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

Venue : Upper Ground Floor, Conference Hall
CERC

Date : 04-11-2016

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

1. The seventh meeting of Technical Committee on Implementation of Framework for Renewables at the State level was held under the Chairmanship of Shri A. S Bakshi, Member, CERC on 4th November 2016. Shri Bakshi welcomed all the members and reiterated the need for speedy implementation of SAMAST Report. There has not been significant progress in this regard. Shri Bakshi requested the Committee o deliberate on ways for faster implementation of SAMAST report.

2. Dr. S.K. Chatterjee, JCRA, CERC, briefed the Committee on the agenda items which included the status of the SAMAST report, DPR of Tamil Nadu, Model DSM Regulation – broad principles and Web based RPO tool compliance.

Discussion

3. Shri Ajit Pandit, Director, IDAM made a presentation on Comparison of F&S framework at State Level and the Model DSM Regulation at the State Level. Copies of the presentation are annexed at Annexure-II and Annexure-III. He briefed about the States which have issued the regulations (Draft & Final). The Key design issues of the Model DSM regulation were discussed in details.

Discussion on State Level DSM Design:-

4. There was a broad consensus on the need for identification of State entities, interface boundaries; coverage of entities (Generators (RE/Non RE), DISCOMS, OA Consumers, CPPs) under DSM pool; uniform definition of 'Deviation' and 'Error at inter-state and intra-State Level; Non-Zero Sum based DSM Pool Design, etc.

5. On the point of applicability of this regulation, Shri Soonee proposed that all the generators including Nuclear and Hydro stations should be covered. These generators could also be requested to provide the schedule of their generation even if they are exempt from any charges. It was also emphasized that the accounting settlement must be done on weekly basis.

6. The aspects related to DSM pricing, volume limits, Area Control Error etc were debated and after discussion, it was decided to deliberate on these issues in greater detail in the next meeting.

7. Shri. Soonee also suggested to consider the following points while preparing the model regulation:-

    a. How deviations are calculated worldwide?
    b. Can ACE (Area Control Error) be used in place of deviation?
    c. Impact of deviation on frequency, etc.

8. Dr. Chatterjee informed that more simulations will be carried out before finalizing the model.

9. Shri Bakshi proposed constituting a sub-committee for overseeing implementation of the DSM regulations in States. Shri. S.K Soonee, proposed that there could be representatives from each RLDC, SLDC and from NLDC in the committee. Dr. S.K. Chatterjee added that a representative from RPC, STU and from the FOR Technical Committee could also be included.

10. In order to expedite the process of implementation at the State level, it was agreed that Chairperson, FOR/CERC could be requested to write to Chairpersons of all SERCs/JERCs for implementation of DSM. Thereafter, SERCs/JERCs could either issue Orders or the Secretaries of the SERCs could write to the STUs and SLDCs for the implementation of DSM at the State level,

and for this purpose to constitute a committee and submit periodical reports to SERCs.

Presentation on Energy Storage and LVRT:

11. Shri Rajsekhar Budhavarapu, Head Wind Business & CTO (Renewable Investments) IL&FS Energy Development Company Limited, made a presentation to the Committee wherein he discussed the need, relevance and barriers involved in integration of Energy storage with wind and solar PV projects. He elaborated that given the intermittent nature and high targets of Renewables in India, Indian grid operators will have to face huge challenges due to frequent ramping up/down of generation- both at the System level and at the regional level. In this context, Energy Storage provides various benefits for which otherwise CTU/STU/Discoms/System Operators incur cost for reliable power & grid stability. It plays an important role in Ancillary services Spinning reserve, Energy generation Time Shift, Scheduling and Peak demand reduction. It was agreed detailed study would be needed to examine the regulatory intervention needed. The Committee appreciated the presentation

    The detailed presentation is attached at **Annexure –IV.**

12. DrPukhraj Singh,Head of Segment, Electrical & Electronics Design, Suzlon discussed upon the "Investment required for Up gradation and Timeframe for Implementation of Project " – Compliance of Wind Turbines. Referring to CERC order dated 5th Jan 2016, w.r.t LVRT feature , it was mentioned that LVRT should be implemented for all wind turbines (except Stall Types) commissioned before 15.04.2014 having installed capacity equal to or more than 500 KW within 2 years. It was also stated that Technical solution development and its testing is expected to be completed not before June 2018 since LVRT testing can only be accomplished during high wind season. It was estimated that 40-50 Lakh/turbine would be needed.

13. The Committee opined that the technical requirements must be guided by CEA and for regulatory requirements, CERC may be approached. The detailed presentation is attached at **Annexure –V**

Other Issues

14. At the end of the meeting, Shri Ajit Pandit, Director, IDAM informed the Committee that their tenure was coming to an end by November 30th, 2016 and requested for an extension in the contract to enable them to complete the tasks.

15. The Committee thereafter deliberated on the Extension of Contract period for the present Consultant (Idam and TERI). It was agreed that scope of TOR has been widened vis-à-vis what was mandated by the Forum of Regulators in its 56th meeting and therefore, the time frame has to be further extended. The committee members expressed that the same Consultant must be allowed to work as to avoid any disconnect from the work progressed till now.

*16.**Decisions***

a) The consultant could present a detailed analysis of DSM Pricing, Volume Limit, ACE etc in the next meeting. The Model DSM Regulations finalized by the Committee could be taken up in the next meeting of FOR.

b) It was decided that the Chairperson, FOR/CERC could be requested to write to Chairpersons of all the SERCs/JERCs for implementation DSM Regulations. SERCs/JERCs can then either issue orders / write to the STUs, SLDCs for implementation of DSM in their State .

c) A sub-committee be constituted for the implementation of the DSM regulations in states with one Representative each from concerned RLDC, SLDC, NLDC, STU and from the FOR Technical Committee. Shri. S.K Soonee could steer/ coordinate the sub-committee.

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

Annexure-I

LIST OF PARTICIPANTS ATTENDED THE SEVENTH MEETING OF THE TECHNICAL COMMITTEE FOR "IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"HELD ON 04.11.2016 AT THE CERC, NEW DELHI

1	Shri. A. S.Bakshi, Member	CERC
2	Shri. S. K.Soonee, CEO	POSOCO
3	Shri. S.Akshaya Kumar, Chairman	TNERC
4	Shri P. Rama Mohan, Member	APERC
5	Shri.Raghuvendra S. Rathore, Member	RERC
6	Shri. Deepak Lad, Member	MERC
7	Shri A.B Bajpai, Member	MPERC
8	Shri D B ManiwalRaju, Member	KERC
9	Shri P. J. Thakkar, Member	GERC
10	Shri S.C. Shrivastava, Chief (Engg.)	CERC
11	Shri Sushanta K. Chatterjee, JC(RA)	CERC

12	Smt..Rashmi Nair, DC (RA)	CERC
13	Shri Akhil K Gupta DC(Engg.)	CERC
14	Smt..Shilpa Agarwal, DC(Engg.)	CERC
15	Shri AjitPandit	IDAM INFRA
16	Shri.RajsekharBudhavarapu	IL&FS
17	Shri ShirishGarud	TERI
18	Smt..Snekalatha A.K.	TERI
19	Shri A.K Saxena	TERI
20	Shri IshwarMangal	SUZLON
21	Shri Sandeep Lonkar	SUZLON
22	Shri Pukhraj Singh	SUZLON
23	Shri Vikalp Vats	SUZLON
24	Shri S. R.Narasimhan	POSOCO
25	Shri Sidhharth Arora	CERC
26	Shri Ankit Gupta	CERC
27	Shri.TanayTarany	FOR

Comparison of F&S framework at state level

Status Update as on

4-Nov-2016

Status update on F&S Regulations at state

Sr. No.	State	Status Update (as on 1-Nov-2016) Notification of F&S Regulation at state level	
		Draft	Final
1	Karnataka		√
2	Rajasthan	√	
3	Madhya Pradesh	√	
4	Tamil Nadu	√	
5	Jharkhand	√	
6	JERC (Manipur & Mizoram)		√
7	Andhra Pradesh	√	

***Note**: Odisha and Chhattisgarh had also published draft earlier.*

Comparison of State level F&S Framework – 1/6

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

Comparison of State level F&S Framework – 2/6

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

Comparison of State level F&S Framework – 3/6

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

Comparison of State level F&S Framework – 4/6

Sr. No.	Particulars	FOR Model F&S	APERC (draft)	JSERC (draft)	Jt ERC (Manipur & Mizoram)
1	**Applicability**	Wind and solar generators selling power within or outside the state	**Wind and solar generators selling power to discoms/ third party sale/captive consumption through OA connected to state grid**	Wind and solar generators selling power within or outside the state	Wind and solar generators selling power within or outside the state
2	**Forecasting Responsibility**	Wind and solar generator or by QCA Or forecast by SLDC to be accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted	Wind and solar generator or by QCA Or forecast by SLDC accepted
3	**Scheduling Responsibility**	Wind and solar generator or by QCA	Wind and solar generator or by QCA Role of QCA & Implementation aspects elaborated.	Wind and solar generator or by QCA	Wind and solar generator or by QCA
4	**Computation of Error Formula**	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator	Available Capacity in denominator

Comparison of State level F&S Framework – 5/6

Sr. No.	Particulars	FOR Model F&S	APERC (draft)	JSERC (draft)	**Jt ERC (Manipur & Mizoram)**
5	Tolerance Band for DSM	10% new wind and solar generator. < = 15% existing wind and solar generator	< = 10% new wind and solar generator , < = 15% existing wind and solar generator	< = 10% new wind and solar generator , < = 15% existing wind and solar generator	< = 10% new wind and solar generator , < = 15% existing wind and solar generator
6	Scheduling Requirement	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day	Weekly and day-ahead with maximum 16 revisions during a day
7	Reference point for DSM	Pooling station	Pooling station	Pooling station	Pooling station
8	Apportion of Energy Deviations & DSM Charges among RE generators at a pooling S/S	In proportion to actual generated units or available capacity	In proportion to actual generated units.	In proportion to actual generated units or available capacity	In proportion to actual generated units or available capacity

Comparison of State level F&S Framework – 6/6

Sr. No.	Particulars	FOR Model F&S	APERC (draft)	JSERC (draft)	Jt ERC (Manipur & Mizoram)
9	Telemetry and Communication Requirement	Data relating to power system output and weather	Data relating to power system output and weather	Data relating to power system output and weather	Data relating to power system output and weather
10	Responsibility of Providing Telemetry and Communication	Generator	Generator	Generator	Generator
11	Procedure for Data Telemetry and Communication	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC covering, info exchange requirement, protocol for sharing, Fee for registration of QCA, event of default etc.	Detailed procedure to be evolved by SLDC	Detailed procedure to be evolved by SLDC
12	DSM For Sale Outside State Specified	Yes	Yes. SLDC shall provide separate Energy/ DSM accounts for inter-State transactions to QCA.	Yes	Yes
13	Meeting Shortfall of DSM Pool	PSDF and NCEF	PSDF and NCEF	PSDF and NCEF	PSDF and NCEF

Comments/ Observations on Revised TANTRANSCO DPR

Observations /Comments on Revised DPR by TN – 1/3

Cost Components	Original DPR (17.03.2016)	Revised DPR (22.08.2016)
Est. cost for ABT Meters, CTPT and calibration	137.26	26.21
Est. cost of MODEMs and other network accessories for online data transfer	7.56	-
Est. cost for AMR facility for windfarm, solar and cogen	2.07	2.07
Est. cost for AMR facility for other intra-state generators and interface feeders	2.66	2.66
Est. cost for software, hardware and network accessories for scheduling, energy accounting and demand forecasting	5.25	5.25
Est. cost for CMRI for meter download	3.10	3.06
Est. cost of furniture, printer, fax, tel, building, consultant	10.20	
Total Estimated Project Cost	**168.10**	**39.25**

Observations /Comments on Revised DPR by TN – 2/3

Earlier DPR - Revised DPR (email dt. 22.08.2016) has strived to address the comments/suggestions made on earlier DPR (17.03.2016) with respect revising the **requirements of CTPT, metering points, number of ABT meters required, need for inclusion of cost of calibration of new meters, cost of consulting support** for implementation to be justified and **other infrastructure & cost office facilities** to be borne by TANTRANSCO.

General Comments:

- CTPTs has been proposed only for state generating stations evacuation feeders.
- Hence, CTPTs reduced from 4956 to 190.

- Standby meter has been eliminated from DPR.
- Hence, total number of ABT meters revised from 17860 to 8474.

