Head, Gross Head, House load, maximum Net head, Minimum Net Head, Pump Turbine, Synchronous Condenser Mode, Turbine Setting, Automatic Voltage Regulator, Power System Stabilizer shall be as defined in the CEA Technical Standards for construction of Electrical Plants and Electric lines, Regulations 2010 or subsequent amendments thereof
- **x.** Words and expressions used but not defined above shall have the same meaning respectively assigned to them in the Act or the State Grid Code

### 3. General

(a) COD: (Commercial Operation Date):

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Date of commercial operation (COD) in relation to a generating unit of hydro generating station including pumped storage hydro generating station shall mean the date declared by the generating company after demonstrating peaking capability corresponding to the Installed Capacity of the generating station through a successful trial run, and after getting clearance from the respective SLDC and in relation to the generating station as a whole, the date of commercial operation of the last generating unit of the generating station.

### Provided that:

(i) Where beneficiaries have been tied up for purchasing power from the generating station, trial run or each repeat of trial run shall commence after a notice of not less than seven days by the generating company to the beneficiaries and concerned SLDC;

(ii) Where the beneficiaries/buyers have not been tied up for purchasing power from the generating station, the trial run shall commence after a notice of not less than seven days by the generating company to concerned SLDC.
 (iii) The generating company shall certify that:

(a) The generating station or unit thereof meets the requirement and relevant provisions of the technical standards of Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010 and State Electricity Grid Code, as applicable including but not limited to :

- I. Black Start Capability
- II. Islanded Operation / House load operation
- III. Dead bus charging and line charging capability
- IV. Auto synchronization
- V. Peaking Capability
- VI. Dynamic VAR support as per the capability curve
- VII. Frequency Response (Primary & Secondary)
- VIII. Synchronous Condenser Mode of Operation wherever applicable
- IX. Pumped Mode of Operation wherever applicable
- X. Part-load operation
- XI. Ramp-up capability

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XII. Ramp-down capability

XIII. AVR and Power System Stabilizer wherever applicable

(b) The main plant equipment and auxiliary systems including Drainage Dewatering system, Primary and Secondary cooling system, air compressor, Firefighting system, etc. have been commissioned and are capable for full load operation of units on sustained basis.

(c) Permanent electric supply system including emergency supplies and all necessary Instrumentations Control and Protection Systems and auto loops for full load operation of the unit are put into service.

(iv) The certificates as required under clause (iii) above shall be signed by the CMD/CEO/MD of the generating company and a copy of the certificate shall be submitted to the concerned SLDC, before declaration of COD. The generating company shall submit approval of Board of Directors to the certificates as required under clause (iii) within a period of 3 months of COD.

(v) Trial run shall be carried out in accordance with Sub-Regulation (b) of this Regulation.

(vi) Where on the basis of the trial run, a unit of the generating station fails to demonstrate the unit capacity corresponding to Maximum Continuous Rating or Installed Capacity or Name Plate Rating, the generating company shall have the option to either de-rate the capacity or to go for repeat trial run. If the generating company decides to de-rate the unit capacity, the demonstrated capacity in such cases shall be more or equal to 110% of de-rated capacity.

(vii) In case a hydro generating station with pondage or storage is not able to demonstrate the peaking capability corresponding to the installed capacity for the reasons of insufficient reservoir or pond level, the date of commercial operation of the last unit of the generating station shall be considered as the date of commercial operation of the generating station as a whole, and it will be mandatory for such hydro generating station to demonstrate peaking capability equivalent to installed capacity of the generating station or unit thereof as the case may be, as and when such reservoir/pond level is achieved:

(viii) If a run-of-river hydro generating station or a unit thereof is declared under commercial operation during lean inflows period when the water inflow is insufficient for such demonstration of peaking capability, it shall be mandatory for such hydro generating station or unit thereof to demonstrate peaking capability equivalent to installed capacity as and when sufficient water inflow is available. In case of failure to demonstrate the peaking capacity, the unit capacity shall be derated to the capacity demonstrated with effect from the COD.

(ix) The concerned SLDC shall accord clearance to the generating company within seven (7) days of receiving the generation data based on the trial run.

