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

Venue : Upper Ground Floor
CERC, New Delhi

Date : 11-01-2019

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

1. The Twenty-Third meeting of Standing Technical Committee was held on 11th January 2019. CERC/ FOR Chairperson, Shri P.K. Pujari chaired the Meeting. Dr. M.K Iyer, Member, CERC, welcomed all the members of the Committee and special invitees. Former Chairperson of the Committee, Shri A.S. Bakshi (former Member of CERC) also attended the meeting as special invitee.
2. Thereafter the agenda items were taken up for discussion:-
3. **Discussions on the Agenda items**

Agenda Item No. 1: Confirmation of Minutes of the 22nd Technical Committee Meeting

The Technical Committee endorsed the minutes of the 22nd Technical Committee Meeting, held on 1st November 2018.

Agenda Item No. 2: Status of implementation of SAMAST and Regulations on Forecasting, Scheduling & Deviation Settlement

- Update by Consultant

- Update in respect of other States by respective Members

a. The Consultant (Idam Infra) made a presentation (**Annexure-II**) on the SAMAST implementation, Forecasting & Scheduling and DSM Regulations at State level for various States.

b. The Consultant updated on State-wise status on SAMAST DPR, F & S Regulations and DSM Regulations. It was highlighted that 14 States have submitted DPR for SAMAST implementation out of which 4 DPRs have been approved. Remaining 18 States are either still preparing their DPRs or have not

started yet. The Committee suggested that POSOCO may expedite the process of approving DPRs through Monitoring Committee of PSDF.

c. Shri. K.V.S. Baba, CMD, POSOCO updated that a total of 19 DPRs have been submitted and the Appraisal Committee is finalizing the standard rates as well as rationalization of the meters to expedite the approval process. He also updated that these Standards would be finalized in the next NPC meeting and once approved the same would be communicated to the States.

d. Standing Technical Committee was told that several large States such as Uttar Pradesh, Uttarakhand, Jharkhand and Odisha have not yet started preparing DPR for SAMAST implementation. Dr. Iyer Suggested to have a special session with the States which have not prepared DPR for SAMAST implementation. He also suggested that the Committee meeting may be planned in these States.

e. Further, the Consultant highlighted that 21 States have come up with either Draft or Final Forecasting & Scheduling Regulations (5 Draft and 16 Final). While 8 States have notified the DSM Regulation and in 6 States, the DSM Regulations are at draft Stage. The Consultant also highlighted proposed revision in Model DSM Regulations in line with the 4th Amendment to CERC Regulations.

f. Joint Chief (RA), CERC suggested to have a full agenda on this item in the next meeting of the Committee to consider required revision in Model FOR DSM Regulations in view of the recent 4th Amendment in CERC DSM Regulations. He also suggested to include operational difficulties in implementation of DSM Regulations at State Levels.

g. The Consultant also pointed out that the existing Contract of the Consultant to support the Standing Technical Committee is valid only upto March 2019. The Committee recommended extension of the term of the Consultant for one more year.

Update in respect of other States by respective Members

Kerala: Chairperson KSERC provided updates on SAMAST and F&S Regulation for the State of Kerala. He highlighted that Kerala has already started the process of preparing DPR for SAMAST implementation. He also updated that the State has prepared the draft 'Kerala State Electricity Regulatory Commission (Forecasting, Scheduling, Deviation Settlement and Related Matters of Solar and Wind Generation Sources) Regulations, 2018,' based on the FOR Model Regulations. He also highlighted that the Regulations would be finalized based on the recommendation of the sub- group on issues of Aggregators/ QCA of the Standing Technical Committee.

Action points/ Decisions

i. *The Committee decided to have a seperate agenda item on DSM in next Technical Committee Meeting.*
ii. *The Committee agreed to have special session with States which have not yet initiated action on SAMAST implementation such as Uttar Pradesh, Uttarakhand, Jharkhand and Odisha.*
iii. *The Committee recommended extension of the term of the Consultant to support Technical Committee for one year more.*
iv. *The Committee also requested the consultant to update on RPO webtool of the States.*

Agenda Item No. 3: Grid Scale Storage: Economics, Regulation and the Future of Thermal Investments

a. Joint Chief (RA), CERC and Dr. Amol Phadke made presentations on primary findings of a joint study on Grid Scale Storage. (**Annexure-III**). This study is part of joint collaboration of FOR & LBNL under MoU between FOR and LBNL.

b. Dr. Amol Phadke of LBNL emphasized that with recent trend of decline in battery cost and low cost PPAs between battery storage providers and Utilities, the battery storage is becoming preferred and economical option in the US. He highlighted the recent development in the State of California where storage has replaced 3 California gas plants. He also mentioned that with increase in RE penetration in the grid, storage would soon become cost effective to meet shoulder demand in the system during evening peak.

c. According to him, by year 2025, the value of standalone storage could become competitive enough to replace thermal capacity addition. He estimated that with the help of storage technologies, India can save substantial capital investment by avoiding almost 58 GW of new coal capacity (assuming capex for battery ESS at $100/kWh in 2025). However, he emphasized that battery storage needs initial push and support to achieve economies of scale and low prices.

d. JC(RA) stated that policy and regulatory intervention is required to promote storage. He highlighted the importance of mandate for adequacy requirement to assess seasonal and diurnal variation and corresponding least cost dependable power procurement plan. The Storage technology could play a significant role in assessment of adequacy requirement and providing Ancillary Service even at State level. He also suggested that regulatory intervention like

that in California may be explored to procure Ancillary Service by system operator for promotion of storage technology. He also suggested having a presentation by POSOCO on adequacy requirement in the next FOR Meeting since it has been one of the most discussed topics in the FOR.

e. TNERC Chairperson informed the situation of open access in the State of Tamil Nadu and the difficulties in tariff determination for the distribution utilities on behalf of open access consumers and CGPs. It was suggested that one dedicated meeting of the Standing Technical Committee may be organized to understand the issues around captive and open access consumers. It was also suggested that TNERC chairperson may present a study in this regard. During the discussion, it was highlighted that the future thermal capacity addition would be to assist the shoulder demand in the system and battery technology would be cost effective to meet this future shoulder demand.

Action points/ Decisions

•*The Committee appreciated the joint study and suggested to go in detail to compare different storage options like pumped storage etc. to suggest cost effective options for system reliability.*

Agenda Item No. 4: Australian Experience with respect to Distributed Energy Resources (DER)

a. MERC Member, Shri. Mukesh Khullar presented on the Australian experience with respect to Distributed Energy Resources (DERs) based on his recent study tour to Australia. (**Annexure –IV**). He highlighted recent development in Australia to manage grid reliability with increased penetration of asynchronous generation like solar and wind and lessons to learn for India.

b. He stated that DER aggregators are becoming reality in Australia in a big way and battery deployment for creating micro grids present unique opportunities to sustainably reach remote locations. He also informed that structural reform has been undertaken in Australia to create National Energy Market in which system operator does load forecasting and schedules power at 5-minutes time-block.

c. He pointed out that DERs have created several opportunities with democratization of generation, peer to peer trade, reduced network losses and implementation of blockchain technology. He also explained the concept of decentralized energy exchange (dex) to promote peer to peer electricity trading through DERs.

d. He also informed about the concept of making “Micro-grid Available As a Service” (MAAS), an initiative by Tech Mahindra of India to make quality power accessible to remote tribal hamlet/ hilly areas. He recommended that similar initiative may help to provide quality power to remote hamlets in India.

e. He also stressed on the need for real-time monitoring of the system security with high penetration of RE including DERs especially for RE rich States. He emphasized the need of registering DERs for real time monitoring of such disruptive technology and showed readiness on behalf MERC to undertake any study in this regard to understand the role of DERs.

Action points/ Decisions

- *The Committee appreciated the presentation by the Member MERC and decided to invite Tech Mahindra in meeting of Standing Technical Committee for sharing the concept of MAAS.*

Agenda Item No. 5: Status update on implementation of Pilot Study on 5-Minute Scheduling, Metering, Accounting and Settlement; and Fast Response Ancillary Services (FRAS)

a. Shri S.R. Narasimhan, Director(POSOCO) presented the update on the two pilot studies (on 5-minute scheduling and FRAS) as directed by the CERC through its suo motu order dated 16th July 2018. (Annexure –V). POSOCO informed that for implementation of 5-minutes scheduling, procurement of metering is still in progress by CTU and the same would be in place in the next three (3) months or so. However, POSOCO informed that the pilot study on the implementation of FRAS has been implemented since 26th November 2018.

b. He highlighted that a meeting was organized with all stakeholders on 31st October 2018 to understand the complexities and to evolve a consensus for broad-based solutions, for implementation of FRAS. He informed that constraints provided by the hydro stations have been honoured and beneficiary schedules have not been disturbed for implementation of the pilot as directed. He highlighted the importance of pilot study to address frequency spike at hourly boundaries by participation of hydro projects in FRAS. He also informed that 20 hydro projects with total of 75 generating units are participating in the FRAS. He also informed that out of 20 hydro projects, 19 hydro projects have Francis Turbine with forbidden zone for operation and all such constraints collected from the hydro generators have been considered for implementation of the pilot project.

c. He also provided overview of information process to incorporate final schedule of FRAS and mentioned that total energy dispatched under FRAS has been squared off by the end of the day. He mentioned that during the first month of implementation of FRAS, instructions of maximum "Regulation UP" is 427 MW and maximum "Regulation DOWN" is 600 MW. Total mark-up for the hydro generators during the same period is around Rs. 4.6 lakh. He highlighted the challenges in implementation of the pilot project. He also stated that small residual energy are left during some days because some units are committed for some other use and he suggested compensating plant energy charge on D+ 1

to handle the same. He revealed that the initial result shows improvement in the frequency but also suggested a longer time period to assess the impact of FRAS on frequency improvement.

d. On key learning on the pilot, it was mentioned that initial results are very positive and few more months of experience would be helpful in enriching the experience on FRAS. On the pilot of 5-minutes scheduling, it was hoped that required metering would be in place soon and the same would be updated accordingly.

Action points/ Decisions

•*The Committee noted the status update on FRAS implementation and suggested to expedite the implementation of 5 minutes scheduling, accounting and settlement and also recommended to continue the pilot for six months.*

Agenda Item No. 6: Areas of Co-operation between Centre for Energy Regulation (CER) and SERCs

a. Dr. Anoop Singh made a presentation (Annexure –VI) and informed that Centre for Energy Regulation (CER) is an initiative by Department of Industrial and Management Engineering, IIT Kanpur which has been actively engaged in education, research, capacity building, consulting and policy advisory in the energy/ power sector. He further explained the objectives behind the CER which include enhanced regulatory-academia- utility interactions, develop knowledge base and database repository related to power sector for informed and evidence-based policy and regulatory decisions. He highlighted that CER has received seed funding under DFID of the United Kingdom and informed the Committee about the activities of the CER.

b. He also detailed different activities under CER covering Regulatory Research, Knowledge Database and Institutional Capacity Building.

c. On the list of ongoing activities, he mentioned that CER publishes quarterly newsletter on the development in the regulatory field and circulated a copy for information of members of the Committee. He informed that the newsletter tracks regulatory development across all states to provide regulatory information at one place. He also mentioned about online discussion forum of the CER and informed about one such discussion on offshore wind.

d. He also informed about the Regulatory Research Camp organized by the CER for representatives of different Regulatory Commissions, Utilities and academia on long term demand forecasting and power procurement planning.

e. He mentioned about the MoU signed with Florence School of Regulation (FSR), Florence, Italy and common symposium organized in October 2018.

f. On the issue of potential area of cooperation, he stated that these may be activities around creating Regulatory database in public domain and on benchmarking. He proposed Regulatory Officers in Residence (ROIR) program in which regulatory officers can spend about 3-5 days at CER. He also requested members to nominate officers for ROIR program which according to him would help in capacity building of Regulatory officers on a continuous basis.

g. The Member MERC mentioned about the institute of policy research and recent initiative taken by MERC to estimate agriculture consumptions. He also volunteered to nominate some regulatory officers for Regulatory Research camp as a pilot which can be replicated with other SERCs later.