Note : Format & Content of the DPR is strictly not in accordance with contours of the Model DPR as deliberated/presented during Sixth Meeting of the Technical Committee of FOR on 22nd August 2016.

Observations /Comments on Revised DPR by TN – 3/3

Other Observations / Comments

1. DPR to include detailed specifications of meters, AMR, Hardware, Servers along with system architecture
2. As regards IT infrastructure and Hardware, a summary table with comparison of present system configuration/specs and proposed system configuration/specs with augmentation of facilities/ additional features would be useful.
3. It is not clear whether AMC support for hardware/software and additional support of 3-5 years after warranty period (typically 1 year) is covered or not.
4. Clarity on inclusion of cost of software licences, database licenses etc. in the DPR
5. Clarity on cost estimation basis of Unit rate assumptions for various components (viz. ABT meters, CMRI, CTPT, Servers etc.), which need to be outlined under DPR.
6. Cost estimated to be based on recent tenders/bids awarded or budgetary quotes/offers received from Vendors/Suppliers.
7. Copy of complete DPR with Annexures and supporting documents is necessary.

Status update on SAMAST activities

- Inputs to be received from FOR secretariat

The Energy and Resources Institute

Thank You

APERC draft F&S Regulations

5. ROLE OF QCA AND IMPLEMENTATION ASPECTS

- 5.1 Each Pooling Sub-station will have only one QCA. Accordingly, QCA shall be identified and mapped to every Pooling Sub-station for the purpose of coordination with STU/SLDC.
- 5.2 SLDC shall register the QCAs subject to fulfilment of the eligibility conditions to be outlined under the Guidelines to be formulated by the SLDC.
- 5.3 SLDC shall formulate Guidelines for Registration of QCAs at state level within a period of one month from the date of publication of these Regulations in the AP Gazette upon approval by the State Commission.
- 5.4 QCA shall be single point of contact with SLDC for energy account, deviation settlement and co-ordination and issuance of instructions for despatch/curtailment.
- 5.5 The QCA shall undertake all commercial settlement on behalf of the generator(s) connected to the respective pooling station(s).
- 5.6 QCA shall undertake settlement of only Deviation Charges at Pooling Substation with State DSM pool for Wind and Solar generators.
- 5.7 QCA shall provide weekly/monthly/quarterly energy account statements (as applicable) in respect of RE Generator(s)/Pooling Sub-stations in line with following principles. i. Energy accounting and DSM computation shall be for each time block (15-min) duration ii. Settlement period for all Energy Accounts and DSM accounts shall be on weekly basis iii. Adjustment/true-up of DSM accounts, if necessary, shall be for each entity on quarterly basis.
- 5.8 Subject to conditions outlined under these Regulations, QCA and RE Generators will be free to mutually decide professional fees for services rendered by QCA (in INR/MWh or MW; one time /annual).
- 5.9 Within two months from the date of publication of these Regulations, SLDC shall formulate Detailed Procedures covering following aspects:
    - i. Data/information exchange requirement, protocol for sharing between QCA, SLDC and Generators.
    - ii. Prescribe Fees for registration of QCA upon approval by SERC - One time & annual recurring or one time
    - iii. Conditions and proposed treatment for dealing with default in State Pool Settlement by QCA

Model DSM Regulations at state level

For discussion during 7th Meeting of

FOR Technical Committee

4-Nov-2016

Salient features of CERC DSM Regulations – 1/2

Parameter	Description
Notification	• CERC (Deviation Settlement Mechanism and Related Matters) Regulations, 2014 *(includes third amendment, 30.05.2016)*
Objective	• To maintain grid discipline and grid security as envisaged under Grid Code through commercial mechanism for Deviation Settlement through drawal and injection of electricity by users of the grid.
Applicability	• Buyers and Sellers involved in transactions facilitated through short term / medium term / long term open access in inter-state transmission of electricity.
Deviation	• Total Actual Injection – Total Scheduled Generation (*for Seller*) • Total Actual Drawal – Total Scheduled Drawal (*for Buyer*)
Absolute Error	• Error (%) = 100 X [Actual Generation– Scheduled Generation] / (AvC) *(Applicable for Wind/Solar Regional Entities)*
Pricing Framework	• Charges payable (overdrawal/under-injection) and receivable (under-drawal/over-injection) for each time-block • Linked to average frequency for each time block (15 min duration) in steps of 0.01 Hz over range from 49.7 Hz to 50.05 Hz

Salient features of CERC DSM Regulations – 2/2

Parameter	Description
Other Conditions for Deviation Charges	• Capping of Deviation Charges for Generating Stations regulated by CERC • Cap Rate of Paise 303.04/ unit • Volume Cap of 150 MW or 12% of Schedule [Different volume caps for RE Rich States] • Additional Charges for exceeding Volume Cap
Infirm power injection	• Upto 6 months or as per time extension allowed by Commission • Priced at 178 Paise/unit (coal/lignite/hydro), 282 Paise/unit (APM Gas), 303 Paise/unit (imported coal), 824 Paise/unit (RLNG). • Subject to ceiling of Cap Rate for Main fuel
Limits for Deviation	• Volume Cap of 150 MW or 12% of Schedule [Different volume caps for RE Rich States] • No over-drawal/under-injection when Frequency below 49.7 Hz • Additional Charges at rate of 20%, 40%, 100% of Applicable Deviation Charges in steps of deviation 12%-15%, 15%-20%, > 20% or 150-200 MW, 200-250 MW, > 250 MW
DSM Pool	• Regional Deviation Pool Account to be operated by RLDC and Accounts by RPCs • Surplus to be transferred to 'Power System Development Fund' at the end of month.
Institutional Arrangement	• Regional Power Committee to prepare Statement for Deviation Charges on Weekly basis • Regional Load Despatch Centres to operate & maintain 'Regional Deviation Pool Account Fund'

Comparison of ABT framework at State level – 1/3

Parameter	Gujarat	Maharashtra	Madhya Pradesh	Delhi	West Bengal
Notification/Order	Order No. 3 of 2006 dt. 11.08.2006	Case 42 of 2006 dt. 17.05.2006	2299/MPERC/2009 Balancing & Settlement Code Regulations	F.17(115)/Engg./DERC/2006-07/ dt. 31.03.2007 *(Order for Assignment of PPA, pursuant to second transfer scheme)*	No. 48/WBERC/ Tariff Regulations, 2011
Applicability	• Generators • DISCOMs • OA Users	• DISCOMs • TOA Users • *(Generators excluded)*	• Generators • DISCOMs • OA Users	• State Generating Stations • DISCOMs	• WBPDCL and Gen. stations >50 MW • DISCOMs / Deemed Licensees
Generator Tariff Design	• Capacity charge linked to availability • Energy Charge linked to Schedule (for hydro-actual) • UI charge	• Capacity charge linked to availability and incentive linked to PLF • Energy Charge linked to Actual	• Capacity Charges linked to availability • Energy Charges linked to schedule energy • UI charges	• Capacity Charges linked to availability • Energy Charges linked to schedule energy • UI charge	• Capacity Charge • Energy Charge • UI charge
Deviation/ Imbalance	Actual - Schedule	Increment /Decrement Contract – Actual plus allocation of Regional UI	Actual - Schedule	Actual – Schedule	Actual - Schedule

Comparison of ABT framework at State level – 2/3

Parameter	Gujarat	Maharashtra	Madhya Pradesh	Delhi	West Bengal
Scheduling and Despatch framework	• Generators, DISCOMs and OA Users (excluding wind, mini hydel and generating stations having total capacity 5-15 MW) connected to the grid shall schedule and despatch as per SLDC. • Scheduling of hydro in consultation with beneficiaries • De-Centralised scheduling and Despatch Model	• SLDC Responsible for scheduling, despatch and MOD. Done as per 15 minute time blocks as per load forecast schedules from state pool participants. • Centralised MoD based Despatch Model	• Scheduling shall be done on 15-minutes Time Block. • Generation Schedules and Drawal Schedules issued / revised by SLDC shall become effective from designated Time Block • Scheduling of hydro to be finalized by SLDC based on DCs • De-Centralised scheduling and Despatch Model	• Discoms to adhere to grid discipline. • Under frequency relays to be kept in operation. • STU/SLDC shall exercise necessary control in transmission/load dispatch as specified in the Act, IEGC, Regulations of CERC, CEA, Rules etc • Surplus adjustment amongst state DISCOMs on day-ahead	All the Scheduling shall be done on 15-minutes Time Block basis. De-Centralised scheduling and Despatch Model
Pricing Framework	• Linked to frequency • As per CERC deviation charges.	• Linked to Wt. Avg. System Marginal Price (WASMP) • Allocation of Regional UI	• Linked to frequency • UI rates as per CERC 2007 Regulation and amendments thereof.	• UI rates as per CERC UI/DSM Regulations • Inter-DISCOM exchange at PX rate+10 paise	• UI rates linked to frequency.

Comparison of ABT framework at State level – 3/3

Parameter	Gujarat	Maharashtra	Madhya Pradesh	Delhi	West Bengal
Limits on Deviation / Other conditions	Var and Voltage control at limits of 97% and 103% of voltage level. Generating stations generating 105% in a time block and averaging 101%, not considered as gaming.	• DISCOMs entitled to schedule/draw upto contracted capacity • Despatch governed as per centralised MOD principles	Var and Voltage control at limits of 97% and 103% of voltage level. Generating stations generating 105% in a time block and averaging 101%, not considered as gaming.	Not stipulated in the Order	Generating stations generating 105% in a time block and averaging 101%, not considered as gaming. Drawal less than 95% of the scheduled drawal in a block construed as gaming.
DSM Pool	The UI Payable is adjusted to make it equal after equal to UI receivable. • Zero-sum DSM Pool • Some delays in pool account settlements	• State level Imbalance Pool under operation since 2009 • Zero-sum DSM Pool • Some delays in pool account settlements	Payable/ receivable by each Intra-State Entity and Regional UI payable/ receivable for MP to be matched with the average of total payables and total receivables.	UI pool account under operation since 2013.	Any mismatch amount after UI energy accounting is done, such amount shall be distributed on prorata basis of actual energy injected or drawn by the entities and net balance of the accounts of UI charge is zero.
Institutional Arrangement	Entry and exit points defined by STU. Billing and settlement of 'UI charge' and 'reactive charge' prepared by SLDC.	• Governance structure in place through Maharashtra State Power Committee. • MSLDC-OD and MSLDC-CD would see 'day to day' functioning, • UI settlement and form Maharashtra State Powel Pool	SLDC to perform accounting. Discoms to pay energy and capacity charges to generators (through MP Trading Co.)	• Operation Coordination Committee (OCC) for issues relating operating of the system. • Delhi Transco Limited (DTL) looks after the ABT meter reading • STU to identify non-critical feeders.	Generators, discoms and SLDC. SLDCs perform the task of energy accounting and settlement.

State specific considerations for DSM framework – 1/2

- **State experiences**
  - Identification of Intra-State Entities, interface boundary limits (inter-utility and intra-utility, G<>T and T<>D) is cumbersome and evolving process.
  - Significant time (over 2 yrs), efforts and coordination necessary for implementation of metering and communication infrastructure.
  - Different Treatment of Open Access transactions (TOA, DOA/Embedded, Full/Partial OA) is necessary under DSM framework.
  - Centralised Despatch or De-centralised Despatch Model has close links to status of power market reforms at state level and power scenario (surplus/deficit) at state level.
  - Managing deviations of intra-State entities within volume cap of (12%, 150 MW to 250 MW), without flexible resources / demand response is challenge.

State specific considerations for DSM framework – 2/2

- **Payment mechanism for Generators**
  - Operation of Two part/ Multi-part for Generators is necessary.
  - Whether Energy Payment to Generators to be linked to (Actual v/s schedule)?
  - Modification to PPA (IPPs and SGS) and Amendments to Tariff Regulations may be necessary.
  - Hydro generation is used as balancing resource (single part payment operation in place)
- **Market developments in the country**
  - Power Supply scenario has improved significantly.
  - Regional and National power market operation are growing rapidly. With emergence of Multiple entities viz. traders, open access entities, volume of merchant transactions are expected to grow.
  - Reference market price discovery through market mechanism (thru Power Exchanges) is available.
  - With conducive policy and Grid Integration of RE, share of RE transactions (inter/intra-state) is expected to grow further.

With this background, Key Design Parameters for DSM framework at state level needs to be discussed.