(x) If the concerned SLDC notices any deficiency in trial run, it shall be communicated to the generating company within seven (7) days of receiving the generation data based on trial run.

(xi) Scheduling shall commence from 0000 hrs after declaration of COD.

### (b) Trial Run or Trial Operation :

Trial Run in relation to a hydro generating station or unit thereof shall mean the successful running of the generating station or unit thereof at maximum continuous rating or installed capacity for continuous period of 12 hours:

Provided that:

- (i) The short interruptions, for a cumulative duration of 4 hours, shall be permissible, with corresponding increase in the duration of the test. Cumulative Interruptions of more than 4 hours shall call for repeat of trial operation or trial run.
- (ii) The partial loading may be allowed with the condition that average load during the duration of the trial run shall not be less than Maximum Continuous Rating, or the Installed Capacity or the Name Plate Rating

excluding period of interruption and partial loading but including the corresponding extended period.

- (iii) Where the beneficiaries have been tied up for purchasing power from the generating station, the trial run or each repeat of trial run shall commence after a notice of not less than seven days by the generating company to the beneficiaries and concerned SLDC.
- (iv) Units of hydro Generating Stations and intra-State Generating Stations shall also demonstrate capability to raise load up to 110% of this Maximum Continues Rating or Installed Capacity or the Name Plate Rating as the case may be.

### 4. Tariff Determination:

In relation to multi-purpose hydro schemes, with irrigation, flood control and power components, the capital cost chargeable to the power component of the scheme only shall be considered for determination of tariff.

### (c) Capital Cost:

The Capital cost includes the cost of land, the cost of building and equipment, cost of installation and the cost of designing and planning of the station. It varies with the site and location of the station and the type of the equipment used. The Generating Company can obtain the capital for financing their investment in the form of equity or debt or a mix of both.

Capital Cost for a Project includes the expenditure incurred or projected to be incurred, including interest during construction and financing charges, any gain or loss on account of foreign exchange risk variation during construction on the loan - (i) being equal to 70% of the funds deployed, in the event of the actual equity in excess of 30% of the funds deployed, by treating the excess equity as normative loan, or (ii) being equal to the actual amount of loan in the event of the actual equity less than 30% of the funds deployed, - up to the date of commercial operation of the project, as admitted by the Commission, after prudence check,

Provided that the Commission may issue guidelines for vetting of Capital cost of Hydroelectric projects by independent agency or expert and in that event the Capital cost as vetted by such agency or expert may be considered by the Commission while determining the tariff for the Hydro generating station The Capital cost as determined by the Commission after prudence check in accordance with this regulation shall form the basis of determination of tariff for existing and new hydro projects. The capital cost in case of existing/new hydro generating station shall also include the following (in addition to the regular expenditure acceptable under the head Capex for all other projects):

(i) cost of approved rehabilitation and resettlement (R&R) plan of the project in conformity with National R&R Policy and R&R package as approved; and

(ii) cost of the developer's 10% contribution towards Deen Dayal Upadhyay Gram Jyoti Yojna
 (DDUGJY) project in the affected area.

### (I) Exclusions from the Capital cost:

The followings shall be excluded from capital cost of hydro projects:

(i) In case of hydro generating station any expenditure incurred or committed to be incurred by a project developer for getting the project site allotted by the State government by following a two stage transparent process of bidding; and

(ii) the proportionate cost of land which is being used for generating power from generating station based on renewable energy:

Provided that any grant received from the Central or State Government or any statutory body or authority for the execution of the project which does not carry any liability of repayment shall be excluded from the Capital Cost for the purpose of computation of interest on loan, return on equity and depreciation;

### (II) Prudence Check of Capital Expenditure

The Commission may issue new guidelines or revise the existing guidelines for vetting of capital cost of hydro-electric projects by an independent agency or an expert and in that event the capital cost as vetted by such agency or expert may be considered by the Commission while determining the tariff for the hydro generating station;

The Commission may issue new guidelines or revise the existing guidelines for scrutiny and approval of commissioning schedule of the hydro-electric projects in accordance with the tariff policy issued by the Central Government under section 3 of the Act from time to time which shall be considered for prudence check.