Action points/ Decisions

- *The Committee noted the presentation and it was agreed that the framework of Regulatory Officers in Residence program (ROIR) and Regulatory Research Camp should be gainfully utilized by the Regulatory Commissions.*

5. JC(RA) extended vote of thanks to all participants and special invitees for enriching discussions on the agenda items.

Annexure-I

LIST OF PARTICIPANTS AT THE TWENTY THIRD MEETING OF TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL HELD ON 11TH JANUARY 2019 AT CERC, NEW DELHI

1	Sh. P.K. Pujari, Chairperson	CERC
2	Sh. Akshaya Kumar, Chairperson	TNERC
3	Sh. Preman Dinraj, Chairperson	KSERC
4	Dr. M.K. Iyer, Member	CERC
5	Sh. A.S. Bakshi, Former Member	CERC
6	Sh. P.J. Thakkar, Member	GERC
7	Sh, Mukesh Khullar, Member	MERC
8	Sh. H.M. Manjunatha, Member	KERC
9	Sh. Sanoj Kumar Jha, Secretary	CERC
10	Sh. S.C. Shrivastava, Chief (Engg.)	CERC
11	Sh. S.K. Chatterjee, Joint Chief (RA)	CERC
12	Sh. K.V.S. Baba, CMD	POSOCO
13	Sh. S.K. Soonee, Advisor	POSOCO
14	Sh. Ramakantha, Consultant (Technical)	KERC
15	Sh. S.R. Narasimhan, Director (SO)	POSOCO
16	Dr. Anoop Singh, Associate Professor	IIT Kanpur
17	Ms. Rashmi Nair, Deputy Chief (RA)	CERC
18	Sh. Ajit Pandit, Director	IDAM
19	Sh. Anupam Kumar, Manager	POSOCO
20	Sh. Nilesh Singh	IDAM
21	Sh. Amul Phadke	LBNL
22	Sh. Ravindra Kadam, Advisor (RE)	CERC
23	Sh. D. Rajagopal	LBNL
24	Sh. Arun Kumar, Assistant Secretary	FOR
25	Sh. Neeraj Singh Gautam, Research Officer	CERC
26	Sh. Tanay Tarany, Research Associate	FOR

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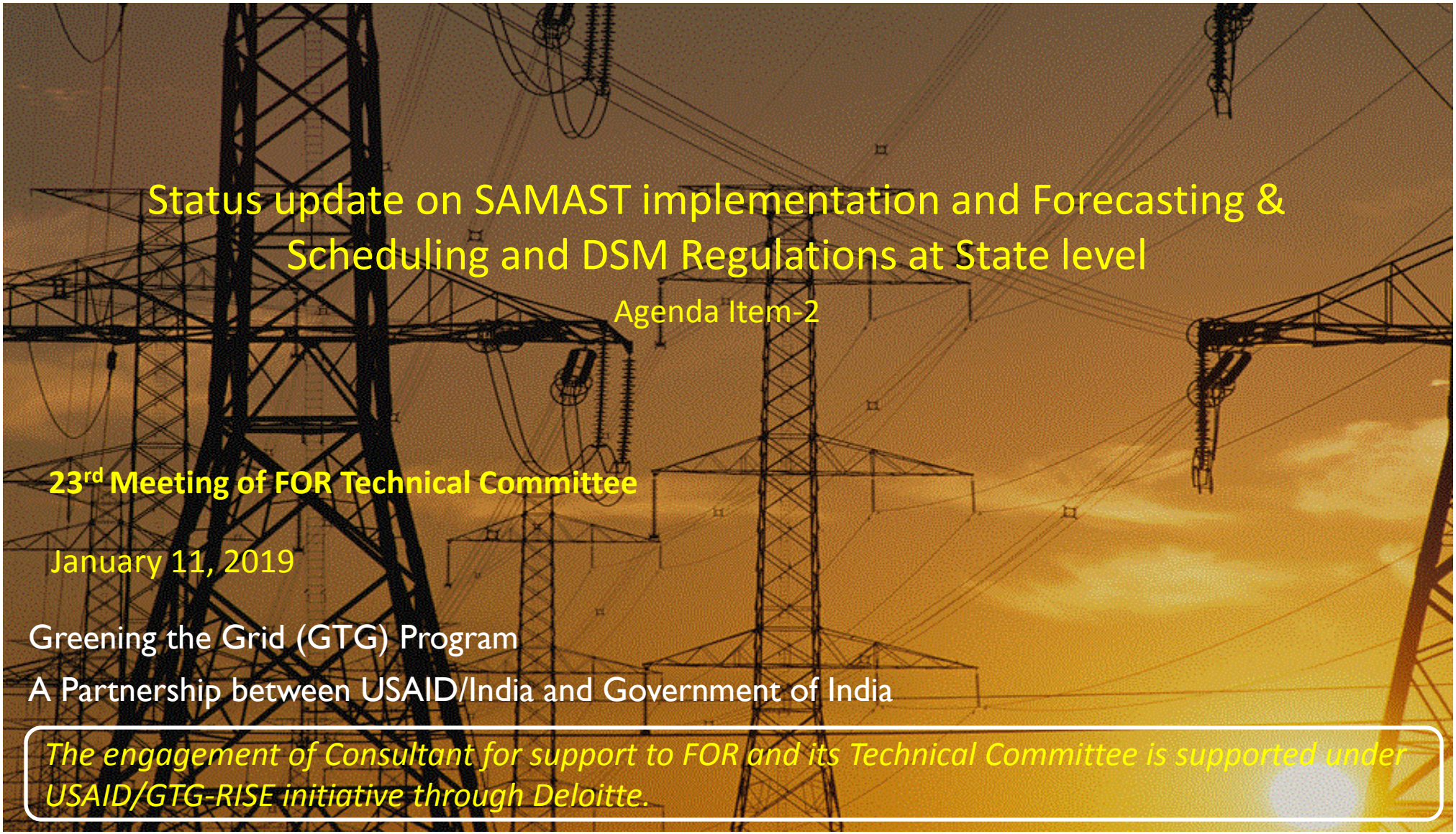

Status update on SAMAST implementation and Forecasting & Scheduling and DSM Regulations at State level

Agenda Item-2

23rd Meeting of FOR Technical Committee

January 11, 2019

Greening the Grid (GTG) Program

A Partnership between USAID/India and Government of India

The engagement of Consultant for support to FOR and its Technical Committee is supported under USAID/GTG-RISE initiative through Deloitte.

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- **Proposed Revisions in Model DSM Regulations in line with 4th Amendment to CERC DSM Regulations**

Status Update of State Specific Activities

- Region wise Summary
- North Region
- West Region
- South Region
- East Region
- North-East Region

Summary of status SAMAST, F&S and DSM Regulations (as on Jan 2019)

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States	SAMAST DPR			F&S Regulations			DSM Regulations		
Region	DPR Submitted	DPR approved	Yet to Prepare (or WIP)	Notified	Draft Published	Yet to initiate regulatory process	Notified	Draft Published	Yet to initiate (or WIP)
North	3 HP, HR & PB	1 RJ	4 UK, UP, J&K, DL	3 RJ, UP, UK	2 HR, PB	3 DL, J&K, HP	4 HP, DL,RJ, UK		4 J&J, PB, UP, HR* *Draft prepared
West	1 MP	-	4 GJ, MH, CG, Goa	3 CG, MP, MH	1 GJ	1 Goa	3 GJ, CG, MP	1 MH	1 Goa
South	2 KA, TS	2 AP, TN	1 KL	3 AP, KR, TS	1 TN	1 KL		1 TN	4 AP, KR, TS* KL * Draft prepared
East	1 BR	1 WB	3 JH, OR, SK	2 JH, SK	1 OR	2 BR, WB		2 WB, OR	3 JH, SK, BR
North-East	7 AR, AS, MN, ML, MZ,NL, TR			5 AS, MN, ML, MZ,TR		2 AR,NL	1 ML	2 AS, TR	4 AR, MN, MZ,NL
UT			6 CH, PY, DD, DNH, LD, AN			6 CH, PY, DD, DNH, LD, AN			6 CH, PY, DD, DNH, LD, AN
TOTAL	14	4	18	16	5	15	8	6	22

Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

States	SAMAST	F&S Regulations	DSM Regulations
Northern Region			
Chandigarh	• Intrastate entities identified • No. of interface points identified	• Yet to be initiated	• Yet to be initiated
Delhi	• Delhi Transco Ltd. has initiated SAMAST implantation in the State on 6th December, 2017	• Yet to be initiated	• ABT mechanism is implemented from April, 2007 in line with CERC UI framework.
Haryana	• DPR Submitted to PSDF (21 Mar, 2018). • PSDF Queries addressed (Sept, 2018) • under scrutiny by PSDF committee	• **Draft** published on (17th Jan, 2018) • SOR submitted by consultant(June,18) • 2nd Public consultation by HERC on 9th Aug, 2018	• Draft prepared and submitted by consultant on (Aug, 2018) • HERC is reviewing the Draft for public consultation
Himachal Pradesh	• Revised DPR Submitted to PSDF (8th Oct, 2018) • under scrutiny by PSDF committee	• Not initiated • (No major Wind and Solar Resources in the state)	• **Notified** (16th Oct, 2018) in line with FOR Model and CERC DSM Regulations.
Jammu & Kashmir	• Intrastate entities identified • No. of interface points identified	• Yet to be initiated	• Yet to be initiated

Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

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States	SAMAST	F&S Regulations	DSM Regulations
Northern Region			
Punjab	• DPR Submitted to PSDF (19 Nov, 2018)	• **Draft** published (June, 2018) • SOR by consultant(July,18) • Public hearing on 9th Sept, 2018 • SOR by Consultant(20 Oct18 and 15 Dec, 2018)	• Yet to be initiated
Rajasthan	• SAMAST implantation initiated in the State. • DPR submitted to PSDF of INR 13.54 Crs. 29 Aug2016 • DPR approved by PSDF Committee May,2017(INR11.86 Crs.) • 84% of work completed by RVPN	• **Notified** (14th Sept, 2017) in line with Model F&S Regulations. • Implementation from	• **Notified** (08th Nov, 2017) • **Draft Amendment to DSM** Regulations published on 3rd Jan2019 in line with 4th Amendment to CERC DSM Regulations • Comments upto 24th Jan 2019
Uttar Pradesh	• Intrastate entities identified • No. of interface points identified	• **Notified** (12th Dec, 2018) in line with Model F&S Regulations	• Yet to be initiated
Uttarakhand	• Intrastate entities identified • No. of interface points identified	• No separate F&S Regulation for RE generators. • Scheduling in mandatory under DSM Regulations	• **Notified** (6 Feb, 2017) in line with FOR model DSM Regulations

Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

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States	SAMAST	F&S Regulations	DSM Regulations
Western Region			
Chhattisgarh	• Implementation initiated on 3 Nov, 2016	• **Notified** (7th Nov, 2016) under DSM Regulation	• **Notified** (7th Nov, 2016) in line with CERC DSM Regulations
Daman & Diu	• Intrastate entities identified • No. of interface points identified	• Yet to be initiated	• Yet to be initiated
D.N Haveli	• Intrastate entities identified • No. of interface points identified	• Yet to be initiated	• Yet to be initiated
Goa	• Not Initiated	• Yet to be initiated	• Yet to be initiated
Gujarat	• Implementation initiated (30 July, 2018)	• **Draft** (13th Jan, 2017) • SOR Preparation in progress	• DSM mechanism implemented in line with CERC DSM Regulations (17 Feb 2014)
Madhya Pradesh	• Implementation (Oct, 2018). • DPR submitted for 5 Min ABT meters at existing interface points (INR 6.68 Cr) • DPR under scrutiny.	• Notified (20th April, 2018) in line with FOR Model Regulations	• **Notified** (18 Sept, 2015) in line with CERC DSM Regulations
Maharashtra	• Implementation initiated (13 Oct, 2017	• **Notified** (20th July 2018) inline with Model F&S Regulations. • F&S Procedure approved by MERC (7 Dec, 2018)	• ABT mechanism (2007)- FBSM • **Draft DSM Regulations published on 23 Oct, 2018.** • Finalisation of DSM Regulations in progress. • In line with Model DSM and CERC DSM Regulations.

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Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

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States	SAMAST	F&S Regulations	DSM Regulations
Southern Region			
Andhra Pradesh	• DPR Submitted (6 Apr,17) for INR 52.72 Crs • **DPR approved (2 May,18) for INR 19.36 Crs.**	• **Notified** (21 Aug, 2017) in line with Model F&S Regulations. • Implementation initiated	• Balancing and Settlement Code implemented as on 11 Aug, 2006 for OA only.
Karnataka	• DPR Submitted (22 Dec, 2017) INR 43.34 Crs • Under scrutiny	• **Notified** (31 May, 2016) • Implementation from 1st June 2017.	• ABT mechanism implemented from 20 June, 2006 for OA only
Kerala	• Implementation initiated	• Draft under preparation	• Yet to be initiated
Tamil Nadu	• DPR approved INR 11.98 Crs • Implementation initiated on 17 July, 2018	• **Draft published** (28th Dec, 2017). • SOR submitted May, 2018. • Revised Draft and clarifications submitted to the TNERC on 24 Dec, 2018	• **Draft published** (28th Dec, 2017) . • SOR submitted (June, 2018) • Clarification and revised Draft submitted in Nov, 2018
Telangana	• DPR Submitted (11 Oct, 2017) INR 84.64 Crs • Under scrutiny	• **Notified** (30th May, 2018) • F&S Procedure submitted to the TSERC by TSSLDC in Dec, 2018	• Draft submitted to TSERC by consultant (Aug, 2018) • Revised draft in line with CERC DSM Amendment submitted to TSERC (15 Dec18)
Puducherry	Status not available	• Yet to be initiated	• Yet to be initiated

Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

States	SAMAST	F&S Regulations	DSM Regulations
Eastern Region			
Bihar	• DPR Submitted (27th Feb, 2018) INR 93.76 Crs. • Under scrutiny	• Regulatory Process initiated by the Commission	• Regulatory Process initiated by the Commission
Jharkhand	• No information available	• **Notified** (28th Sept, 2016)	• Balancing and settlement mechanism for OA (28 Jan, 2010)
Orissa	• Implementation initiated (5 Dec, 2017) • DPR yet to submitted.	• Draft Published on 23 Sept, 2015 under DSM Regulations	• Draft published (23rd Sept, 2015)
West Bengal	• DPR Submitted (22nd Dec, 2017) INR 25.96 Crs • DPR Approved in Aug, 2018	• Yet to be initiated	• **Draft** balancing and settlement code published (23rd Feb, 2017)
Sikkim	• Status not available	• **Notified** (19th April,2018)	• Yet to initiated

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Status of SAMAST implementation, F&S and DSM Regulations (as on Jan 2019)

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States	SAMAST	F&S Regulations	DSM Regulations
North-Eastern Region			
Arunachal Pradesh	• DPR submitted (30 May, 2018) for INR 13.43 Crs • Under-scrutiny, queries responded	• Yet to be initiated	• Yet to be initiated
Assam	• DPR submitted (30 May, 2018) for INR 18.53 Crs • Under-scrutiny, queries responded	• **Notified** (6th Sept 2018)	• **Draft Published** (2Nov 2018) • SOR under preparation
Manipur	• DPR submitted (23 April, 2018) for INR 24.60 Crs • Under-scrutiny, queries responded	• **Notified** (9th Aug 2016)	• Yet to be initiated
Meghalaya	• DPR submitted (31 May, 2018) for INR 18.77 Crs • Under-scrutiny, queries responded	• **Notified** (31st Oct 2018)	• **Notified** (5th Nov 2018)
Mizoram	• DPR submitted (30 May, 2018) for INR 18.26 Crs • Under-scrutiny, queries responded	• **Notified** (9th Aug 2016)	• Yet to be initiated
Nagaland	• DPR submitted (30 May, 2018) for INR 18.72 Crs • Under-scrutiny, queries responded	• Yet to be initiated	• Yet to be initiated
Tripura	• DPR submitted (4 June, 2018) for INR 15.12 Crs • Under-scrutiny, queries responded	• **Notified** (18 Nov 2016)	• **Draft published** (20th July 2016)

Proposed Revisions in Model DSM Regulations in line with 4th Amendment to CERC DSM Regulations

Proposed Revisions in Model DSM Regulations in line with 4th Amendment to CERC DSM Regulations (1/2)

Parameters	CERC 4th Amendment, 2018	Model DSM Regulations, 2017	Proposed revision in Model DSM Regulations
Additional Definitions	• Introduction of Definition of Area Clearing Price (ACP), • Day Ahead Market (DAM) • Revision of def. of Time-block	• No Provision	• Definitions of ACP and DAM to be Incorporated
Frequency Band	• 49.85 Hz to 50.05Hz	• 49.70 Hz to 50.05 Hz	• To be revised to 49.85 Hz to 50.05Hz
Charges for Deviation and DSM Price Vector	• Dynamic slope by joining the price points at 50 Hz. (daily simple average ACP), charges at 49.85 Hz (Rs. 8/kWh) and 50.05 Hz (zero) on a daily basis. • Cap rate for the charges for deviation for the generating stns. whose tariff is determined by the Commission shall be equal to its energy charges as billed for the previous month.	• DSM Price vector linked to frequency (Paise 178/unit at 50 Hz) and differential slope Paise 35.60/unit from 50 to 50.05 Hz and Paise 20.84/unit from 49.7 to 50 Hz • Cap rate for the charges for Deviation for the generating stations regulated by CERC	• In line with 4th Amendment to CERC DSM Regulations • DSM Price Vector and slope to be revised
Cap Rate	• Rs.8.00/kWh	• Rs.8.24/kWh	• Proposed to revise to Rs.8.00/kWh

Proposed Revisions in Model DSM Regulations in line with 4th Amendment to CERC DSM Regulations (2/2)

Parameters	CERC 4th Amendment, 2018	Model DSM Regulations, 2017	Proposed revision in Model DSM Regulations
Limits on Deviation volume & Consequences of crossing limits	• **Additional Proviso:** Total deviation from schedule in energy terms during a day shall not be in excess of 3% of the total schedule for the drawee entities and 1% for the generators and additional charge of 20% of the daily base DSM payable / receivable shall be applicable in case of said violation . • (applicability of above clause within 1 year – by separate notification)	• No such provision	• May be adopted by SERCs at the later stage of implementation of DSM Regulations in the State.
Provision of Change in Sign (Zero Crossing)	• Provision of Sign Change once within 12 time blocks is revised to once within 6 time blocks . • Violation shall attract, Additional Charges of 20% on daily base DSM payable as against 10%	• Sign Change, at least once, after every 6 time blocks. • Violation shall attract, Additional Charges of 10% of Deviation Charges payable.	• In line with 4th Amendment to CERC DSM Regulations.
Annexure 1	• Cap Rate being equivalent to the energy charges as billed for the previous month	• The Additional Charge for Deviation ……..Cap Rate for Deviations of 303.04 Paise /kWh …..	• In line with 4th Amendment to CERC DSM Regulations.

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- **RISE Contracting Officer Representative: Monali Zeya Hazra**, USAID India, mhazra@usaid.gov
- **Chief of Party: Shubhranshu Patnaik**, RISE, spatnaik@deloitte.com

Grid scale storage: Economics, regulation, and the future of thermal investments

Dr. Amol Phadke (LBNL) & Dr. Sushanta K Chattarjee (CERC)

FOR Technical Committee Meeting

Jan 11, 2019

Major research inputs from Dr. Nikit Abhyankar & Shruti Deorah, LBNL

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CERC

Introduction to Lawrence Berkeley National Laboratory

Managed by the University of California for the United States Department of Energy

Lawrence Berkeley National Laboratory

13 — Nobel Prizes
13 — National Medal of Science recipients
4,200 — Employees
200 — Site acreage

- **Dedicated to solving the most pressing scientific problems facing humankind**
  - Basic science for a secure energy future
  - Science of living systems to improve the environment and energy supply
  - Understanding and control of matter and energy in the universe
  - Translation to applied energy programs
- **Build and safely operate world-class scientific facilities**
- **Train the next generation of scientists and engineers**

Outline

1. Large grid scale storage projects: Highlights of recent developments in the US
2. Grid scale storage in India: Need-value, costs, and timelines
3. Storage policy-regulation and and future strategy

1. Large grid scale storage projects: Highlights of recent developments in the US

BRIEF

Storage will replace 3 California gas plants as PG&E nabs approval for world's largest batteries

AUTHOR
Gavin Bade
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PUBLISHED
Nov. 9, 2018

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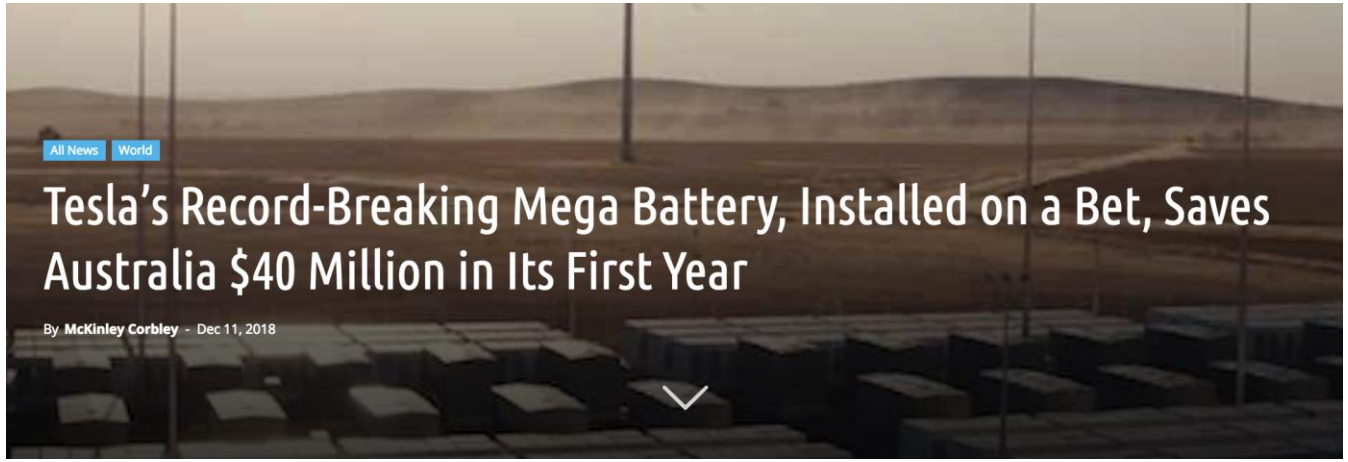
Dive Brief:

- The California Public Utilities Commission on Thursday approved four energy storage projects for Pacific Gas & Electric (PG&E) to replace retiring gas generators, including two batteries that would be the largest in the world.
- The CPUC granted approval for a total of 567.5 MW / 2,270 MWh of storage, including a 300 MW / 1,200 MWh project from Vistra Energy and a 182.5 MW / 730 MWh project from Tesla that the utility would own. Those batteries, once completed, would be the two largest in service.
- The CPUC directed PG&E to purchase the storage in January instead of approving new ratepayer-funded contracts for three gas plants in PG&E's service area. Analysts told Utility Dive the cost of the batteries is likely cheaper than continuing to operate the plants.