Model DSM Regulations : Key Design issues – 1/2

1. Pre-condition for introduction of DSM – Applicability of Multi-part tariff design
2. Applicability and coverage of DSM at state level
3. Definition of DSM and Error
4. Principle for Pricing of Deviations
5. DSM Price Vector
6. Identification of State Entity
7. DSM Pool design
8. Governance structure and Institutional arrangement
9. State Energy Accounting and Settlement Accounting
10. Reactive Energy accounting

Model DSM Regulations : Key Design issues – 2/2

11. DSM Fund Operationalisation : Utilisation rules, Application of residual fund
12. Treatment for Gaming / Curtailment / Despatch
13. Treatment for infirm power
14. Metering & AMR infrastructure
15. Detailed Implementation procedures – Nodal Agency, Roles & responsibility of stakeholders

1. Pre-conditions for introduction of DSM at state level

- Pre-conditions for introduction of DSM at state level
  - Identification of State Entities
  - Identification of interface boundaries (G<>T and T<>D)
  - Ensuring Metering Infrastructure and Communication links covering interface points
  - Operationalising multi-part tariff for generating stations
- Key Considerations
  - What should be the timelines for Metering/Communication infrastructure?
  - Phase-wise Action plan can be explored. What should be priorities for implementation stages and Monitoring mechanism for Regulatory oversight?
  - Coverage of Multiple DISCOMs and Gencos is crucial.

Suggestion:

- Necessary amendments to MYT/Tariff Regulations to enable Multi-Part tariff design for Hydro in line with CERC Tariff Regulations.

2. Applicability and Coverage of DSM at state level

- Applicability and Coverage
  - Generating Stations – Thermal, Hydel, Renewable
  - Distribution Licensees
  - Deemed Distribution Licensees (SEZs, Railways) and Exempt Licensees (RESCOs)
  - Open Access Users (TOAUs / DOAUs) and (Full OA Users and Partial OA Users)
  - Captive Users (Captive Wheeled, In-Situ)
- Key Considerations
  - Whether distinction to be made between Existing v/s New Generating Stations?
  - Need to examine provisions under PPA of IPPs / SGS (need for amendments / overarching regulatory framework)
  - How to address Treatment of existing Banking and Wheeling arrangements (Captive and RE)?
  - What should be Minimum threshold Installed Capacity (50 MW & above) and other conditions such as connectivity to Transmission (InSTS Grid) be imposed?

Suggestion:

- Applicability to cover Thermal, Hydel, RE (as per conditions), DISCOMs, Full TOAUs

3. Definition of DSM and Error

- Deviation and Error
  - **Deviation** = Actual – Schedule (to be computed for Injection and Drawal)
  - Deviation to be computed for each state entity separately
  - **Error (%)** = Deviation / Av. Capacity x 100 (relevant only for Wind/Solar)
  - Imbalance = Increment/decrement vis-à-vis contracted capacity to be monitored (?)
- Key Considerations
  - How to ensure that Model DSM framework at state level is compatible with regional and national level framework?
  - To be determined for time-block (15 min) and to be scalable to cover 5-min duration in future
  - Treatment for Constrained Stations (e.g. Nuclear, Run-of river Hydel) schedule = Actual
  - Sum of deviations (+/-ve) of intra-state entities vis-à-vis regional DSM Pool to be balanced in terms of energy volume. (Non-Zero Sum in Value Terms).
  - Assumes continuation of market design with decentralised scheduling/despatch regime.

Suggestion:

- Definition of Deviation and Error to be aligned with CERC DSM Regulations.
- May need to be reviewed in case change in market design to Centralised scheduling/despatch regime.

4. Principle for Pricing of Deviations

- Linkage of DSM to frequency or Alternatives for De-linking from frequency
  - Operating band of frequency range narrowing (49.7 Hz to 50.05 Hz).
  - Granularity in steps of 0.01 Hz not adequate. May need to move to higher resolution of 0.005 Hz; however it will pose measurement accuracy related challenges.
  - Volume cap (150 to 250 MW) also need to be operationalised, in addition to frequency.
- Key Considerations
  - One of the Alternative for delinking from frequency could be to devise 'state deviation band' (+/-) in steps of 10 MW or 25 MW (upto +/- 150 MW or 250 MW) or 'percentage deviation band' (+/- of % of schedule)
  - Linkage to absolute deviation would be unfair to smaller State Entities and smaller States
  - Percentage deviation band is not 'intuitive' for corrective actions as compared to 'frequency'.

Suggestion:

- Hybrid approach to be explored.
- For compatibility with regional framework, linkage to frequency to be continued during initial stage.
- Planned transition to 'percentage deviation band' approach at regional and state level over 2 to 3 yr.

5. DSM Price vector

- Design of DSM Price vector
  - Options for DSM Pricing : COG of liquid fuel, Market Price thru PX, WASMP, FC+VC of state marginal station (LRMC)
  - What are key influencing factors for design of DSM price vector - demand variation, Time of day, Seasonal variation, locational aspects?
  - Whether DSM pricing vector should recognise any or all of these points?
  - Need for simplified formulation for accounting & implementation.
  - Linkage of DSM Price vector and Volume Limits
- Key Considerations
  - DSM Price Vector – Dynamic or static to seasonal variation, demand-supply, locational factors?
  - How to factor in State-wise variation? (State level MoD and Demand/Supply factors)
  - 'Percentage Deviation Band' approach is amenable for state specific customisation of Price Vector

Suggestion:

- Under frequency linkage approach, fixed price vector with COG of liquid fuel stations for outer limits of frequency range can be devised. Differential price range/caps for Injection/Drawal can be devised.
- For deviation beyond, Volume cap Additional DSM charge as certain % applicable DSM Charge.
- For Deviation Band approach, linkage of Price vector to state-specific MoD can be devised.
- Impact on different states need to be analysed further through simulation studies to evaluate various options.

6. Identification of state entities

- State Entities to be Imbalance Pool Participants
  - Identifying a State Entity to be an entity under SLDC control area and whose metering and energy accounting is done at the State level.
  - Generating Stations (Thermal, Hydel, RE thru QCAs), DISCOMs, CPPs/Captive Users, OA Users (TOAUs/DOAUs, Full/Partial OA Users)
- Key Considerations
  - Identification as State Entity to be distinct from being a Pool Participant.
  - Rules for Membership of Imbalance Pool to be devised by SLDC/State Power Committee
  - To be guided by State Grid Code, State DSM Regulations and TOA/DOA Regulations to be aligned.

Suggestion:

- Procedure for Mapping/Accreditation/Registration of State Entities to be approved.
- Rules/principles for Membership of Pool Participation to be devised.
- Imbalance handling of State Entities who are not Pool Participant to be addressed through OA Regulations.

7. DSM Pool Design

- State level Imbalance (DSM) Pool Design
  - Imbalance Pool design to be Non-Zero sum in value terms. (+ve balance)
  - Rules for Pool Settlement and Administration
  - Handling of Pool reserves, interest, cashflow management
  - Treatment for delayed payment and payment security mechanism
- Key Considerations
  - Differential price vector with price cap to ensure Pay-in and Pay-outs over weekly settlement period
  - Regional UI (DSM) payments to be ensured.
  - Priority of payments – Regional, Ancillary, reactive, transmission, System Opn, State DSM. Pro-rate reduction in Payouts in case of shortfall.
  - Two-tier Payment security mechanism in the form of LC and BG to cover average monthly payout
  - Penal provisions in case of default or continued non-compliance

Suggestion:

- To be aligned with CERC DSM Regulations and state specific customisation necessary

8. Governance structure and Institutional arrangement

- Institutional Arrangement
  - Creation of **State Power Committee** with representative from State Pool Participants
  - SLDC institution to have two distinct functions/teams - System Operation and Market Operation
  - **System Operation**: Scheduling, forecasting, MoD/Load-Generation, Congestion Mgmt, Protection
  - **Market Operations**: Energy Accounting, DSM, Settlement System, Open Access, Pay-in/Pay-out, Compliance reporting, Market monitoring
- Governance Structure
  - A System of “Maker-Checker” in energy accounting to be in place similar to the maker checker for financial accounting.
  - Timely Web-publication of accounting data/ settlement statement in Transparent manner
  - Need for Mechanism for third party verification and sample audit
  - Compliance reporting and Remedies for default with Regulatory oversight

Suggestion:

- Model DSM Regulations to cover these aspects in detail.

9. State Energy Accounting and Settlement accounting

- State energy accounting and settlement accounting
  - **Energy Accounting**: Imbalance/DSM computation for each time-block on Weekly basis.
  - **Settlement Period**: Weekly or Monthly considering volume of data/interface points to be covered.
  - **Loss Accounting**: Loss accounting to be done for each time block. However, no post-facto administration of Loss.
  - **Reconciliation**: Periodic reconciliation and process audit of accounts to be mandatory.
- Key Considerations
  - Energy Accounting to be compliant with basic principles of Accounting – adhering to principles of double entry, going concern and full disclosure principle.
  - Rule for data substitution, profiled data use in the absence of unavailability of data to be laid out.
  - Time-limits for finalisation of Provisional Statement to Final Statement

Suggestion:

- Model DSM Regulations to cover these aspects in detail.

10. Reactive Energy Accounting

- Reactive Energy Measurement and Accounting
  - Sharing of costs with respect to settlement of regional reactive energy accounts
  - State-level measurement of reactive energy exchange over interface points
  - Metering infrastructure to cover voltage differentiated reactive energy injection/drawal.
- Key Considerations
  - Reactive Energy Pricing framework at state level to be in place (*At present, different treatment for Generators, Beneficiaries, RE Generators*).
  - Compensation for Reactive energy support at behest of SLDC instructions?

Suggestion:

- State level reactive energy compensation study is necessary.
- Suitable amendments to MYT/RE Tariff Regulations, State Grid Code and DSM Regulations necessary.
- Model DSM Regulations to cover these aspects in detail.

11. DSM Fund Operationalisation

- Rules for Operationalising DSM Fund
  - DSM Pool to be surplus by design so that there is provision of Reserve Funds.
  - Guaranteed settlement of trades to all members maintaining adequate margins.
  - Exposure limits for each player to be derived from past record of creditworthiness
  - DSM fund to be utilized to incentivise the generators/ beneficiaries that help support the grid stability.
- Key Considerations
  - Mitigation of systemic risk and credit risk for all Regulatory Pool Accounts
  - STOA Registry and Central Clearing house to be established similar to depositories in capital market
  - Utilisation of surplus DSM Fund to be guided by Regulatory discretion/direction

Suggestion:

- Model DSM Regulation to address core principles – administration, utilisation, governance
- Separate rules / practice directions for DSM Fund Operationalisation to be formulated.

12. Treatment for Gaming and Curtailment

- Gaming, its implications and remedies
  - Gaming is an intentional mis-declaration of a parameter related to commercial mechanism in vogue, in order to make an undue commercial gain.
  - Various scenarios for Gaming by Generators and Beneficiaries to be evaluated and suitable conditions to imposed.
  - Potential opportunities for Gaming to be minimised
  - Continued instances of 'Gaming' to be dealt with severe penal provisions.
- Key Considerations
  - To be able to distinguish between 'Gaming' and genuine 'Trading' activities
  - Tiered mechanism for dealing with 'Gaming' at various levels. Viz. SLDC, SPC, Commission

Suggestion:

- Provisions and treatment for Gaming under Model DSM Regulations to be aligned with CERC DSM Regulations.

13. Treatment for Infirm Power

- Treatment for Infirm power
  - Scope and time limit for infirm power injection (Generating stations, RE Generators, CPPs)
  - Treatment for Start-up power consumption
  - Treatment for Standby power during operations phase
  - Provisioning under Tariff Regulations/
- Key Considerations
  - Accounting for infirm power (with identified beneficiary and for Merchant Generator)
  - Credit to beneficiaries (provisions under PPA for netting-off for SGS)

Suggestion:

- Provisions and treatment for Infirm Power under Model DSM Regulations to be aligned with CERC DSM Regulations.
- Other aspects for treatment of Start-up power, standby power support also need to be addressed. However, there are state-specific variation in approach covered through Tariff Orders/Regulations, which need to be factored in while determining uniform treatment.

14. Metering and AMR infrastructure

- Interface Metering with AMR Infrastructure
  - Availability of Metering infrastructure – Main, Check, Standby for interface points and state entities
  - Compliance with metering standards and communication protocol for implementation
  - Clear demarcation of Role and responsibility between STU, SLDC and State Entity for installation
  - Metered data testing, protocol for substitution and replacement meters
- Key Considerations
  - Availability of CT/PT for installations at identified locations could be challenge.
  - Implementation timelines to cover interface points and covering all state entities could pose major challenge in implementing state level DSM mechanism.

Suggestion:

- Model DSM Regulations, State Grid Code, Metering Code to address the concerns.
- Regulatory oversight and compliance monitoring / reporting for implementation is necessary.