### (III) Initial Spares:

Initial spares shall be capitalised as a percentage of the Plant and Machinery cost up to cutoff date, subject to a ceiling of 4% for Hydro generating stations including pumped storage hydro generating stations.

### (IV) Expenditure on account of Natural calamities

In case of hydro generating stations, any expenditure which has become necessary on account of damage caused by natural calamities (but not due to flooding of power house attributable to the negligence of the generating company) and due to geological reasons after adjusting the proceeds from any insurance scheme, and expenditure incurred due to any additional work which has become necessary for successful and efficient plant operation, may be admitted by the commission after the cut-off date subject to prudence check;

### 5. Tariff Structure:

The tariff for supply of electricity from a hydro generating station shall comprise of capacity charge and energy charge to be derived in the manner specified in Regulation 7 of these regulations, for recovery of annual fixed cost (consisting of the components referred to in regulation 7) through the two charges.

### 6. Capacity Charges:

The Capacity charges shall be derived on the basis of annual fixed cost. The annual fixed cost (AFC) of a hydro generating station or a transmission system including communication system shall consist of the following components:

- (a) Return on equity;
- (b) Interest on loan capital;
- (c) Depreciation;
- (d) Interest on working capital; and
- (e) Operation and maintenance expense

Provided that special allowance in lieu of R&M where opted in accordance to Regulation \_\_\_\_\_and/or separate compensation allowance in accordance to Regulation\_\_\_\_, wherever applicable shall be recovered separately and shall not be considered for computation of working capital.

- 7. Computation of Annual Fixed Cost (AFC):
- (a) Return on Equity: Base Rate = 15.5 % for RoR Hydro; 16.5 % for Storage & Pumped Storage Type Hydro Power stations,

Provided that:

 Additional ROE of 0.5% will be allowed subject to timely completion within time line specified in <u>Appendix-</u>.....; The additional return of 0.5% shall not be admissible if the project is not completed within the timeline specified above for reasons whatsoever.

- (ii) the rate of return of a new project shall be reduced by 1% for such period as may be decided by the Commission, if the generating station is found to be declared under commercial operation without commissioning of any of the Free Governor Mode Operation (FGMO), Overload capability (as per OEM subject to a minimum of 110 % as specified in the CEA Technical Standards for Connectivity), Blackstart Capability, Pumped Mode of Operation, Synchronous Condenser Operation, data telemetry, communication system up to load dispatch centre or protection system
- (iii) as and when any of the above requirements are found lacking in a generating station based on the report submitted by the respective SLDC, RoE shall be reduced by 1% for the period for which the deficiency continues. The SLDC shall submit a procedure for periodic testing of above mentioned capabilities for approval by the Commission
- (b) Interest on Ioan capital: (Similar to any other generation project)
- (c) Depreciation: In case of hydro generating station, the salvage value shall be as provided in the agreement signed by the developers with the State Government for development of the Plant. Depreciation shall be calculated annually based on Straight Line Method and at rates specified in Appendix-...... to these regulations for the assets of the hydro generating station;

Provided further that the capital cost of the assets of the hydro generating station for the purpose of computation of depreciated value shall correspond to the percentage of sale of electricity under long-term power purchase agreement at regulated tariff:

Provided also that any depreciation disallowed on account of lower availability of the generating station shall not be allowed to be recovered at a later stage during the useful life and the extended life;

The land for reservoir in case of hydro generating station shall not be a depreciable asset and its cost shall be excluded from the capital cost while computing depreciable value of the asset;

- (d) Interest on Working Capital (IOWC) : IOWC for Hydro generating station including pumped storage hydroelectric generating, station and transmission system including communication system, shall include:
  - (i) Receivables equivalent to two (2) months of fixed cost;

(ii) Maintenance spares @ 15% of operation and maintenance expenses specified in regulation; and

(iii) Operation and maintenance expenses for one (1) month.