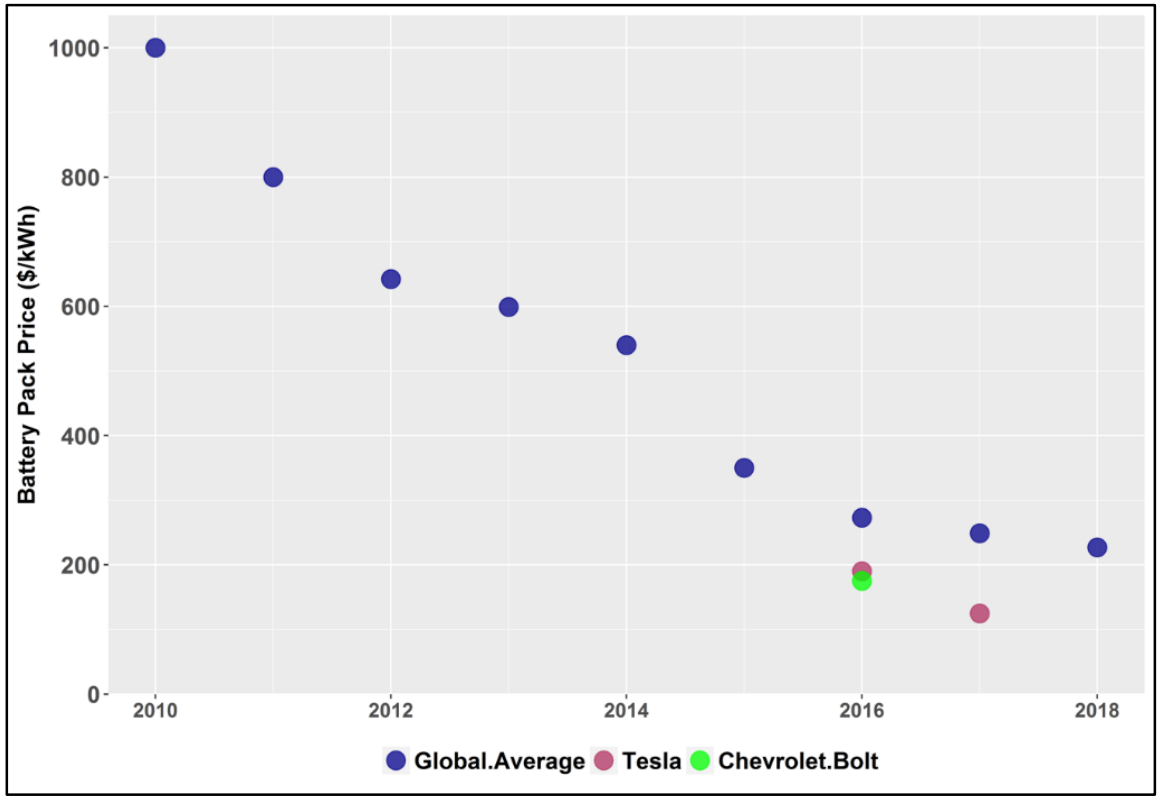
Elon Musk: I can fix South Australia power network in 100 days or it's free

The Tesla founder says he can build a 100MW battery storage farm within 100 days or provide the system free of charge

▲ Elon Musk has weighed into the South Australia energy debate by issuing a challenge to the state's government. Photograph: Shannon Stapleton/Reuters

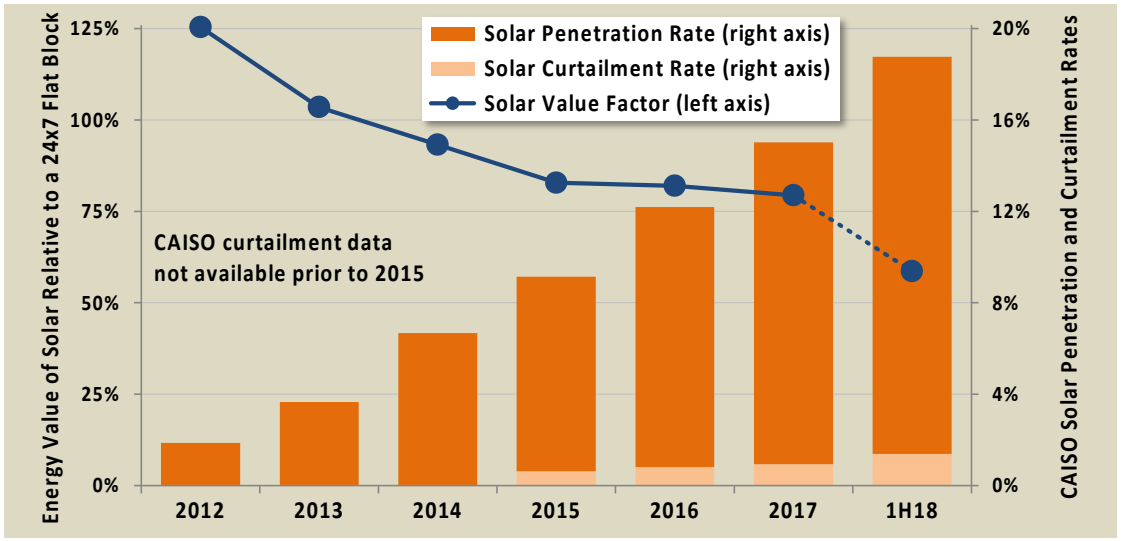


Drivers of grid scale battery storage: 1. Dramatically declining battery prices 2. Increasing need due to RE & uncertain load 3. Storage mandate



Battery prices have dropped more than 80% since 2010 and are projected to decline further

Source: BNEF, 2018 & LBNL



- To mitigate the declining value of solar to the power system – duck curve: enable peak shaving with solar
- Cheaper way to meet/address system reliability; ancillary services; transmission constraints
- Fast deployment option to deal with demand uncertainty

Several solar + storage PPAs being signed to restore the declining value of solar

State	Project			Actual or Expected COD (PV/Battery)	Capacity (MW-AC)		Battery Storage		Battery:PV Capacity Ratio	% of PV MWh used to charge	Levelized PPA Price (2017 $/MWh)
	Name	Sponsor	Offtaker		PV	Battery	Hours	MWh			
HI	Kapaia	Tesla	KIUC	Apr-17	13	13	4.0	52	100%	85%	117.7
FL	Babcock	NextEra	FPL	Dec-16/Mar-18	74.5	10	4.0	40	13%	9%	N/A
FL	Citrus	NextEra	FPL	Dec-16/Mar-18	74.5	4	4.0	16	5%	4%	N/A
AZ	Pinal Central	NextEra	SRP	Apr-18	20	10	4.0	40	50%	25%	67.7
HI	Lawai	AES	KIUC	Oct-18	20	20	5.0	100	100%	71%	87.8
TX	Castle Gap	Luminant	Luminant	Jun-18/Dec-18	180	10	4.2	42	6%	3%	N/A
HI	West Loch	HECO	HECO	Dec-18	20	20	4.0	80	100%	67%	N/A
MN	Ramsey/Athens	Engie/NextEra	Connexus	Dec-18	10	15	2.0	30	150%	57%	?
HI	Molokai	MNEP	MECO	Jun-19	4.88	3	5.0	15	61%	43%	140.0
HI	Kekaha	AES	KIUC	Sep-19	14	14	5.0	70	100%	77%	84.0
AZ	Wilmot	NextEra	TEP	Dec-19	100	30	4.0	120	30%	15%	[illegible]
CA	Desert Harvest II	EDF-RE	SCPPA	Dec-20	70	35	4.0	140	50%	24%	LMP (+$15.25)
AZ	Redhawk(?)	First Solar	APS	Jun-21	65	50	2.7	135	77%	26%	?
NV	Battle Mountain	Cypress Creek	NV Energy	Jun-21	101	25	4.0	100	25%	12%	22.8
NV	Dodge Flat	NextEra	NV Energy	Dec-21	200	50	4.0	200	25%	13%	23.5
NV	Fish Springs Ranch	NextEra	NV Energy	Dec-21	100	25	4.0	100	25%	13%	26.4

Solar + 4 hour storage at 25% peak capacity ~ Rs 2/kWh for 2021 delivery

Source: Bolinger et. al 2018, LBNL

Aggressive bidding with several projects and bids: Xcel utility solicitation 87 bids, 69 projects, 16 GW capacity

RFP Responses by Technology

Generation Technology	# of Bids	Bid MW	# of Projects	Project MW	Median Bid Price or Equivalent	Pricing Units
Combustion Turbine/IC Engines	30	7,141	13	2,466	$ 4.80	$/kW-mo
Combustion Turbine with Battery Storage	7	804	3	476	6.20	$/kW-mo
Gas-Fired Combined Cycles	2	451	2	451		$/kW-mo
Stand-alone Battery Storage	28	2,143	21	1,614	11.30	$/kW-mo
Compressed Air Energy Storage	1	317	1	317		$/kW-mo
Wind	96	42,278	42	17,380	$ 18.10	$/MWh
Wind and Solar	5	2,612	4	2,162	19.90	$/MWh
Wind with Battery Storage	11	5,700	8	5,097	21.00	$/MWh
Solar (PV)	152	29,710	75	13,435	29.50	$/MWh
Wind and Solar and Battery Storage	7	4,048	7	4,048	30.60	$/MWh
Solar (PV) with Battery Storage	87	16,725	59	10,813	36.00	$/MWh
IC Engine with Solar	1	5	1	5		$/MWh
Waste Heat	2	21	1	11		$/MWh
Biomass	1	9	1	9		$/MWh
Total	430	111,963	238	58,283		

Solar + storage median bid price ~ Rs 3/kWh (adjusted for 30% ITC subsidy)for higher capacity storage