15. Detailed Implementation Procedures

- Implementation Procedures, Rules, Practice Directions
  - Model Procedure for Scheduling and Despatch Procedures
  - Model Procedure for Energy Accounting and DSM settlement
  - Model Practice Directions for Implementation of Metering & AMR Infrastructure
  - Model Rules for DSM Fund Operationsalisation
- Key Considerations
  - Clear demarcation of Role/Responsibility amongst stakeholders – STU, SLDC, SPC, Generators etc.
  - Uniformity across State would streamline implementation process. However, state specific customisation would be necessary.
  - Compliance Monitoring, Reporting and Regulatory oversight would be necessary

Suggestion:

- Apart from Model DSM Regulations, FOR could formulate Model Procedures covering various implementation aspects – Model Scheduling/Despatch Procedures, Model Energy Accounting/DSM Procedure, Model Practice Directions for Implementation of Metering/AMR Infrastructure, Model Rules for DSM Fund operationalisation.

Thank You

Need, Relevance & Barriers

for

Integration of Energy Storage with Wind & Solar PV Projects

Presentation to the Members of FoR

at

7th Meeting of the "Technical Committee for Implementation of Framework in Renewables at the State Level"

4th November, 2016 at CERC, New Delhi

Rajsekhar Budhavarapu
Head Wind Business & CTO (Renewable Investments)
IL&FS Energy Development Company Limited

1

Overview of the Presentation

- Why Energy Storage is needed in India?
- Cost-Performance overview of various Energy Storage technologies?
- Business case definition for co-locating Energy Storage with Wind-Solar projects
  - Inertia & Primary Frequency response
  - Frequency Regulation- Managing Short-term Variability & Uncertainties
  - Plant Level Ramp management
  - System Level Ramp management
  - Peak Energy and Capacity
  - T&D Applications
- Required Regulatory and Policy Considerations
- Monetizable benefts of Energy Storage
- Points for Discussion for co-locating Energy Storage with VRE projects
- Typical System architecture for a Energy Storage integrated VRE project

2

Why Energy Storage may be needed in India?

Energy Storage Applications :

– **Generation:** Firming up VRE & Energy Time–Shift

– **Ancillary Services:** Frequency Regulations, Spinning & non-Spinning reserve, Voltage support, Black start support

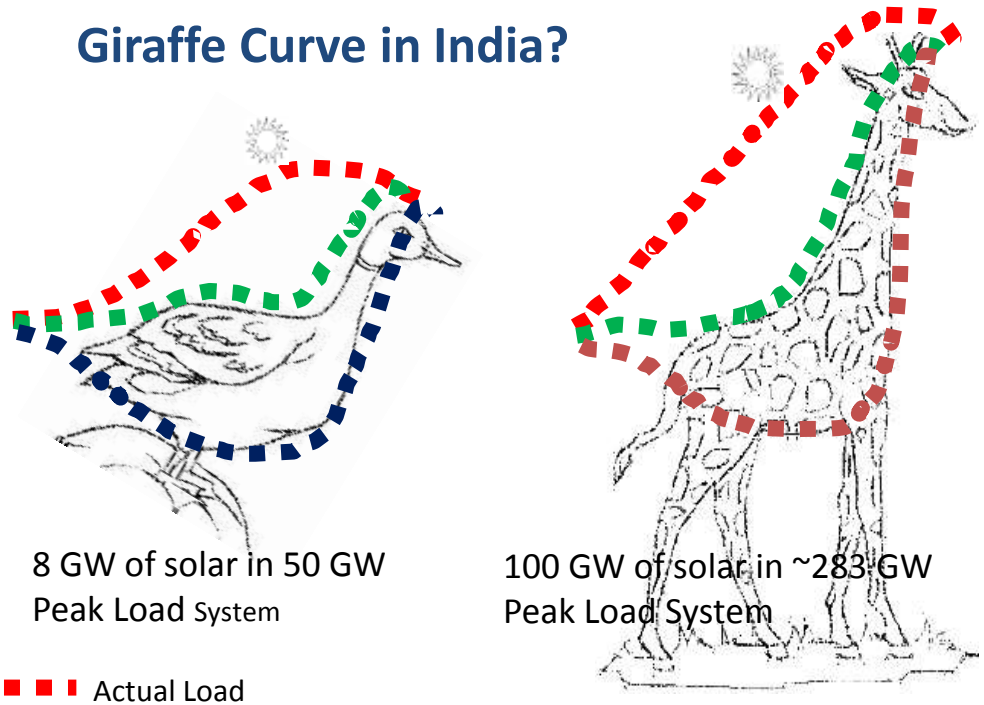
– **S/s & Transmission** :Upgrade deferral & congestion relief

– **Distribution**: Peak shaving, Upgrade deferral, Voltage support

– **Customer End Management Services**: Power reliability, Power quality & Backup power

– **Micro grid or Off-grid**: Power access, Power reliability & quality

Giraffe Curve in India?



8 GW of solar in 50 GW Peak Load System

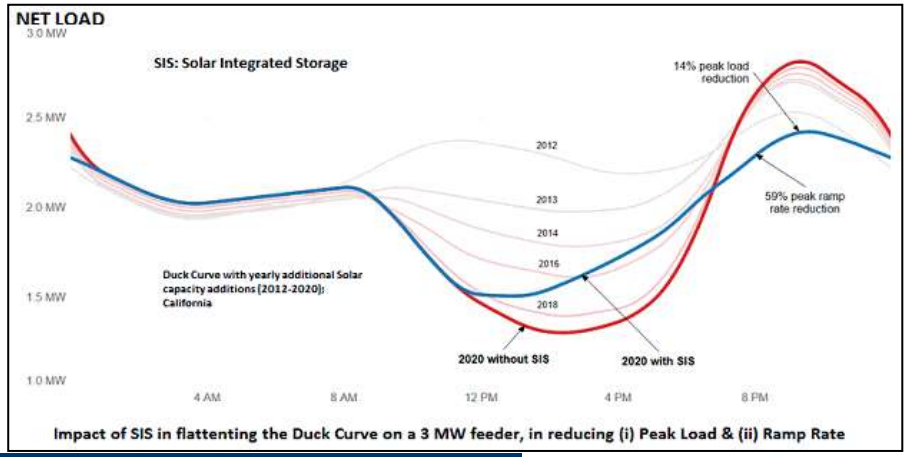
100 GW of solar in ~283 GW Peak Load System

Actual Load
Net-Load with high solar penetration
Net-Load with very high solar penetration

Need & Relevance for Energy Storage:

- Providing Inertia & Primary Response, as 160GW of VRE is going to be added to take RE generation mix to 17-19% by 2022
- Indian grid operators will face huge challenges due to frequent ramping up/down of generation- both at the System level and at the regional level
- Frequency Regulation- managing short-term variability and uncertainties
- Like at the Duck Curve syndrome in California, serious issues related to Peak Energy & Capacity

Source: Power System Operation Corporation (POSOCO); Green Corridor report; Power Grid Corporation of India Limited (PGCIL); June'12



Impact of SIS in flattening the Duck Curve on a 3 MW feeder, in reducing (i) Peak Load & (ii) Ramp Rate

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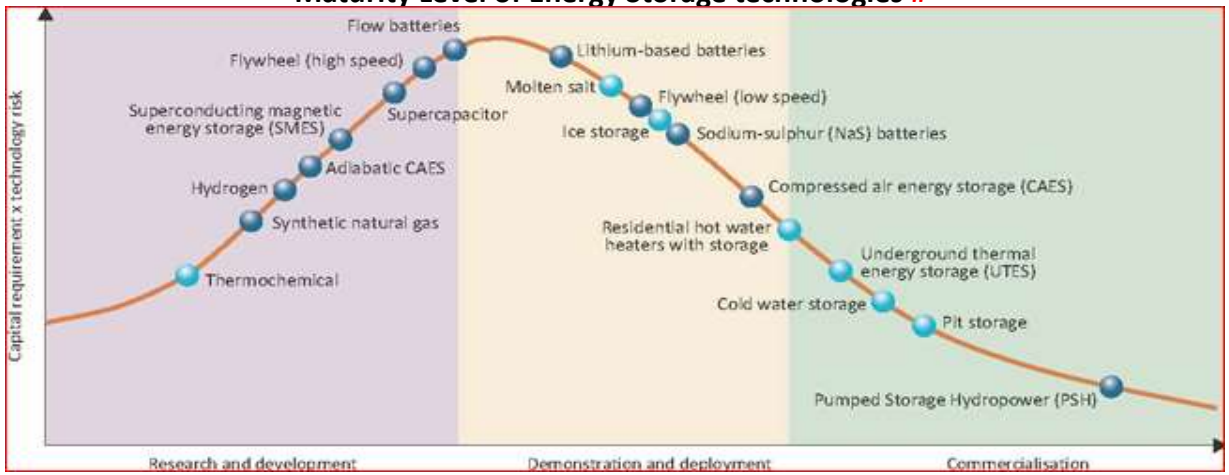
Cost –Performance of Energy Storage Technologies- Fast evolving transformation?

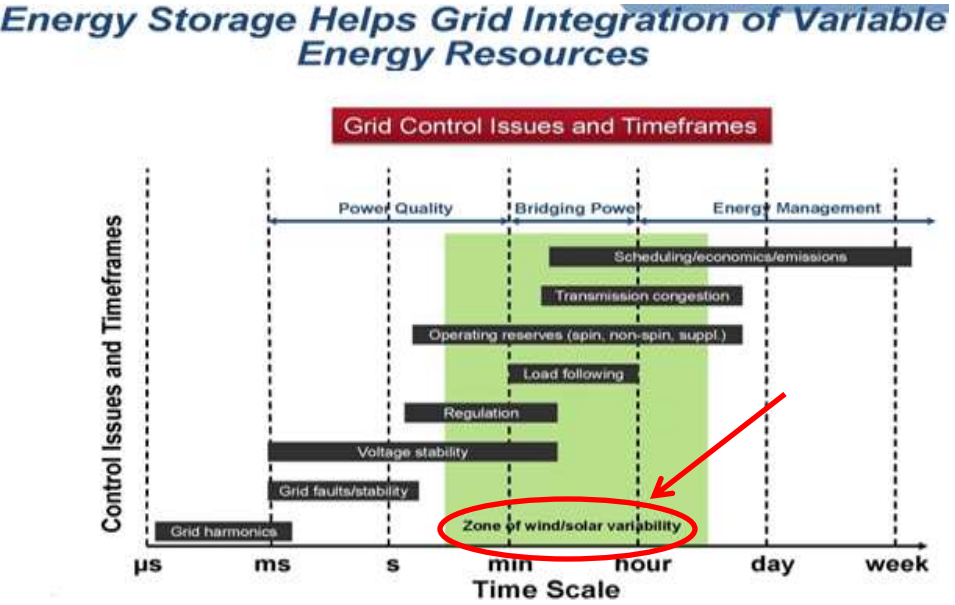
Cost and Performance parameters of Energy Storage technologies *

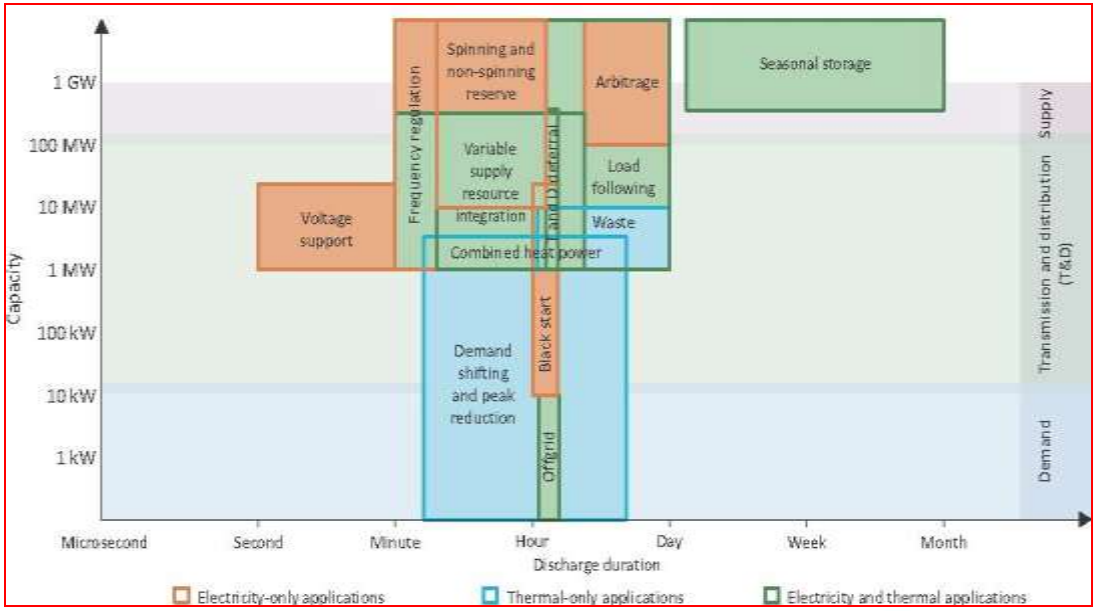
Technology	Storage Duration (Hrs)	Efficiency (%)	Total Cycle in life	Total Cost $/kWh
Sodium Sulfur (NaS)	6	75%	4,500	520-550
Advanced Lead Acid	4	85-90%	2,200	425-475
Fe/Cr Redox flow battery	5	75%	>10,000	360-380
Zn/Br Redox flow battery	5	60%	>10,000	290-350
Zn/air Redox flow battery	5	75%	>10,000	290-340
Vanadium Redox flow battery	5	65-75%	>10,000	620-740
Sodium Nickel Chloride (NA Nicl2)	6	90%	4500	NA
Lithium Ion	0.5-2	80-93%	5,000	600-700