### (e) Operation and Maintenance Expenses

Following operations and maintenance expense norms shall be applicable for hydro generating stations which have been operational for three or more years as on 01.04.2014:

### (To be specified station wise by the State Commission for the control period)

- (i) In case of the hydro generating stations, which have not been in commercial operation for a period of three years as on 1.4.2014, operation and maintenance expenses shall be fixed at 2% of the original project cost (excluding cost of rehabilitation and resettlement works) for the first year of commercial operation. Further, in such case, operation and maintenance expenses in first year of commercial operation shall be escalated @6.04% per annum up to the year 2013-14 and then averaged to arrive at the O&M expenses at 2013-14 price level. It shall be thereafter escalated @ 6.64%per annum to arrive at operation and maintenance expenses in respective year of the tariff period.
- (ii) In case of the hydro generating stations declared under commercial operation on or after 1.4.2014, operation and maintenance expenses shall be fixed at 4% and 2.50% of the original project cost (excluding cost of rehabilitation & resettlement works) for first year of commercial operation for stations less than 200 MW projects and for stations more than 200 MW respectively and shall be subject to annual escalation of 6.64% per annum for the subsequent years.

#### 8. Computation of Capacity Charge and Energy Charge:

- (1) The fixed cost of a hydro generating station shall be computed on annual basis, based on norms specified under these regulations, and shall be recovered on monthly basis under capacity charge (inclusive of incentive) and energy charge, which shall be payable by the beneficiaries in proportion to their respective allocation in the saleable capacity of the generating station, i.e., in the capacity excluding the free power to the home State.
- (2) The capacity charge (inclusive of incentive) payable to a hydro generating station for a calendar month shall be :

### AFC x 0.5 x (NDM / NDY) x (PAFM / NAPAF) (in Rupees)
Where,

AFC = Annual fixed cost specified for the year, in Rupees

NAPAF = Normative plant availability factor in percentage

NDM = Number of days in the month

NDY = Number of days in the year

PAFM = Plant availability factor achieved during the month, in percentage

(3) The PAFM shall be computed in accordance with the following formula:

PAFM = 10000 x  $\Sigma^{N}$  DCi / { N x IC x (100 - AUX ) } %

Where,

AUX = Normative auxiliary energy consumption in percentage

DCi = Declared capacity (in ex-bus MW) for the ith day of the month which the station can deliver for at least three (3) hours, as certified by the nodal load dispatch centre after the day is over. The three (3) hour period shall be decided by the SLDC.

IC = Installed capacity (in MW) of the complete generating station

N = Number of days in the month

(4) The energy charge shall be payable by every beneficiary for the total energy scheduled to be supplied to the beneficiary, excluding free energy, if any, during the calendar month, on ex power plant basis, at the computed energy charge rate. Total Energy charge payable to the generating company for a month shall be:

# (Energy charge rate in Rs. / kWh) x {Scheduled energy (ex-bus) for the month in kWh} x (100 – FEHS) / 100

(5) Energy charge rate in Rupees per kWh, for a Hydro generating station, shall be calculated according to the following formula (determined up to three decimal places):

Energy charge rate = AFC x 0.5 x 10 / {DE x (100 – AUX) x (100 – FEHS)}

Where,

DE (MWh) = Annual design energy specified for the Hydro generating station FEHS (%) = Free energy for the home State (if any)

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(6) In case the actual total energy generated by a hydro generating station during a year is less than the design energy for reasons beyond the control of the generating station, the following treatment shall be applied on a rolling basis on an application filed by the generating company:

(a)In case the energy shortfall occurs within ten years from the date of commercial operation of a generating station, the ECR for the year following the year of energy shortfall shall be computed based on the formula specified in clause (5) with the modification that the DE for the year shall be considered as equal to the actual energy generated during the year of the shortfall, till the energy charge shortfall of the previous year has been made up, after which normal ECR shall be applicable.

Provided that in case actual generation form a hydro generating station is less than the design energy for a continuous period of 4 years on account of hydrology factor, the generating station shall approach CEA with relevant hydrology data for revision of design energy of the station.

(b) In case the energy shortfall occurs after ten years from the date of commercial operation of a generating station, the following shall apply.

Explanation : Suppose the specified annual design energy for the station is DE MWh, and the actual energy generated during the concerned (first) and the following (second) financial years is A1 and A2 MWh respectively, A1 being less than DE. Then, the design energy to be considered in the formula in clause (5) of these regulations for calculating the ECR for the third financial year shall be moderated as (A1 + A2 - DE) MWh, subject to a maximum of DE MWh and a minimum of A1 MWh.