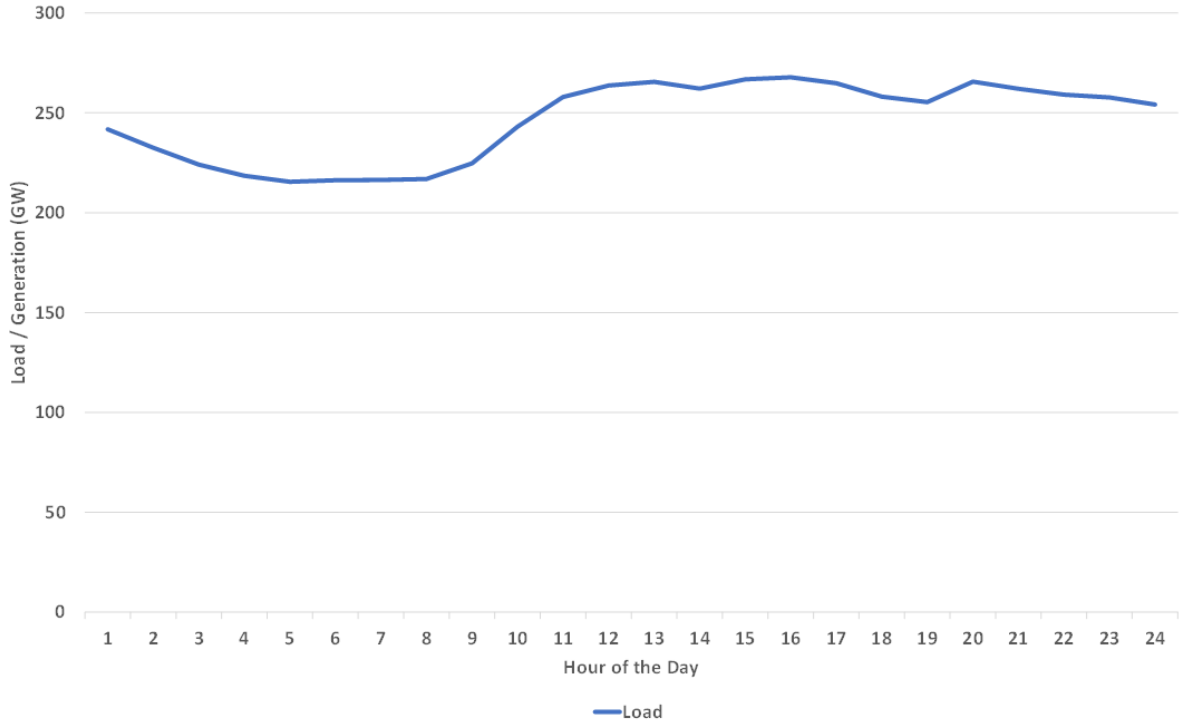
2. Grid scale storage in India:

- **Need/value**
- **Costs**
- **Timelines**

Need/value of grid scale battery storage in India

1. Effective alternative to thermal to meet shoulder demand
2. Solar + storage as a short lead-time and modular option to deal with inherent uncertainty in demand
3. Grid reliability – ancillary services – transmission congestion
4. Learning and future cost reduction

Future of thermal capacity needs to be assessed carefully

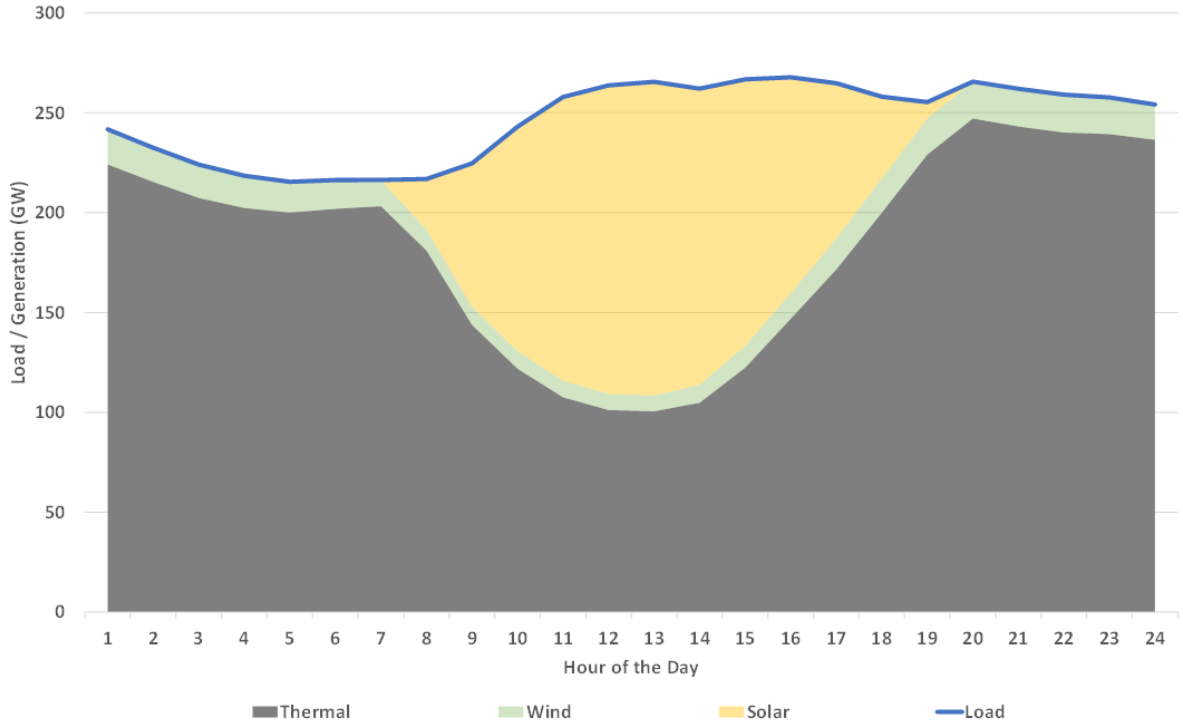


The chart shows projections for average hourly load in April 2027 (national)

Peak Load ~290 GW (May)

April has the highest residual load

Future of thermal capacity needs to be assessed carefully

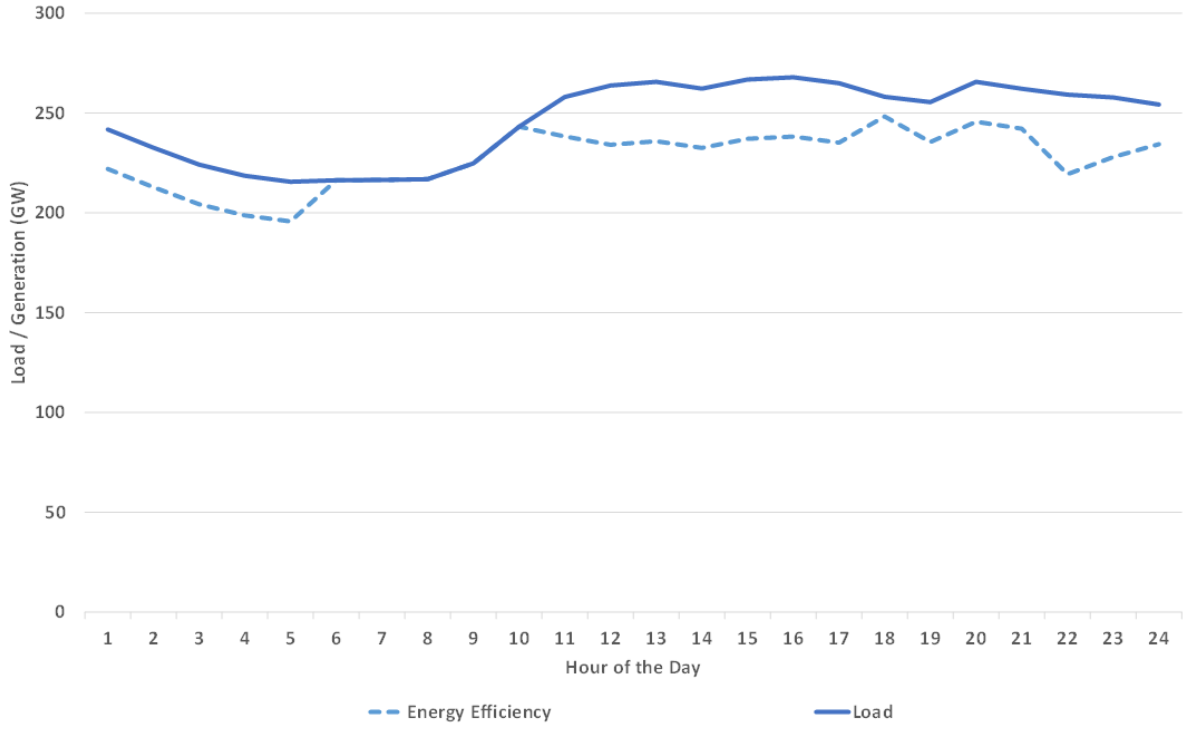


Current plans include installing ~275 GW of RE by 2027

RE generation during evening peak is small

⇒ Peak thermal capacity requirement = ~250 GW

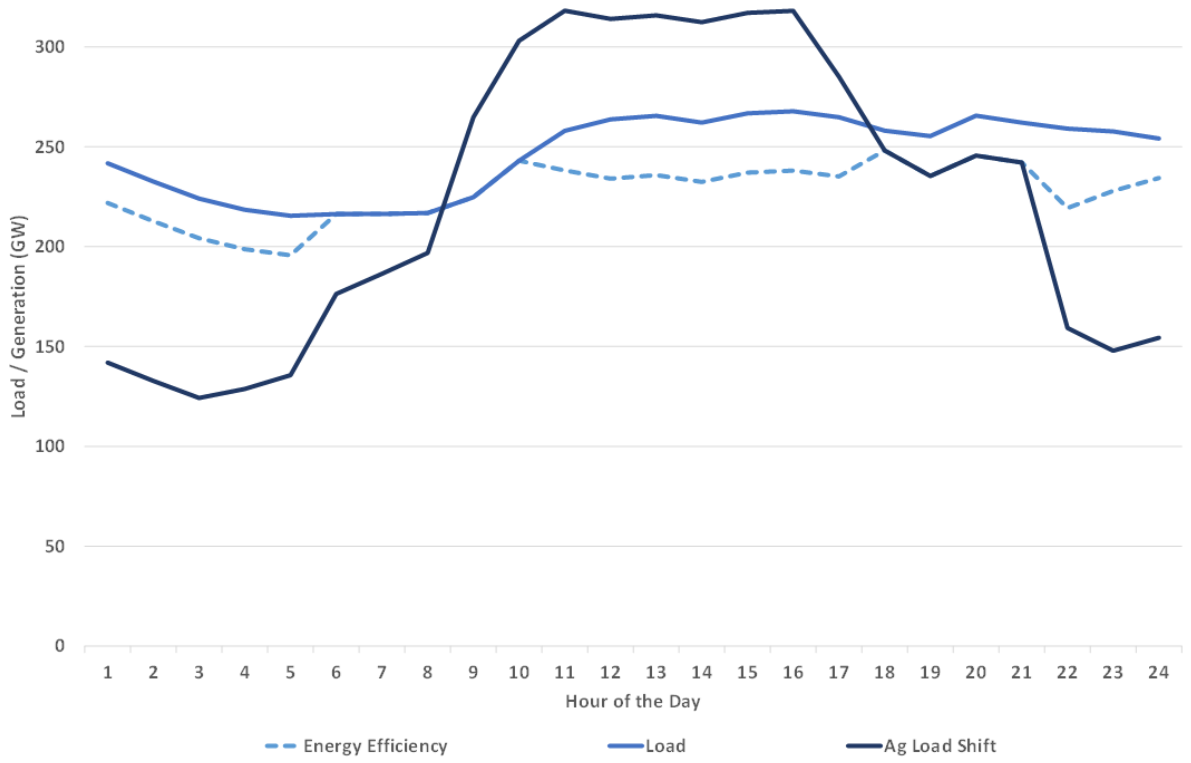
Future of thermal capacity needs to be assessed carefully



Let's look at an alternative scenario.