Maturity Level of Energy Storage technologies #



- High Capital Cost is the major barrier for widespread implementation- Typical Catch 22 situation (like Solar PV in 2010) of Volume & Cost Reduction
- Industry & major analysts expect CAPEX to reduce drastically in next 3 to 4 years





*Source : Electricity Energy Storage Technology Options; EPRI ; December, 2010

 # Source : *Energy Technology Perspectives. 2014; IEA*

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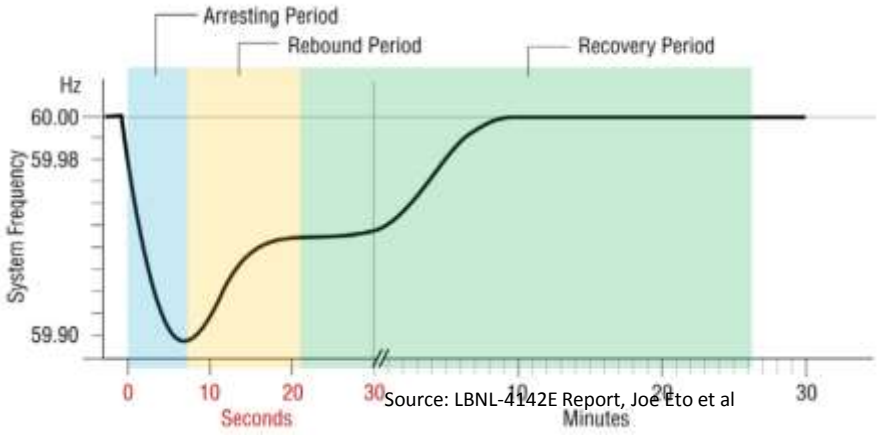
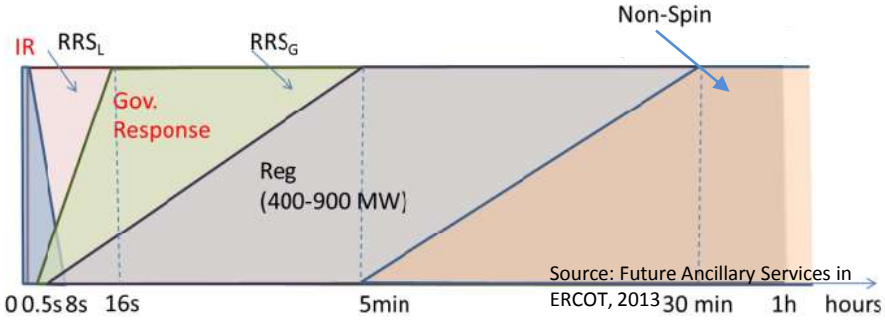
Inertia and Primary Frequency Response

What is it?



Source: LBNL-4142E Report, Joe Eto et al



Source: Future Ancillary Services in ERCOT, 2013

Inertial response: Involuntary service provide by all synchronous generators

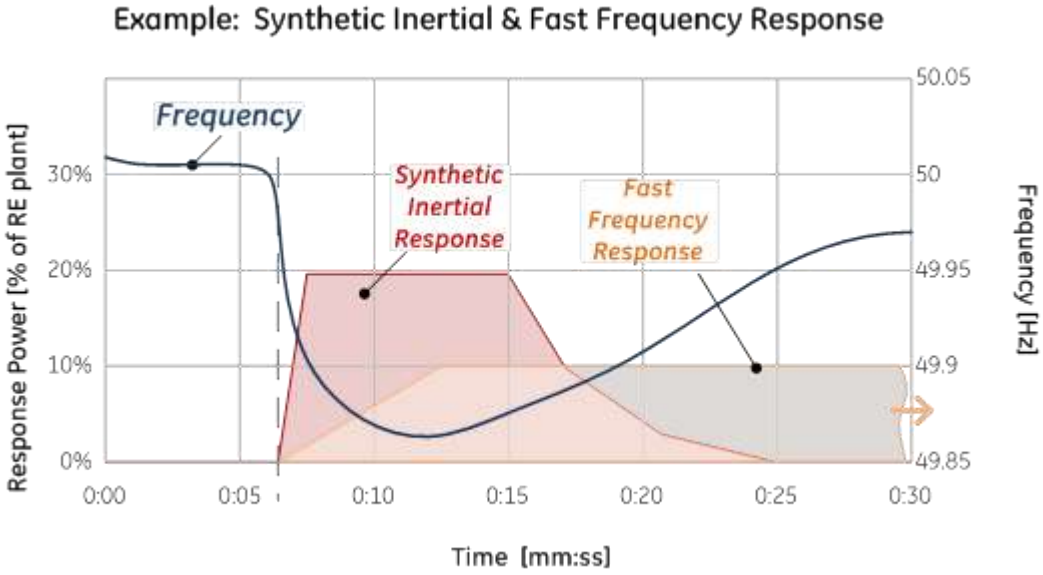
Primary Frequency Response: Voluntary service provided by plants with governors that have headroom

RRS$_L$ – Responsive Reserves from Load
RRS$_G$ – Responsive Reserves from Generation
Reg – (Frequency) Regulation

Why should it be in focus?

- Decreasing system inertia due to displacement of conventional generation during high RE hours
- Inertia not being contributed by power electronics-based generators
- Insufficient primary frequency response due to improper or blocked governors
- RE plants not providing primary frequency response (they can with proper grid codes and a compensation mechanism)

How can Energy Storage Help?



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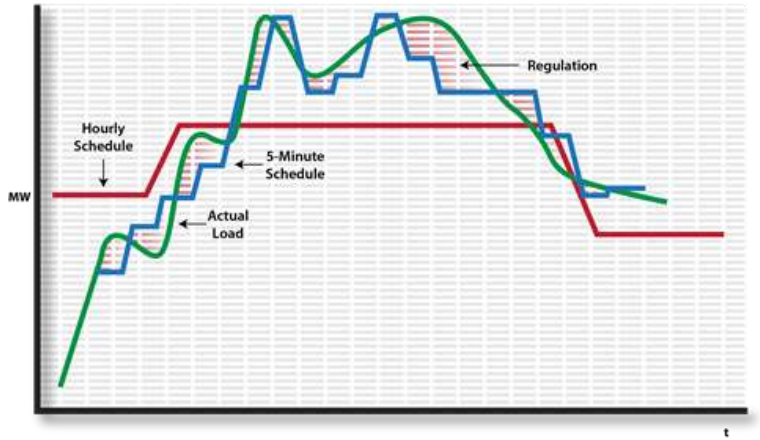
Frequency Regulation – Managing Short-term Variability and Uncertainty

What is it?



Frequency Regulation Reserve in US– Generators on Automatic Generation Control (AGC) receive a signal every 4-5 seconds to regulate Area Control Error (ACE). AGC is required to maintain ACE under normal, as well as contingency conditions. ACE violations will incur penalties.

In India, a similar objective is achieved through the DSM mechanism

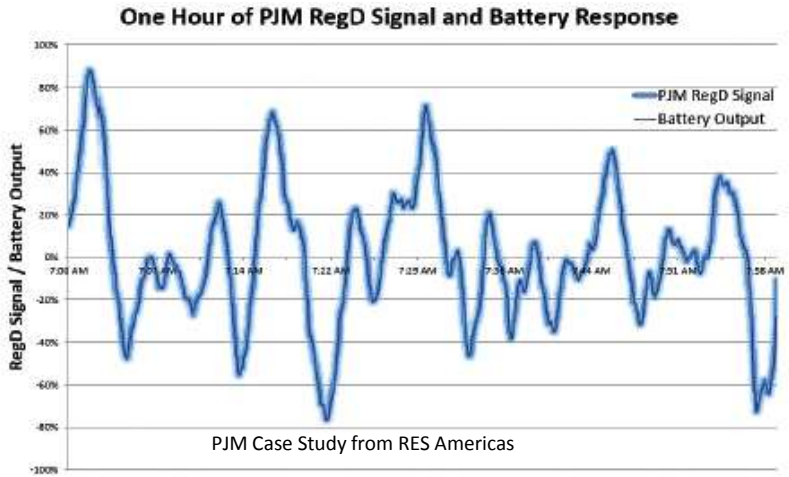
BESS ideal for providing frequency regulation service under the following conditions:

- **Well functioning existing regulation market…** mechanism to pay for regulation service based on lost opportunity cost at marginal cost of energy
- **Energy neutral service…** Market operators make changes to their dispatch procedures to enable regulation to be an energy neutral service between dispatch intervals
- **Payment commensurate with service provided… US** FERC Order 755 required mileage payment… PJM further separated traditional slower response fossil fuel plants (RegA) and dynamic, fast-responding technologies (RegD)

Why should it be in focus?

- Variability and uncertainty in wind and solar generation will cause frequency regulation requirements to go up
- Inadequate reserves will result in higher ACE violation penalties
- In India, inadequate reserves will result in higher DSM changes and could adversely impact system frequency
- Lack of flexibility in the system due to gas unavailability in the near term and hydro plant operational constraints may exacerbate the problem

How can Battery Energy Storage Help?



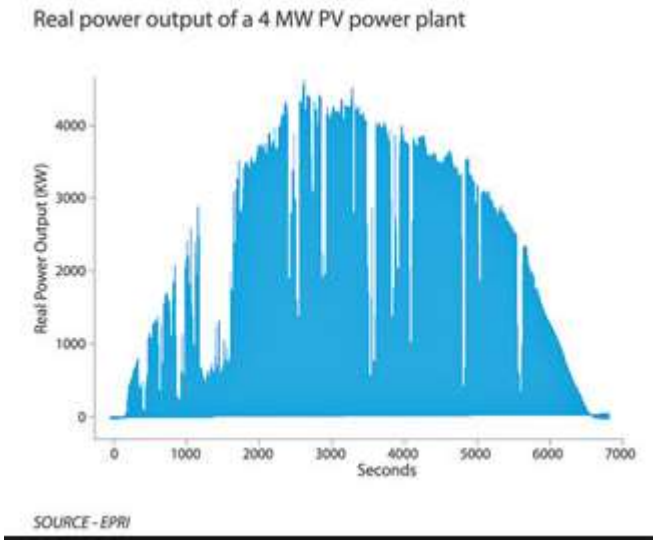
PJM Case Study from RES Americas

BESS can help with DSM Charge Management in India… lessons learnt can be readily applied to the AGC service when it's implemented in India

6

Plant Level Ramp Management

What is it?



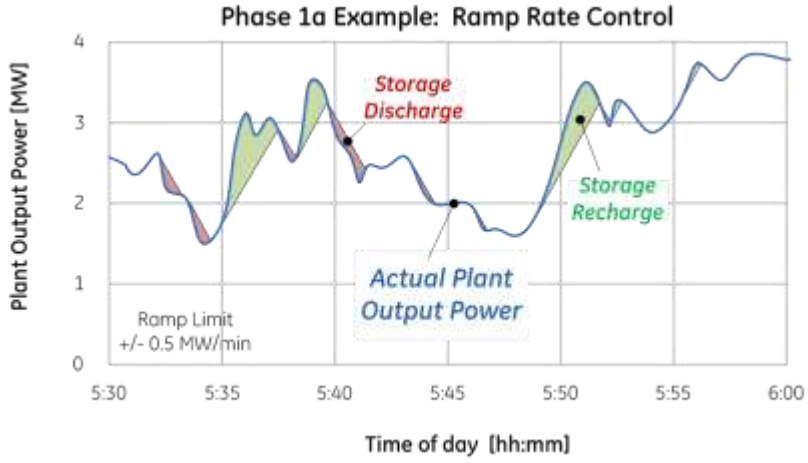
Ramp Rate Control – Grid codes in many systems include a requirement to control the rate of change of power for solar plants. For example, Puerto Rico has placed a 10% ramp rate limit that applies to both the increase and decrease[1] of power output and is independent of meteorological conditions.