(c)Actual energy generated (e.g. A1, A2) shall be arrived at by multiplying the net metered energy sent out from the station by 100 / (100 - AUX).

(7) In case the energy charge rate (ECR) for a hydro generating station, computed as per clause (5) of this regulation exceeds ninety (90) paise per kWh, and the actual saleable energy in a year exceeds {DE x (100 - AUX) x (100 - FEHS ) / 10000 } MWh, the Energy charge for the energy in excess of the above shall be capped at ninety(90) paise per kWh only.

Provided that in a year following a year in which total energy generated was less than the design energy for reasons beyond the control of the generating company, the energy charge rate shall be reduced to ninety paise per kWh after the energy charge shortfall of the previous year has been made up;

#### 9. Pumped Storage Hydro Generating Stations:

(a) The fixed cost of a pumped storage hydro generating station shall be computed on annual basis, based on norms specified under these regulations, and recovered on monthly basis as capacity charge. The capacity charge shall be payable by the beneficiaries in proportion to their respective allocation in the saleable capacity of the generating station, i.e., the capacity excluding the free power to the home State:

(b) The capacity charge payable to a pumped storage hydro generating station for a calendar month shall be:

## CC = (AFC x NDM / NDY) (in Rupees),

*if, actual Generation during the month is*  $\geq P$  % *of the Pumping Energy consumed by the station during the month;* 

OR

CC = {(AFC x NDM / NDY) x (actual generation during the month during peak hours/  $\frac{P}{P}$ % of the Pumping Energy consumed by the station during the month) (in Rupees)},

if actual Generation during the month is  $< \frac{P}{P}$  % of the Pumping Energy consumed by the station during the month;

Where, AFC = Annual fixed cost specified for the year, in Rupees NDM = Number of days in the month NDY = Number of days in the year

Provided that there would be adjustment at the end of the year based on actual generation and actual pumping energy consumed by the station during the year

(c) The energy charge shall be payable by every beneficiary for the total energy scheduled to be supplied to the beneficiary in excess of the design energy plus P% of the energy utilized in pumping the water from the lower elevation reservoir to the higher elevation reservoir, at a flat rate equal to the average energy charge rate of 20 paise per kWh, excluding free energy, if any, during the calendar month, on ex power plant basis.

(d) Energy charge payable to the generating company for a month shall be:

= 0.20 x {Scheduled energy (ex-bus) for the month in kWh – (Design Energy for the month (DEm) + P % of the energy utilized in pumping the water from the lower elevation reservoir to the higher elevation reservoir of the month)} x (100 –FEHS) / 100.

Where,

P = Normative Pumping Efficiency in %

DEm = Design energy for the month specified for the hydro generating station, in MWh

FEHS = Free energy for home State, in per cent, as defined in regulation 42, if any.

Provided that in case the Scheduled energy in a month is less than the Design Energy for the month plus P % of the energy utilized in pumping the water from the lower elevation reservoir to the higher elevation reservoir of the month, then the energy charges payable by the beneficiaries shall be zero

The generating company shall maintain the record of daily inflows of natural water into the upper elevation reservoir and the reservoir levels of upper elevation reservoir and lower elevation reservoir on hourly basis.

The generator shall be required to maximize the peak hour supplies with the available water including the natural flow of water. In case it is established that generator is deliberately or otherwise without any valid reason, is not pumping water from lower elevation reservoir to the higher elevation during off-peak period or not generating power to its potential or wasting natural flow of water, the capacity charges of the day shall not be payable by the beneficiary.

For this purpose, outages of the unit(s)/station including planned outages and the forced outages up to 15% in a year shall be construed as the valid reason for not pumping water from lower elevation reservoir to the higher elevation during off-peak period or not generating power using energy of pumped water or natural flow of water:

Provided that the total capacity charges recovered during the year shall be adjusted on pro-rata basis in the following manner in the event of total machine outages in a year exceeds 15%:

#### (ACC) adj = (ACC) R x (100- ATO)/85

Where,

(ACC)adj – Adjusted Annual Capacity Charges

(ACC) R – Annual Capacity Charges recovered

ATO - Total Outages in percentage for the year including forced and planned outages

Provided further that the generating station shall be required to declare its machine availability daily on day ahead basis for all the time blocks of the day in line with the scheduling procedure of Grid Code.