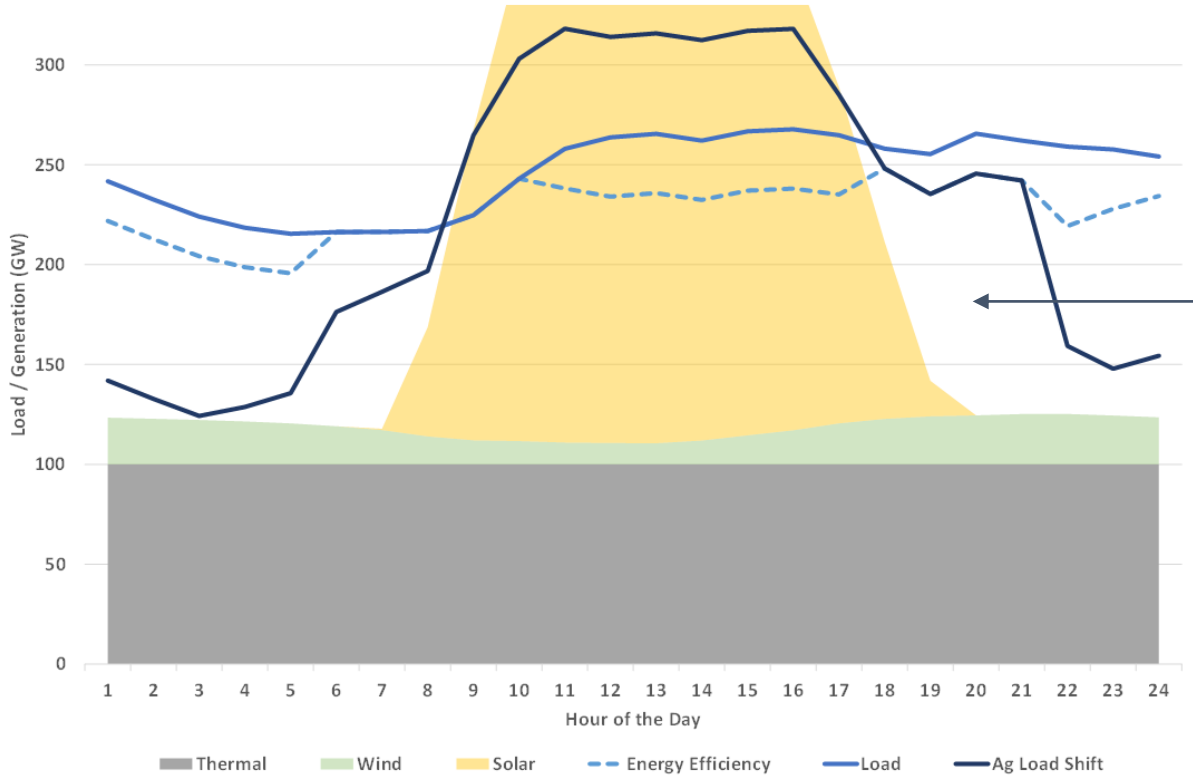
Appliance energy efficiency can avoid significant load during evening peak and night

Future of thermal capacity needs to be assessed carefully



Shifting of agricultural load to day-time can reduce the night-time load by ~60-80 GW (in peak months) - with corresponding increase in the day-time load

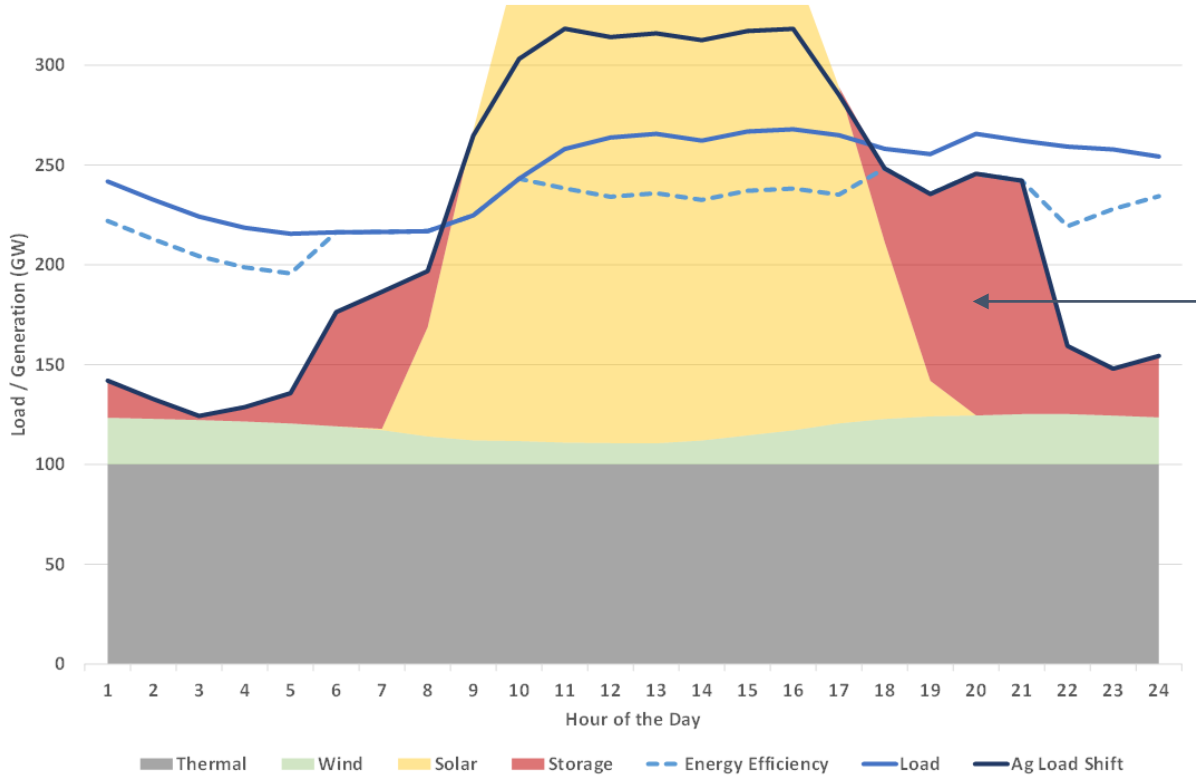
Future of thermal capacity needs to be assessed carefully



This can enable higher solar penetration

But ~150GW of thermal capacity will have to operate at ~20% capacity factor

Future of thermal capacity needs to be assessed carefully



Solar+storage can replace ~100-150 GW of new thermal capacity

ESTIMATING THE COST OF GRID LI-ION STORAGE FOR INDIA

- The cost ratios from Solar PV analysis are applied to BoS, installation and soft costs of a battery ESS in the US*:

		US		INDIA	
Stand alone storage	**Units**	**2020**	**2025**	**2020**	**2025**
Discharge	hours	6	6	6	6
Power	MW	1	1	1	1
Battery pack	$/kWh	130	88	130	88
BoS hardware	$/kWh	24	14	12	7
Soft Costs	$/kWh	10	5	3	2
EPC	$/kWh	13	9	5	4
Capex	$/kWh	177	115	150	100
Capex	$/kW	1060	691	901	597

* Avg of base & best case scenario numbers are used

LEVELIZED COST OF STORAGE (LCOS) at scale by 2025

- Capital cost of $100/kWh in 2025 is then translated to LCOS with the following assumptions:
- Life of battery : 10 yrs
- Depth of discharge : 90%
- Residual project value : 10%
- Annual degradation : 1%
- # of cycles per year : 365

If we assume 30% of battery capacity required vis-à-vis renewable generation, tariff adder would be
~ Rs.1.04/kWh

- Levelized Cost of Storage (Rs./kWh)
- Fixed Cost 3.22
- Variable Cost 0.22
- Total Cost 3.46

CAPITAL COST SAVINGS WITH STORAGE IN 2025

- Assuming capex for Battery ESS at $100/kWh in 2025, India can save over INR 60,000 crores in capital investment by avoiding 58 GW of new coal capacity.

Potential Capex Savings by avoiding new coal capacity		
Capex for Storage (2027)		
~100	$/kWh	2025 estimate is used as build out over time
45.35	$ Billion	For 458 GWh of BESS
317,443	Rs. crores	@Exch Rate Rs 70/USD
Capex for Coal		
6.5	Rs crores/MW	Assumed constant at 2018 Rupees
378,027	Rs. crores	For 58 GW coal capacity avoided
Savings in capex		
60,585	Rs. crores	Additional savings in variable costs TBD

* Assuming Capex for new coal constant at Rs. 6.5 Crores/MW in 2018 Rs & Exchange Rate of Rs 70/USD.

3. Storage strategy, pathway, and policy-regulation

Big picture

- If low cost storage/ solar + storage (~ Rs 3-4/kWh) is realized in India it provides
  - Effective alternative for peak-intermediate load power – which is challenging to do with coal
  - Viable alternative fast response ancillary service
  - Fast deployment alternative to deal with uncertain demand that leads to shortage or overcapacity
- Timeline – having this option well proved in next 2-3 years provides another option in the next investment cycle to meet incremental demand of 50 GW from 2022-27
- Initial push and support is required to achieve economies of scale and low prices
- Finding areas where storage can solve todays problems with view of potentially much greater role in the future is needed – Time shifting, Ancillary Services, etc

Policy and regulatory options for deployment

- Adequacy requirement mandate
  - Time of day/Seasonal demand assessment and corresponding least cost dependable power procurement plan
    - Valuing storage and providing guidelines for procurement
  - Storage mandate (CA requires utilities to procure 5 GWh of storage capacity by 2020)
- Reserves requirement assessment – Exploring alternatives (including storage as an option) for replacement of high cost ‘Reliability must run’ resources (refer to CA experience) – Need for cost benefit analysis.
- Rewarding fast response through ancillary services market – enabling all resources including storage to compete for this segment. (Can/Should the system operators be asked to procure part of such services requirement?)
- Fiscal incentives

Thank You

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Distributed Energy Resources

Key Learnings from Australia

IEX study tour 10th to 15th February to Sydney and Melbourne

Mukesh Khullar
Member, MERC

Context

- **Solar roof-top** promotion through net metering or net billing causing losses for utilities
  - DER aggregators in Australia
- **Battery** deployment for creating **micro grids** present unique opportunities to sustainably reach remote locations
  - 'Microgrid as a service' available with *Power Ledger* in Australia
- Due consideration of increased penetration of asynchronous generation on **system security**
  - RE rich SA system blackout experience of 28 Sep 2016
  - 'New Rules for System Security Market Framework' by AEMO