1. Most systems only include a ramp rate limit in the upward direction. RE can be curtailed to adhere to the ramp limit. However, very few islanded systems have required ramp rate limits in the downward direction as well.

Why should it be in focus?

- Sudden drop or increase in wind and solar generation can have an impact on the voltage, as well as power balance
- Sudden drop or increase in generation at a plant level is more common in solar plants. Since India has a goal for 100 GW of solar plants, generation ramps could be of particular concern
- Lack of flexibility in the system due to gas unavailability in the near term and hydro plant operational constraints may exacerbate the problem.

How can Battery Energy Storage Help?



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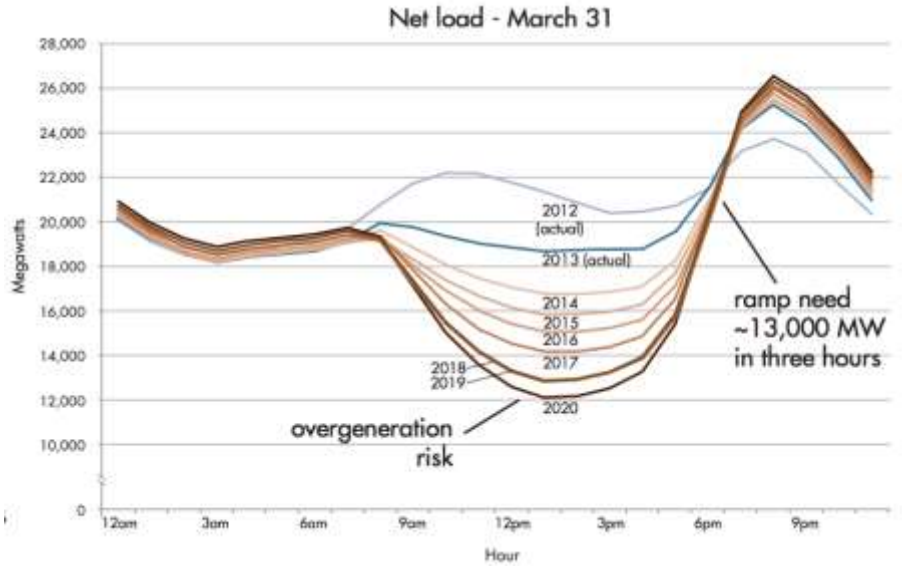
System Level Ramp Management

What is it?

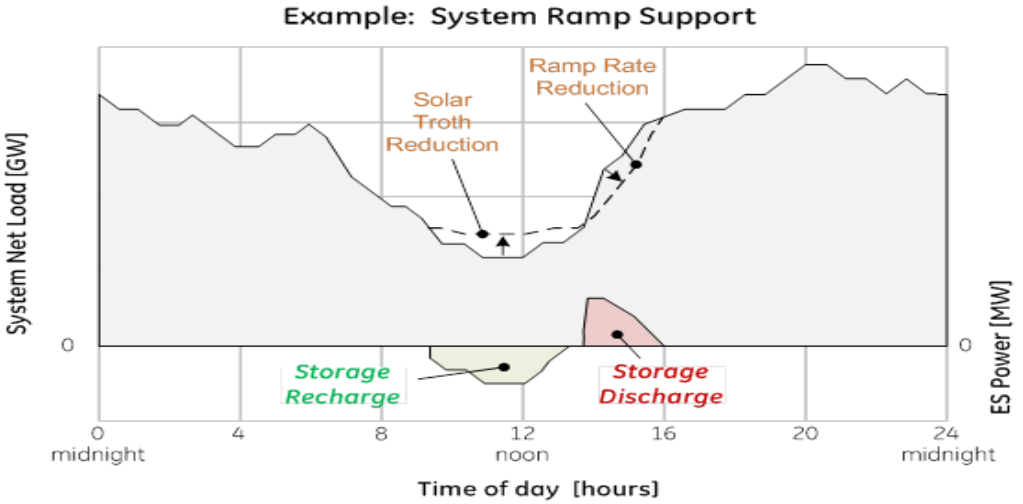


Ramp or Load Following Reserves – Some system operators that are faced with operating their system under very high penetration of solar generation are calling for the need for ramp or load following reserves to help the system meet the steep ramp requirements.

Why should it be in focus?

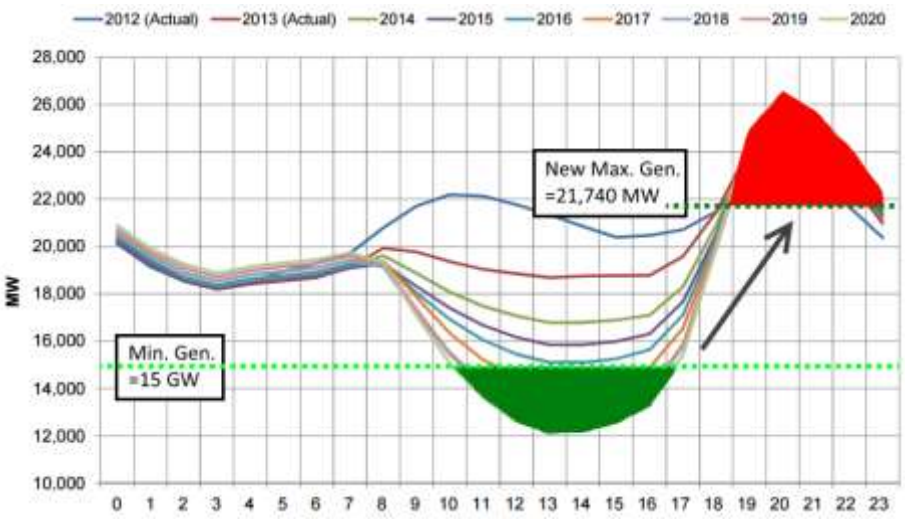
- Very high penetration of solar generation will result in a "net load" curve with a steep neck.
- Several of the thermal plants need to be kept online (except for quick start plants) to meet this ramp requirement. This cause overgeneration in the belly of the curve resulting in curtailment. This also results in inefficient operation of thermal plants.
- Lack of flexibility in the system due to gas unavailability in the near term and hydro plant operational constraints may exacerbate the problem

How can Battery Energy Storage Help?



Peak Energy and Capacity

What is it?

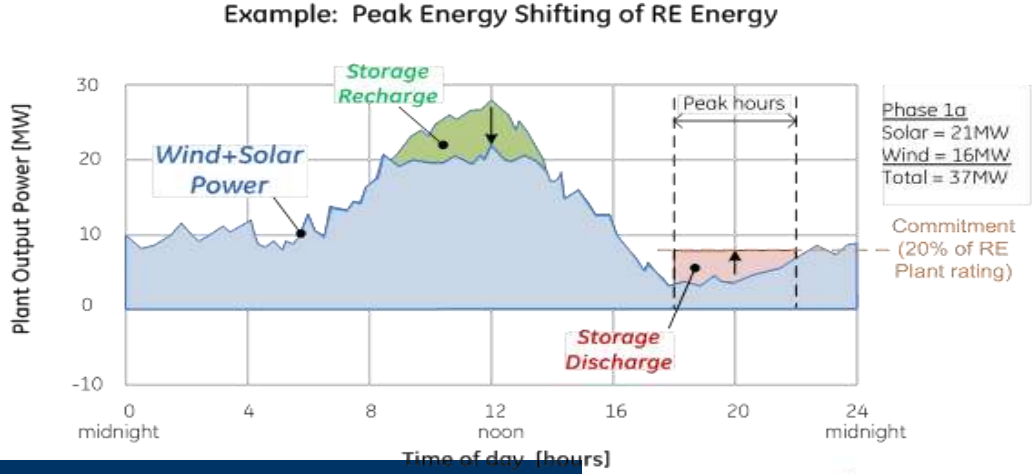


Peak Energy – Energy that is available during the peak hours of the day. For a resource to qualify as a peaking (capacity) resource, it has to be able to provide at least 4 hours of energy at its maximum capacity.

Why should it be the focus?

- Studies have shown that high RE (solar) penetration may result in overgeneration during daytime hours and peak load in the late evening hours.
- A system without quick start units to meet the peak load will need to operate thermal plants below their max rating during the day in order to meet the peak load. This results in inefficient operation (high heat rate) and higher emissions.
- Lack of flexibility in the system due to gas unavailability in the near term and hydro plant operational constraints may exacerbate the problem.

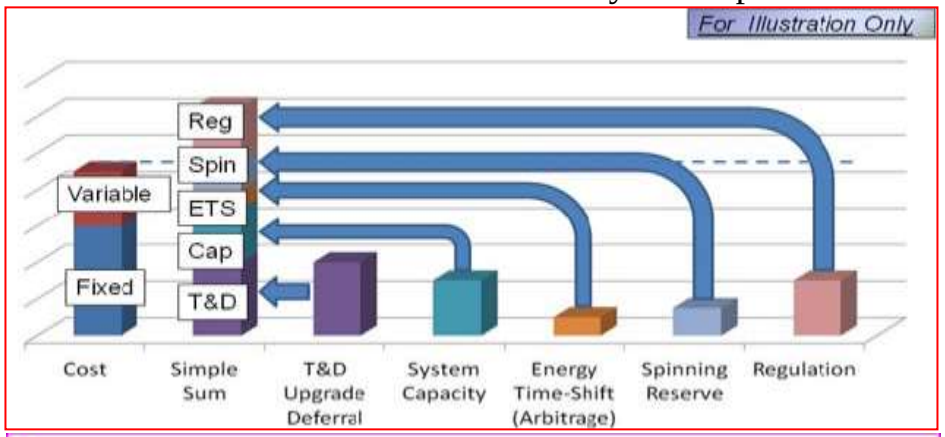
How can Battery Energy Storage Help?

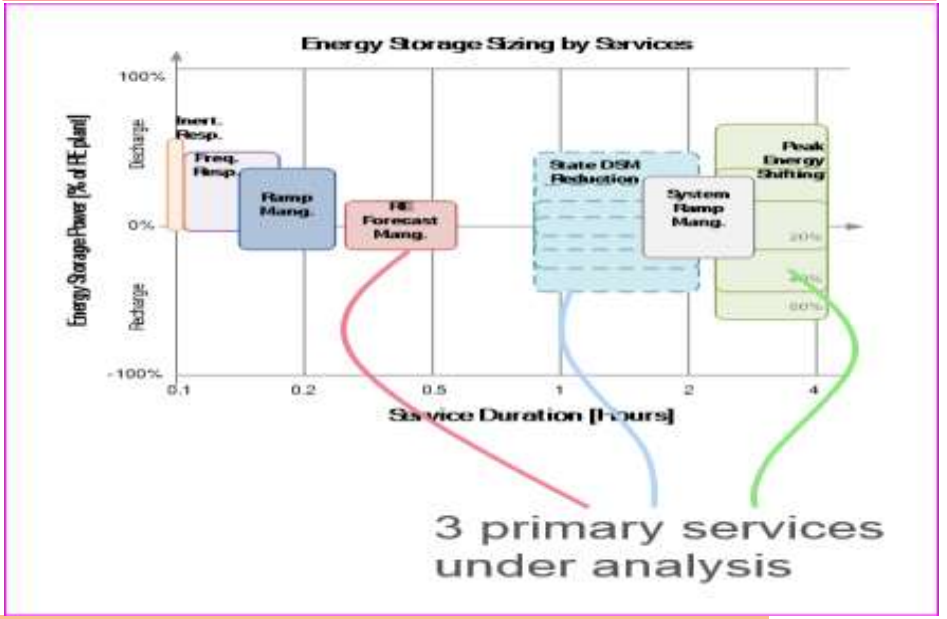


Potential Monetizable Benefits for various Energy Storage services?

Energy Storage provides various benefits that could be stacked, for which otherwise CTU/STU/Discoms/System Operators incur cost for reliable power & grid stability.