(8) In case of Pumped storage hydro generating stations, the quantum of electricity required for pumping water from down-stream reservoir to up-stream reservoir shall be arranged by the beneficiaries duly taking into account the transmission and distribution losses etc. up to the bus bar of the generating station. In return, beneficiaries shall be entitled to equivalent energy of P % of the energy utilized in pumping the water from the lower elevation reservoir to the higher elevation reservoir from the generating station during peak hours and the generating station shall be under obligation to supply such quantum of electricity during peak hours:

Provided that in the event of the beneficiaries failing to supply the desired level of energy during off-peak hours, there will be pro-rata reduction in their energy entitlement from the station during peak hours:

Provided further that the beneficiaries may assign or surrender their share of capacity in the generating station, in part or in full, or the capacity may be reallocated by the Government, and in that event, the owner or assignee of the capacity share shall be responsible for arranging the equivalent energy to the generating station in off-peak hours, and be entitled to corresponding energy during peak hours in the same way as the original beneficiary was entitled.

## **10. Tariff Determination Norms**

(I) Normative annual plant availability factor (NAPAF) for Hydro generating stations is determined by the Commission as per the following criteria:

(a) Storage and Pondage type plants with head variation between Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) of up to 8%, and where plant availability is not affected by silt: **90%** 

(b) Storage and Pondage type plants with head variation between FRL and MDDL of more than 8%, where plant availability is not affected by silt : the month wise peaking capability as provided by the project authorities in the DPR (approved by CEA or the State Government) shall form basis of fixation of NAPAF.

(c) Pondage type plants where plant availability is significantly affected by silt: 85%.

(d) Run-of-river type plants: NAPAF to be determined plant-wise, based on 10-day design energy data, moderated by past experience wherever available/relevant.

(e) A further allowance may be made by the Commission in NAPAF determination under special circumstances, e.g. abnormal silt problem or other operating conditions, and known plant limitations

(A further allowance of 5% may be allowed for difficulties in North East States).

(II) Norms for Auxiliary Energy Consumption

(1) Surface hydro generating stations

(i) with rotating exciters mounted on the generator shaft : 0.7%(ii) with static excitation system : 1.00%

- (2) Underground hydro generating stations
  - (i) with rotating exciters mounted on the generator shaft : 0.9%
  - (ii) with static excitation system: 1.2%

(3) Additional Auxiliary Consumption allowed for Pumped Storage Hydro

(i) Fixed Speed:.....%

(ii) Variable Speed .....%

## 11. Norms of Operation for Intra-state Hydro Power Stations

- a. In compliance to IEGC 5.1 (g) of IEGC, a set of detailed operating procedures for each state grid shall be developed and maintained by the respective SLDC in consultation with the Concerned Users for guidance of the staff of SLDC and shall be consistent with the Indian Electricity Grid Code (IEGC). The operating procedure must incorporate the scheduling, despatch and deviation settlement procedure in respect of the intra-state hydro generating stations and Pumped Storage Stations.
- **b.** Governor Action: All hydro units of 25 MW and above, which are synchronized with the grid, irrespective of their ownership, shall have their governors in operation at all times in accordance with the following provisions:
  - For any fall in grid frequency, generation from the unit should increase as per generator droop up to a maximum of 5% of the generation subject to ceiling limit of <u>110 %</u> of the MCR of the unit subject to machine capability.

- Ripple filter of +/- 0.03 Hz. shall be provided so that small changes in frequency are ignored for load correction, in order to prevent governor hunting.
- iii. If any of these generating units is required to be operated without its governor in operation as specified above, the SLDC shall be immediately advised about the reason and duration of such operation.
- iv. All governors shall have a droop setting of between 3% and 6%.
- c. Facilities available with/in load limiters, Automatic Turbine Run-up System (ATRS), Turbine supervisory control, coordinated control system, etc., shall not be used to suppress the normal governor action in any manner and no dead bands and/or time delays shall be deliberately introduced except as specified in para 8.(c) above:

"Provided that periodic check-ups by third party should be conducted at regular interval once in two years through independent agencies selected by the SLDC. The cost of such test s shall be recovered by the SLDCs from the Generators. If deemed necessary by the SLDC, the test may be conducted more than once in two years."