Structural reforms - 2011

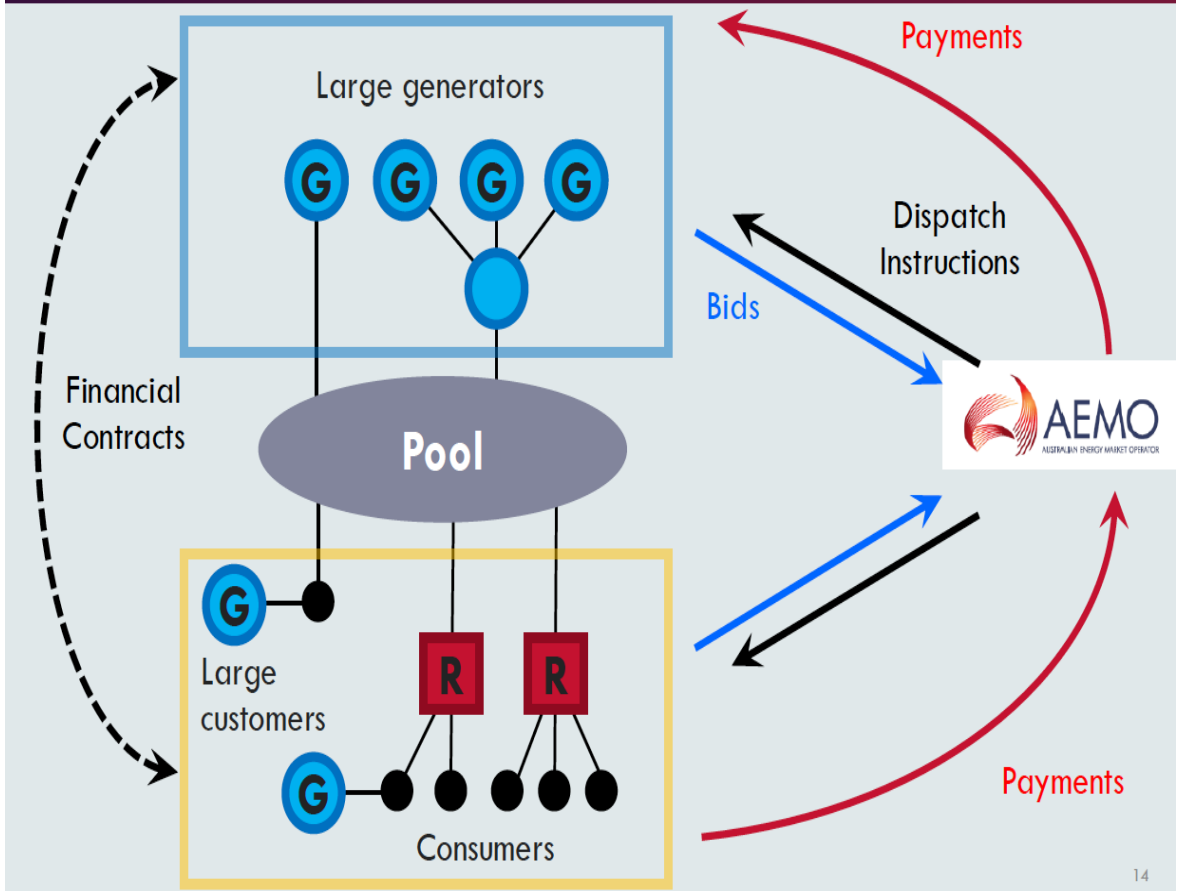
Unique aspects of Australian Electricity Market

- Creation of **National Energy Market**
  - Energy only market, no capacity market
  - Load forecasting done by system operator and not by DLs or retailers
  - Only generators bid a day ahead for supply of energy in **5 minutes time slots**
  - Market operations for AES by the system operator
  - Retailers have economic **'contracts for difference'** between PPA and market rates
- Retailers fix tariff
  - Gas and Electricity retailed together

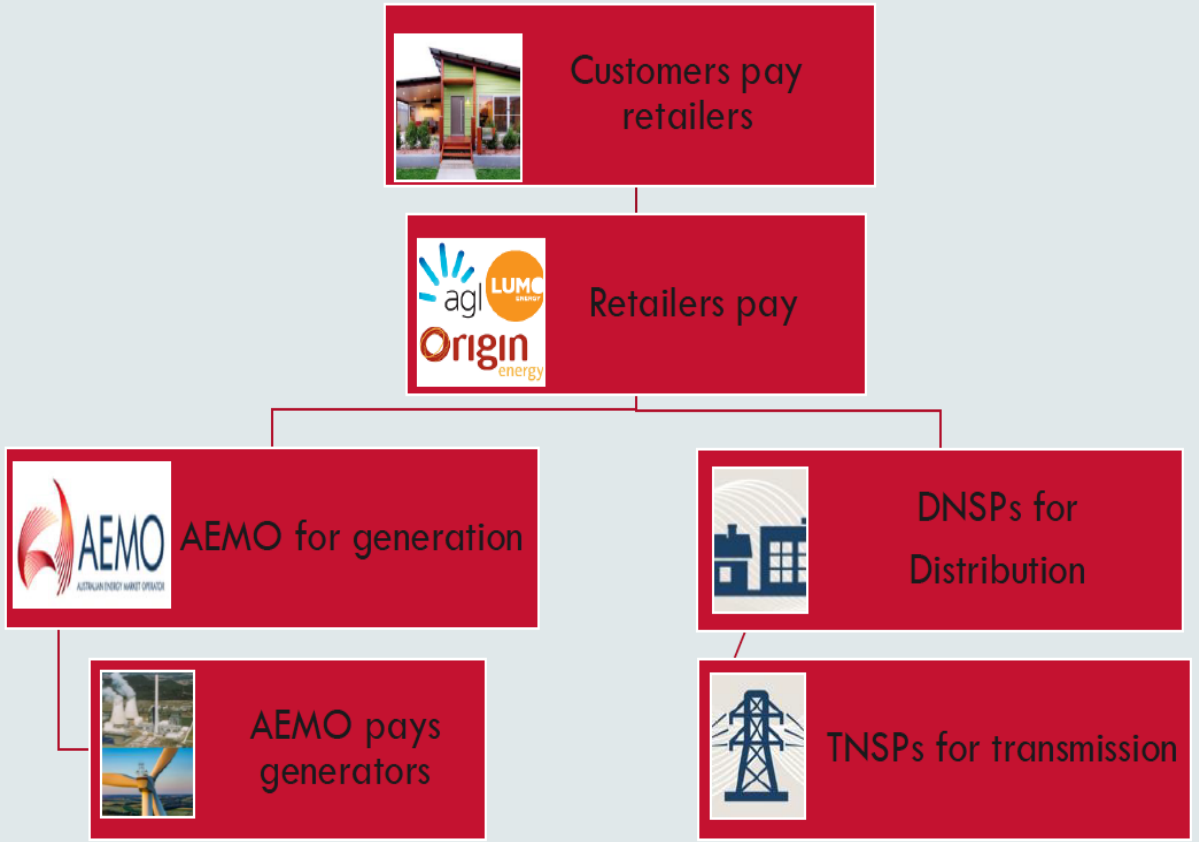
- Division of Governance structure
  - **Energy Commission** – rule making body
  - **System and Market operator** – Gross pooling of energy; system operations
  - **Energy Regulator** – compliance by enforcement, regulation, monitoring
  - **Essential Services Commission** – licensing of utilities, feed in tariff of RE, ARR for distributors and transmitters, energy efficiency targets, Ombudsmen

No common grid across country. WA is separate; NT no grid
SA has very high RE penetration 25 %

The spot market explained



Who pays who for electricity?



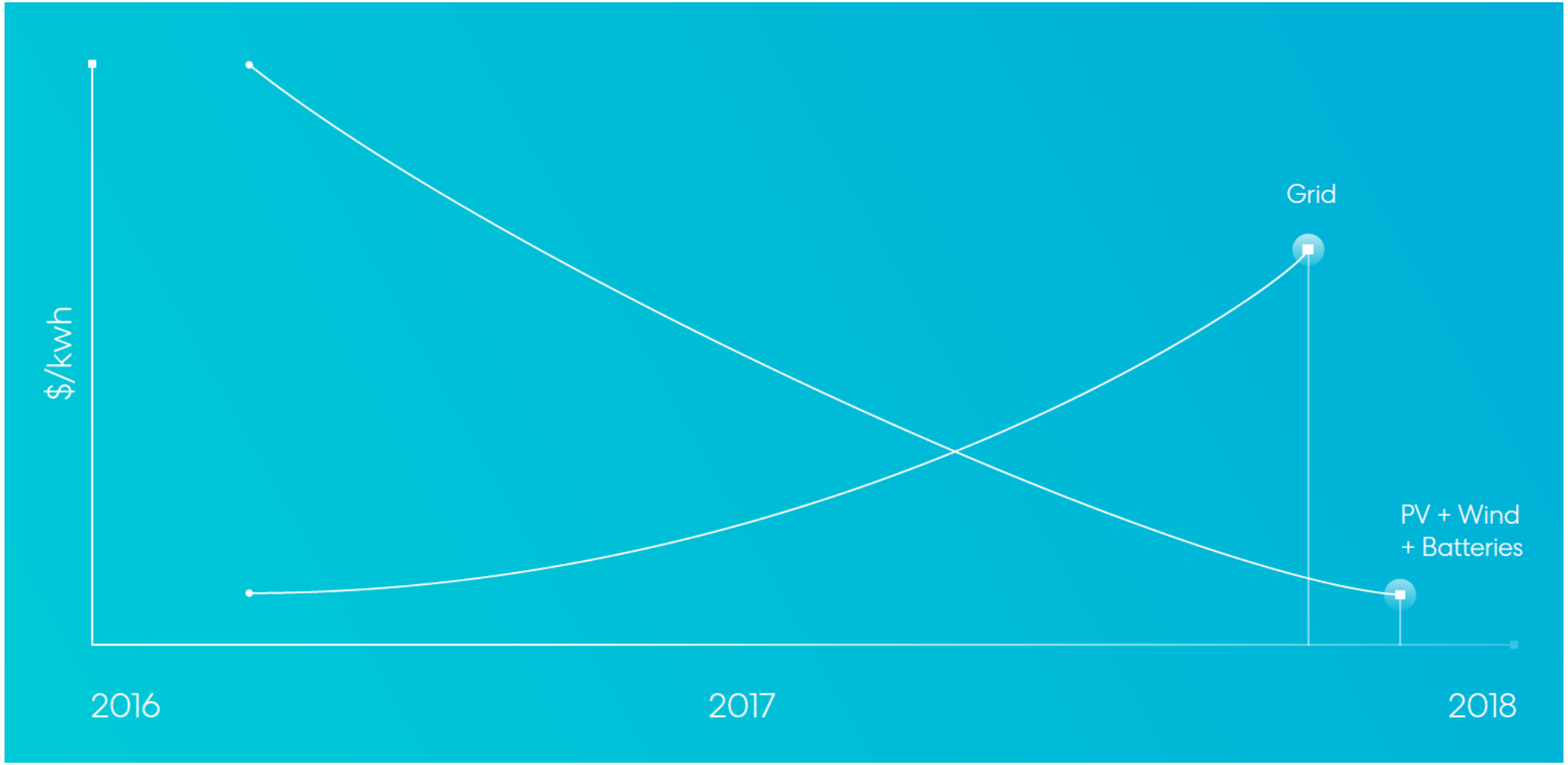
Dispatches subject to constraints

- Thermal constraints, Frequency control, Generation ramping, Voltage stability etc.