- Ancillary services
  - Voltage support , Frequency support, Black start support
- Spinning reserve
- Energy generation Time Shift
  - Making renewable generation plant as a peaking power plant
- Scheduling of variable generation from Wind and Solar PV
  - Making variable generation dispatchable and reducing Grid Operator's need for quick balancing power
- Peak demand reduction
- Benefit of T&D network deferment
  - By deferring need to replace or to upgrade existing T&D equipment and/or to increase the equipment's existing service life
- Transmission network congestion relief
- Back-up power
  - Offsetting costly power diesel generators
- Reliable power in decentralized/local grids
- Reduction in RE evacuation cost

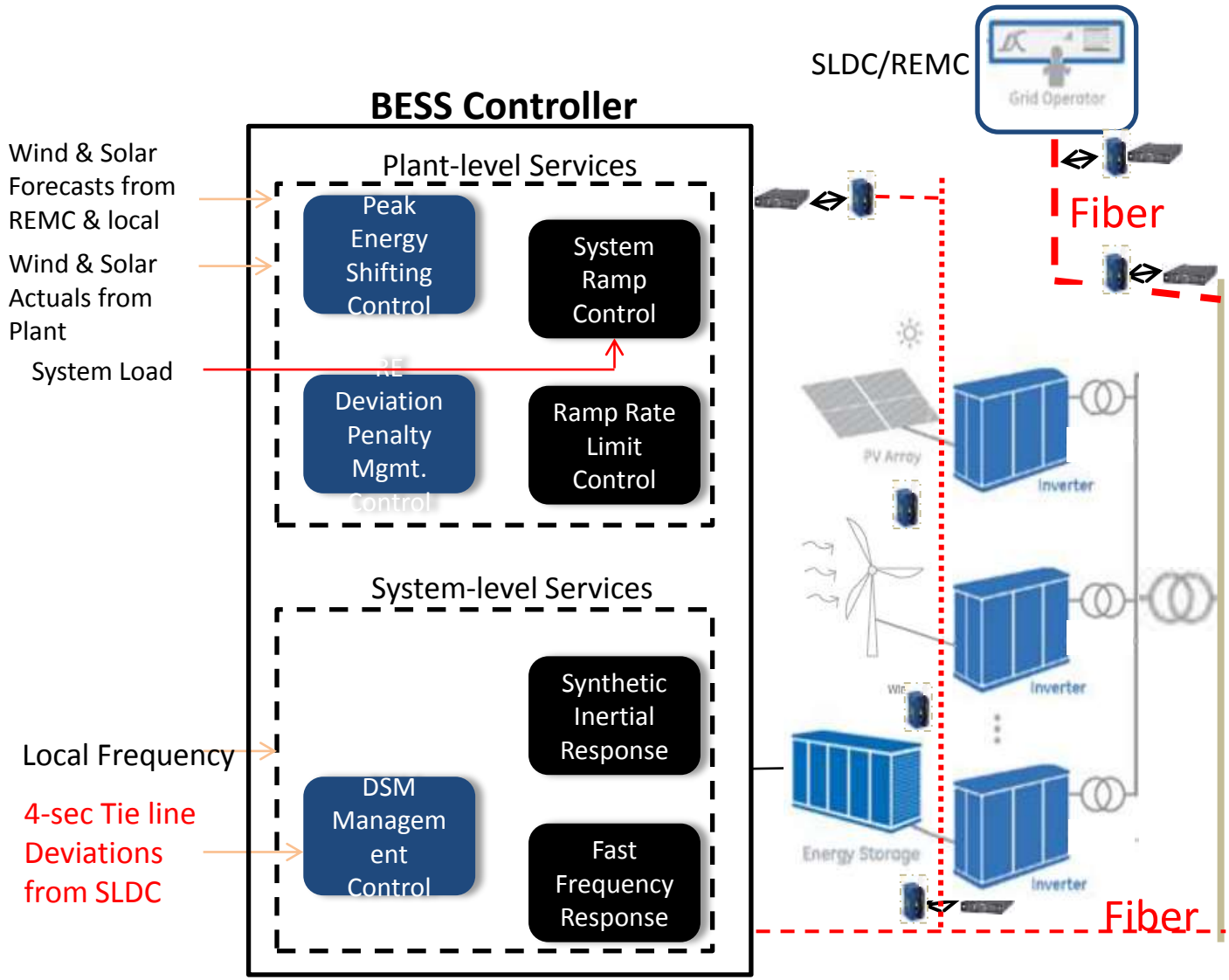




Due Regulatory Treatment is needed to evaluate how these benefits could be translated to evolve viable policies for enabling commercial deployment of Energy Storage

10

System Architecture- Energy Storage co-located with Wind-Solar Plant



KEY TAKEAWAYS

- Technically, BESS is capable of providing various plant and system level services with the highest performance
- Regulations need to be in place
- BESS costs are declining faster than solar PV costs… BESS now is at same inflection point as solar PV was in 2010
- Policies such as mandates and incentives will be needed to bridge the gap between revenues and costs initially

Points for discussion to substantiate the business cases for Energy Storage

For (a) Inertia & Frequency Response and (b) Load Following/Ramping

1. Will the current mechanism of meeting this service/requirement be adequate in a future system with high RE penetration?
2. Would there be a benefit in allowing alternate resources such as BESS to provide this as a service in the future?
3. Would it be feasible for SLDC to procure the above services as a standalone services?
4. What are some options for pricing this type of services?

For (a) Peak Energy Shifting & (b) Ramp Control

1. Is there a business case for providing renewable energy with guaranteed energy during peak load hours , say 6pm to 10 pm?
2. Can state Discoms pay preferential tariff for firm peak power from RE and Ramp up/down control?
3. In the absence of TOU rates, what could be an alternate pricing mechanism for Peak Energy Shifting such as using the avoided cost of a peaking power plant as the basis?

For DSM Charge Management

1. Would there be any value for VRE-rich states to use RE co-located BESS to reduce DSM penalties?
2. When will the transition to AGC for frequency regulation take place?
3. Would it be feasible for SLDC to procure the above services as standalone services from any resource?
4. What are some options for pricing this type of services? Would some kind of a cost sharing or (penalty) savings sharing scheme work?

Frequency regulation (Ancillary market)

1. Can this sort of a procurement mechanism be implemented in India? Is this part of the AGC roadmap being considered by CERC/SERCs to be implemented by April 1, 2017?
2. What policy and regulatory changes are needed to enable SLDCs to call for this service?

How will the generation delivered from energy storage plant count towards the RPO obligations? Any multiplier REC kind of treatment possible like in South Korea..

Policy & Regulatory issues for consideration

At the proposed Electricity (Amendment) Bill 2014		
Clause No.	**Particulars**	**Suggestion**
2 (vi)	'(15A)"decentralised distributed generation" definition	Clause should include deployment of appropriate energy storage devices when clubed with VRE
2 (xi)	'(23 A) "Electricity Distribution Code" means the Electricity Distribution Code specified in section 50	Should include Energy Storage devices to support carraige & content model adoption
2 (xix)	'(57A) " renewable energy sources" definition	Renewable energy sources to be differenctiated btw firm & non firm sources
6	In section 7(1), and clause (b) of section 73 definition of spinning reserve	Non-generating capacities like energy storage devices should be included as part of the spinning reserves definition
45	In section 79 of the principal Act, in sub-section (1), for clause (C)…to regulate inter-state transmission…smart grid, ancillary services…	Energy Storage devices need to be also considered

- **IEGC code related**
  - Section 2.5.2, prohibits indirectly CTU to deploy Energy Storage devices (as they cannot be in generation/trading)
  - Section 3.4 (e), does not list employment of Energy Storage devices as a means for STU & CTU for voltage management
  - Not clear if DISCOM/STU/CTU were to employ Energy Storage Devices to defer S/s or T&D line enhancement, whether it can be part of their ARR
- **Tariff Policy related**
  - Quantifying the value of plant level services that can be offered like peaking reserves, reduce State DSM penalties, Grid Ancillary services, etc.
  - Price the system level benefits that is rendered like Inertia & Primary response, meeting the Energy/Capacity/Ramp needs, etc.
  - Price the ability to serve load by DISCOM/STU reliably without shedding load/generation
  - Introduce Time of Use tariff for generation and consumption as well

Thanks!

rajsekhar.b@ilfsindia.com
9717822199

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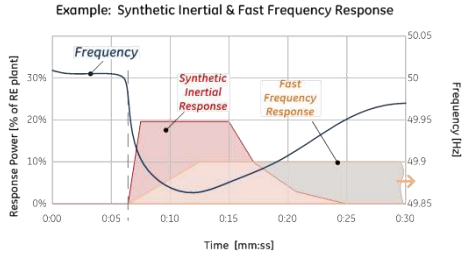
Required Regulatory and Policy considerations

- **Enable alternate resources (like co-located Energy Storage batteries) to provide a market based services**
  - **Ramping/Load Following Reserves**
    - Enable Ramping/Load Following as a separate service that can be contracted by the SLDC (similar to CAISO Flexi Ramp product in US)
  - **Peak energy Shaving**
    - Enable procurement of peak energy from RE as separate service contracted by the SLDC (similar to Southern California Edison (SCE) capacity procurement in US)
  - **DSM Charge management**: Allow co-located Energy Storage devices with VRE projects to reduce DSM penalties of RE-rich states
  - **Peak Shaving**: Shifting the dispatch of VRE generation thru' co-located Energy Storage to reduce evening peak loads
- **Introduce Time of Use (ToU) tariff for both consumption and Generation**

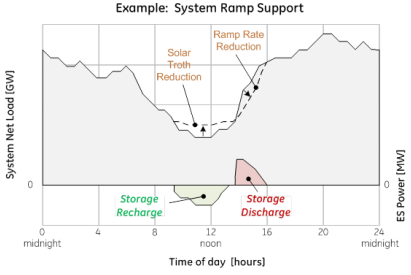
Can SLDC procure bundled service from BESS enabling stacking of services?

Inertia and Frequency Response



DSM Charge Management

Load Following/ Ramping



RE Peak Energy Shifting

BESS with 2-4 hrs. of storage can perform all services

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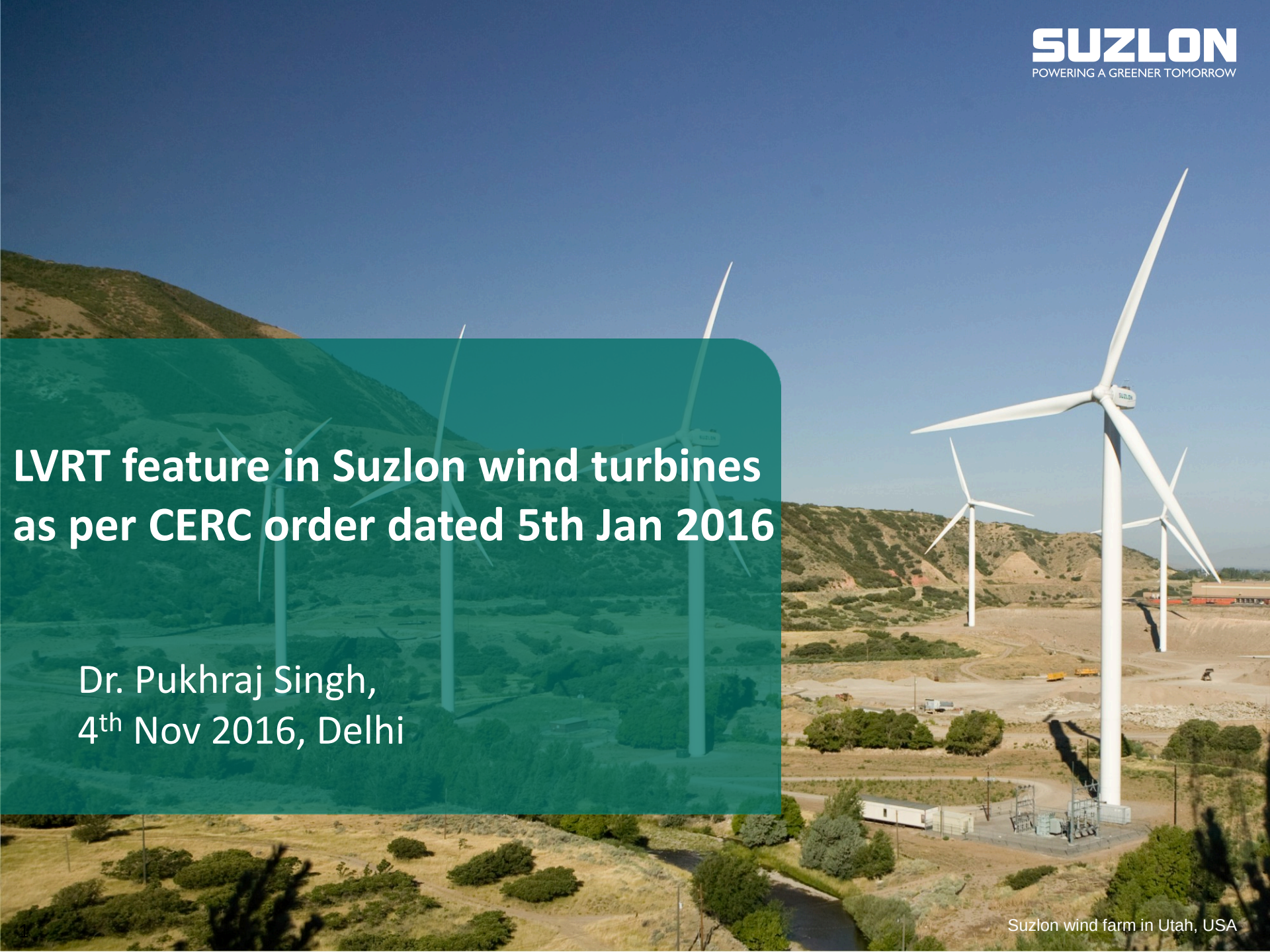
LVRT feature in Suzlon wind turbines as per CERC order dated 5th Jan 2016