- d. All hydro units of 25 MW and above operating at or up to 100% of their Maximum Continuous Rating (MCR) shall have the capability of (and shall not in any way be prevented from) instantaneously picking up to 110% of their MCR, when the frequency falls suddenly. After an increase in generation as above, a generating unit may ramp back to the original level at a rate of about one percent (1%) per minute, in case continued operation at the increased level is not sustainable. Any generating unit not complying with the above requirements, shall be kept in operation (synchronized with the grid) only after obtaining the permission of SLDC.
- For the purpose of ensuring primary response, SLDCs shall not schedule the generating station or unit(s) thereof beyond ex-bus generation corresponding to 100% of the Installed capacity of the generating stat ion or unit (s) thereof. The generating station shall not resort to Valve Wide Open (VWO) operation of units whether running on full load or part load, and shall ensure that there is margin available for providing Governor action as primary response:

Provided that scheduling of hydro stations shall not be reduced during high inflow period in order to avoid spillage:

Provided further that the VWO margin shall not be used by the SLDC to schedule Ancillary Services.

- f. The recommended rate for changing the governor setting, i.e., supplementary control for increasing or decreasing the output (generation level) for all generating units, irrespective of their type and size, would be one (1.0) per cent per minute or as per manufacturer's limits.
- **g.** Except under an emergency, or to prevent an imminent damage to a costly equipment, no State Entity /hydro generating station shall suddenly reduce his generating unit output by more than one hundred (100) MW.
- h. All hydro generating units shall normally have their automatic voltage regulators (AVRs) in operation. In particular, if a generating unit of over fifty (50) MW size is required to be operated without its AVR in service, the SLDC shall be immediately intimated about the reason and duration, and its permission obtained. Power System Stabilizers (PSS) in AVRs of generating units (wherever provided), shall be got properly tuned by the respective hydro generating unit owner as per a plan prepared for the purpose by the STU/SLDC/from time to time under intimation to RLDC & RPC. STU / CTU /RPC/SLDC/RLDC will be allowed to carry out checking of PSS and further tuning it, wherever considered necessary.
- i. Voltage Control and Synchronous Condenser Mode of Operation: The existing & new hydro generating stations shall contribute to voltage control at EHV level by generation or absorption of reactive power as per SLDC instruction subject to the reactive capability limits specified in the capability curve of the hydro machine.

Hydro units having synchronous condenser facility shall periodically demonstrate the capability of operating in Synchronous Condenser Mode of Operation (SCMO). The periodicity of demonstration will be at-least once in a calendar month as per SLDC instructions. The active power drawn by the hydro unit during operation in Synchronous Condenser Mode shall be socialized and included in pooled transmission loss by the SLDC during preparation of state energy accounts. The SLDC shall facilitate periodic testing of SCMO facility. The hydro station having synchronous condenser facility shall be compensated for providing voltage support services to the grid as and when scheduled by the SLDC. The SLDC may schedule operation in SCMO when voltage is more than 103% or less than 97% of the nominal value at the interface point of the station with the grid. The VARh exchange shall be payable to the station @ 25 p/kVArh. This rate shall be reviewed by the Commission from time to time.

- **j. Black Start Capability**: Hydro power stations with black start capability shall demonstrate the following capabilities through conduction of black-start drills at least once in every year.
  - i. Auto-Start facility of Black Start Diesel Generator (BSDG) set
  - ii. Dead bus & dead transmission line charging with the hydro unit
  - iii. Surviving controlled separation from Grid & islanded operation
  - iv. Island build-up with the unit after black-out
  - v. Island synchronisation with the grid

During the black start drill the black-start unit must demonstrate supply of useful Energy to the station bus within 30 minutes from receipt of advice from SLDC to start at least one unit within the facility. The Black Start unit shall operate at No load for a minimum of 5 minutes, or the period that is required to meet the restoration plan goals. The generating unit shall demonstrate energization of the transmission system within the station to supply the facility with restoration power. The units shall pick up load at the remote station and operate stably in islanded mode till the subsystem gets synchronized with the grid. The black start unit (s) within the facility must have a fuel supply (useable under black out conditions) in sufficient quantity to operate at full for a minimum of 20 hours and/or at 50% of accredited capacity for 40 hours.