Dr. Pukhraj Singh,
4th Nov 2016, Delhi

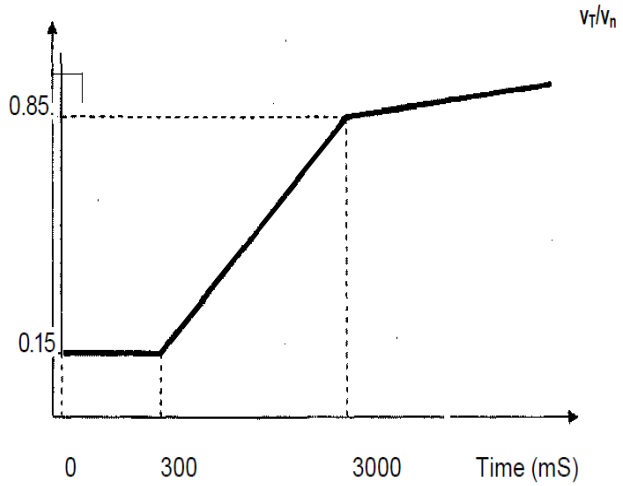


Suzlon wind farm in Utah, USA

CERC order dated 5th Jan 2016: Regarding LVRT feature

1. **LVRT should be implemented for all wind turbines (except Stall Types) commissioned before 15.04.2014 having installed capacity equal to or more than 500 KW within 2 years**
   - **Wind turbines commissioned before 15.4.2014 should ride thru voltage dips as per below LVRT curve**

(3) Wind generating stations connected at voltage level of 66 kV and above shall remain connected to the grid when voltage at the interconnection point on any or all phases dips up to the levels depicted by the thick lines in the following curve:



Where

V/V_n is the ratio of the actual voltage to the nominal system voltage at the interconnection point

Suzlon understand that LVRT feature required at individual wind turbine level only,

CERC requested to confirm that no active or reactive power injection required during faults for turbines commissioned before 15.4.2014

CERC order dated 5th Jan 2016: Regarding LVRT feature

3. **Type Test Certification (in case of LVRT retrofitting) for all WTGs as per applicable Standards should be made mandatory. The modalities for carrying out Type Test Certifications including timeline for completing the process for certification, cost sharing, etc., shall be finalized by the respective Regional Power Committee in consultation with CEA**
4. **In case of wind turbines of less than 500 kW and installed before 15.04.2014 (except stall types), CEA is directed to conduct a study regarding technical feasibility of installation of LVRT in these turbines and submit a report to the Commission within 6 months of issue of this order**
5. **The cost of retrofitting WTG's with LVRT feature to be recovered through revising tariff under the provision of 'Change in Law' in the respective PPAs**

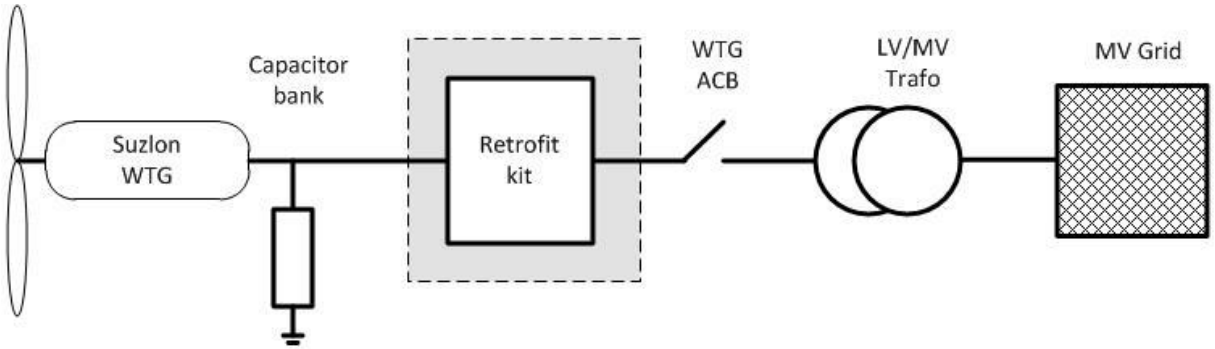
Turbine type certificate for S88, S82, S6x and S52 models as per new guidelines not possible

Statement of grid compliance for LVRT feature from certification agencies like DNV-GL can be provided,

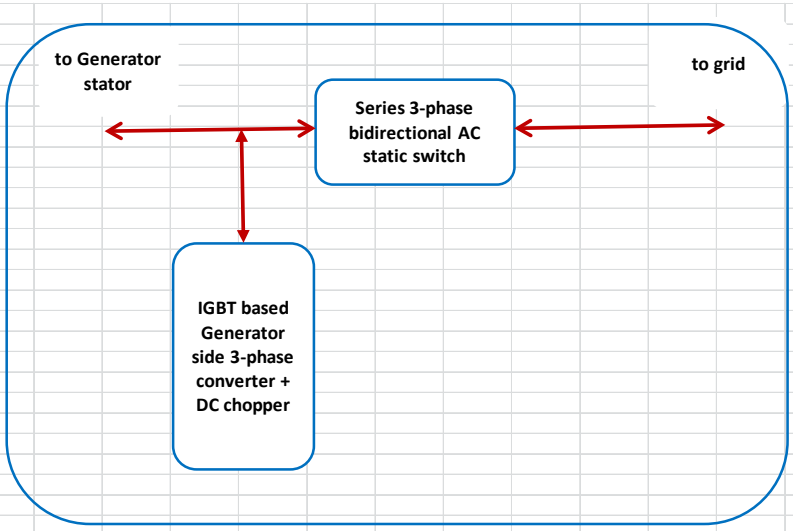
CERC requested to accept the statement of grid compliance

LVRT Solution for S6x (1.25MW) and S52 (600KW)

Suzlon Energy Ltd.



Single line diagram of LVRT feature addition (no active & reactive power injection during faults)



Block diagram of LVRT retrofit kit

Principle of operation:

1. In normal operation, AC ststic switch are closed, generator is directly connected to grid and generate active power
2. Upon fault detection, AC static switch are opened in <20msec,
3. The generator side converter is switched on and it provide rated voltage to generator, the active power is dissipated in chopper resistor,
4. No active or reactive power is supplied to grid during low voltage or fault condition
5. Upon grid voltage recovery or fault clearance, the converter is switched off, AC static switch are turned on and generator is synchronised to grid
6. The active & reactive power equal to prefault level is fed to grid
7. Wind turbine ride thru low voltage condition

The wind turbine characteristics not affected,
However energy losses increased upto 1%,

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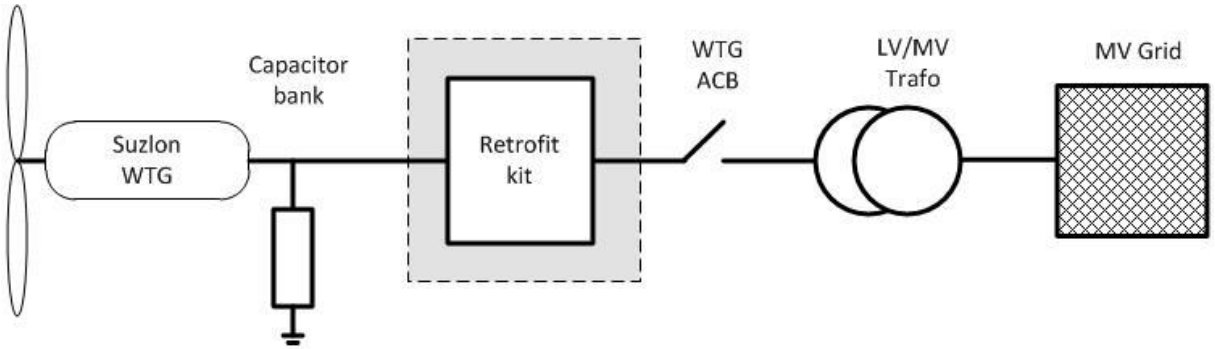
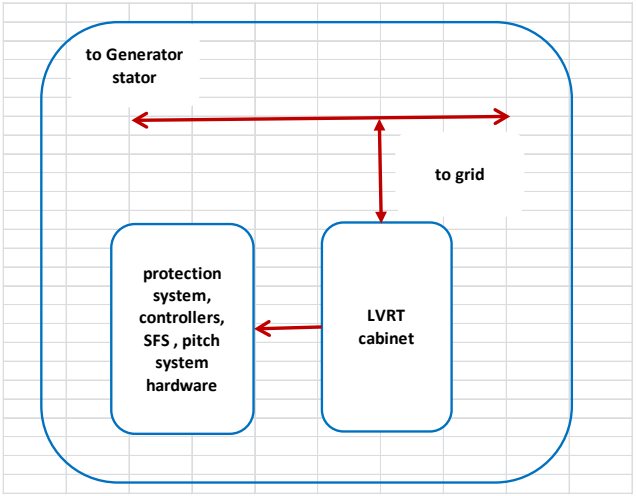
LVRT retrofit Solution for S88 (2.1MW) and S82 (1.5MW

Suzlon Energy Ltd.



Single line diagram of LVRT feature addition



Block diagram of LVRT retrofit kit

Principle of operation:

1. The generator remain connected to grid,
2. LVRT cabinet ensures that all the electrical, electronics and control functions are powered and are not affected by voltage dips.
3. Based on residual voltage, active and reactive power would be supplied to grid.
4. Wind turbine will ride thru low fault as slong as voltage in within defined LVRT curve

No additional energy loss in turbine due to addition of LVRT feature,
Tailor made solution to be developed based on turbine models

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LVRT Solution implementation time lines

WTG's with operation life < 15 years on 05.01.2016 and commissioned before 15.04.2014

WTG model type	Rated Power (kW)	Number of turbines
S52	600	757
S6X	1250	2425
S82	1500	1784
S88	2100	619

Technical solution development and its testing expected to be completed not before June 2018 since LVRT testing can only be accomplished during high wind season (need mimimum 4 LVRT campaign covering complete wind profile).

The retrofit in turbines could take up to 3 years after solution being tested.

Hence overall program not likely to finish before 2020

Timeline for implementation needs to consider time for testing and retrofit activity for a large number and variety of turbines,

Clarifying questions

- **The proposed solution is solely to address low voltage ride thru requirement of grid.**
- **Type certification of turbines with LVRT capability is not possible. However, compliance certificate for each turbine type can be furnished.**
- **Whether CERC or its nominated agency shall approve the technical solution before hand and investing big money on development**
- **Whether CERC shall define the additional tariff to investors to recover this addional capital expenditure towards LVRT**
- **How this additional tariff mechanism shall be implemented by respective SERC / DISCOMS**
- **Whether a different additional tariff shall be defined for every WTG depending upon Capex and residual operational life**
- **It would be better if a joint meeting with few customers & SERC is called by CERC to understand their perspective as well**
- **For S52 and S6X WTGs commissioned after 15-04-2014, a complete solution defined as per Order is practically not possible. However a partial solution as defined for WTGs commissioned before 15-04-2014 is possible.**
- **Depending upon the lead time for development of tailore made solution for each WTG model as well various approvals and huge quantity of more than 5000 WTGs, implementing the solution by 2018 seems quite challanging**

Final agreement on scope of solution and payment to solution provider shall be critical to the success of the project

Suzlon wind farm in Paracuru, Brazil

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