Each black start drill shall be conducted as per the procedure prepared by the SLDC under intimation to the respective RLDC & RPC. Each black start-drill shall be followed by submission of a detailed report by the station describing islanded operation of the hydro unit with plots of island frequency, MW & MVAR flows voltage trends and any other observations & learnings from the exercise. The SLDC shall in turn prepare a report & share with the RLDC/RPC highlighting its observations & potential areas of improvement.

Diesel Generator sets (BSDG) for black start would be tested on weekly basis and test report shall be sent by the hydro power stations to concerned SLDCs on quarterly basis. The Commission shall approve necessary tariff for provision of a redundant BSDG set for each hydro power station where black start capability has been tested as certified by the concerned SLDC. Further the Commission shall approve an annual incentive for successful testing of black start-capability as per these regulations as certified by the SLDCs. The hydro power stations after successfully demonstrating the black-start capability

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through conduction of black start drills shall approach the Commission with a separate petition enclosing a certificate from the SLDCs to this effect. The O&M expenses incurred during the blackstart shall be approved by the Commission as per actual. A lump sum incentive of Rs. \_\_\_\_\_ Lakh shall also be allowed subject to certification of successful demonstration of blackstart capability by the SLDC.

A list of intra-state hydro generating stations with black start facility will be prepared by the SLDCs & be made available on their websites along with the most recent date of black start drill conducted at the station.

## 12. Scheduling:

The concerned State Load Despatch Centre shall finalise the schedules for the hydro generating stations, in consultation with the beneficiaries, for optimal utilization of all the energy declared to be available, which shall be scheduled for all beneficiaries in proportion to their respective allocations in the generating station.

(a) Declaration by the Generating stations: Hydro generating stations shall furnish following details by 06:00 AM on day ahead basis to the concerned SLDCs:

- Ex-power plant Declared Capability (DC) for the next day in MW (block wise) with Maximum MW possible for a cumulative duration of 3 hours during the day.
  Pumped storage hydro stations shall intimate the DC in MW as well as proposed duration for pumped mode & generation mode operation for the next day
- ii. Expected energy in MWh foreseen for the next day based on inflows & water release protocol for the station. Pumped storage hydro stations shall intimate the expected energy in MWh to be dawn as a pump in addition to expected generation energy (MWh) for the next day
- iii. Maximum MW capability in on time block including over-load capability
- **iv.** The number of units mechanically available for the day and details of planned /forced shutdown (if any).
- v. Ramp-Up and Ramp down rates (in MW/minute)
- vi. Despatch Constraints (if any) for the day

(b) Entitlement: SLDC shall prepare entitlement of beneficiaries by 08:00 AM and upload on its website on day ahead basis. Entitlements shall be prepared as per the State Govt./ Water Tribunal allocation order by using the DC (MW) submitted by the power station.

(c) Requisition: The beneficiaries shall furnish their requisition to the SLDC by 10:00 hours. While furnishing requisition, the beneficiaries shall duly honour the DC (in MW), expected energy (in MWh), the peaking duration declared by the station etc.

(d) Schedule: Schedule shall be prepared by the SLDC by 12:00 hours based on the declared capability of the station and requisition of the beneficiaries for the next day. Generally, maximum generation schedule shall be provided during peak hours. However, at times, moderation in Declared Capability and Schedule of the hydro station shall be done by the SLDCs in view of better system operation.

(e) For storage & pondage type hydro stations, SLDC shall finalize the schedule by honouring the energy constraint, ramp-up and ramp-down rates so that the generating stations are despatched for optimum utilization of available hydro energy and provide peaking support (during morning as well as evening peaks). While preparing & moderating the schedule SLDC shall ensure optimum utilization of the available units duly factoring state demand pattern, requisition of the beneficiaries, pattern of price variation in the power exchanges etc.

(f) For Private (IPP) Hydro Stations, SLDC shall schedule the plants as per mutually agreed schedule furnished by the Generator with its beneficiaries.

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