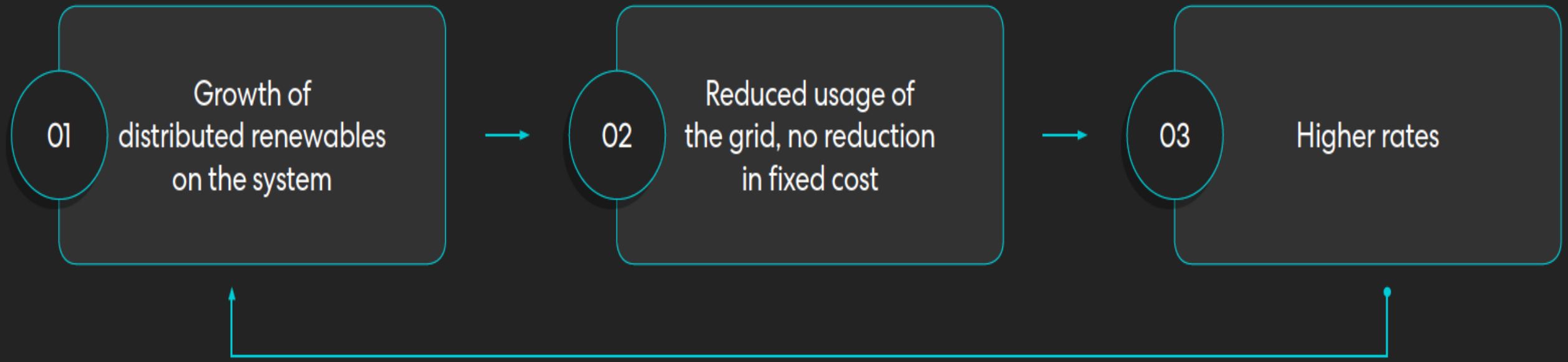
Issues relating to DER

- Death spiral for utilities
- Asynchronous generation
  - Volatility and grid instability
- Inefficient deployment: High cost, wasted resource
- Forecasting: Accuracy and viability for individual DER

Falling RE prices against increasing Network costs



The Utility Death Spiral



Why utilities will change

- Utilities are losing revenue and customers

  From increased solar generation and **grid defection**

- Transportation costs are rising

  From poor utilization of network assets, & competition from local generation

- The fear of losing control

  as more assets for generation & storage, are owned by customers

By 2050, up to 45% of all electricity in Australia will be generated by customers

Source: Electricity Network Transformation Roadmap: 2017-27

The Traditional, Centralized Energy System

Electricity is generated from carbon-intensive, centralized sources, far from the end user. The infrastructure is impacted by natural disasters. End users have no control of where their power comes from, if the system fails or the price they pay.

Large Scale Generation

Transmission & Distribution

Retail

Consumer

Carbon Intensive

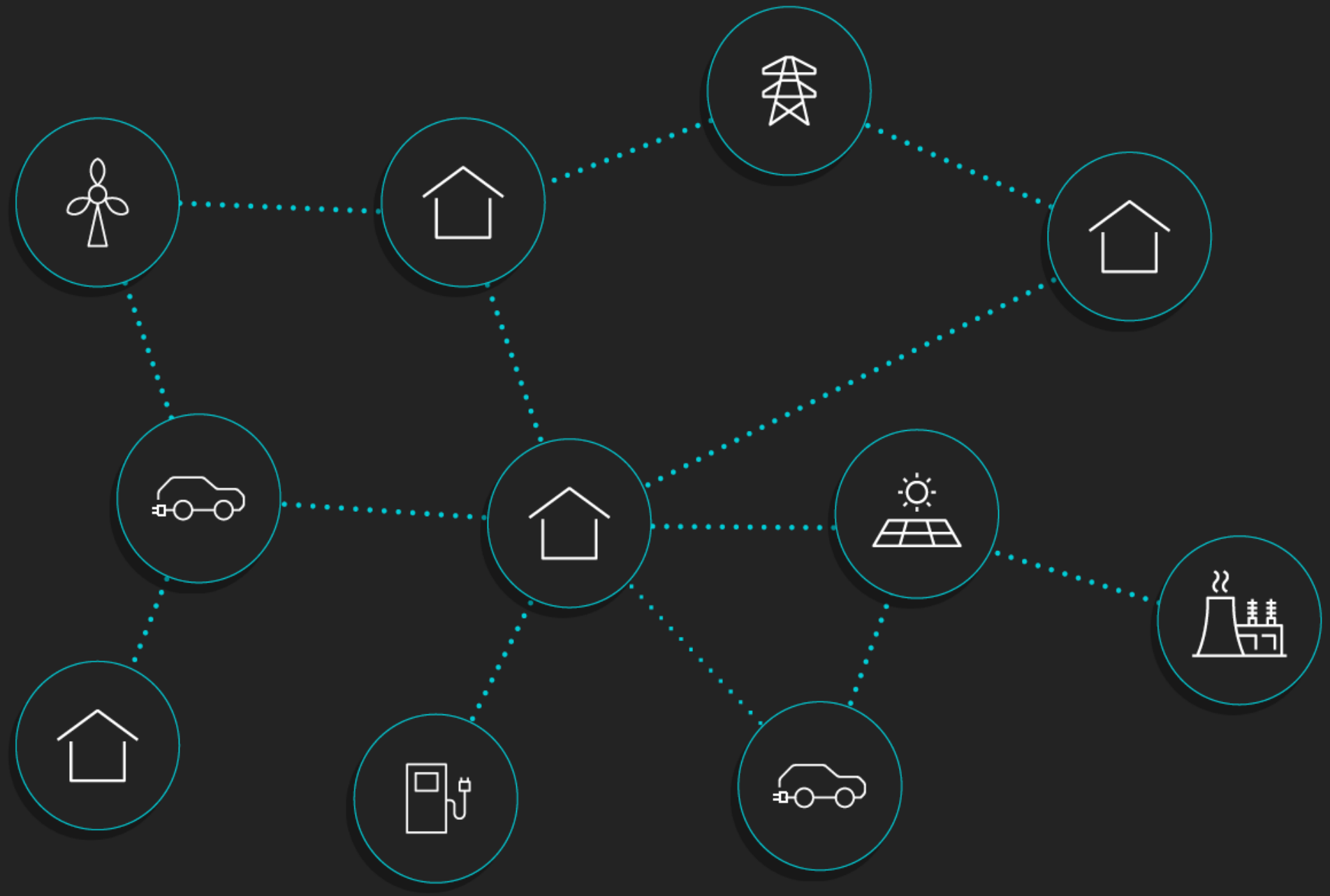
Inefficient

Expensive

Dependent

This is what a decentralized electricity system looks like...

- Consumers empowered
- Clean
- Resilient
- Affordable
- Value creation for all players

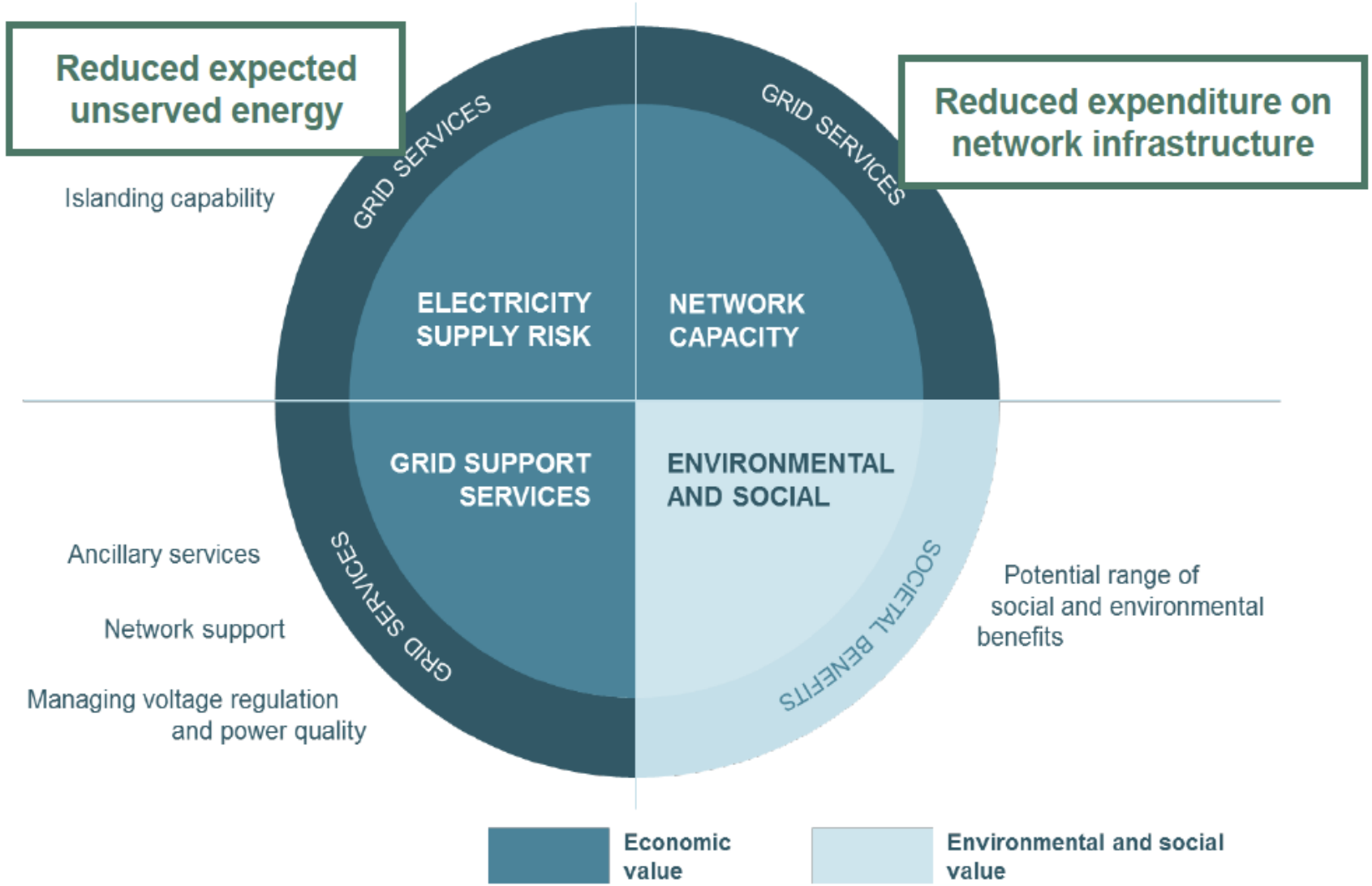


Coordination of distribution energy can save lot of wasted resource; Market ripe for aggregators

Opportunities created by DER

- Democratization of generation
  - Decentralized clean energy generation and consumption
- New markets
  - Aggregation for Ancillaries, Peer to Peer trade, blockchain technology
  - VPP, BTM and many other product offerings
- Reduced power procurement cost for retailers
  - Demand Response – prosumers/aggregators
  - Reduced network losses

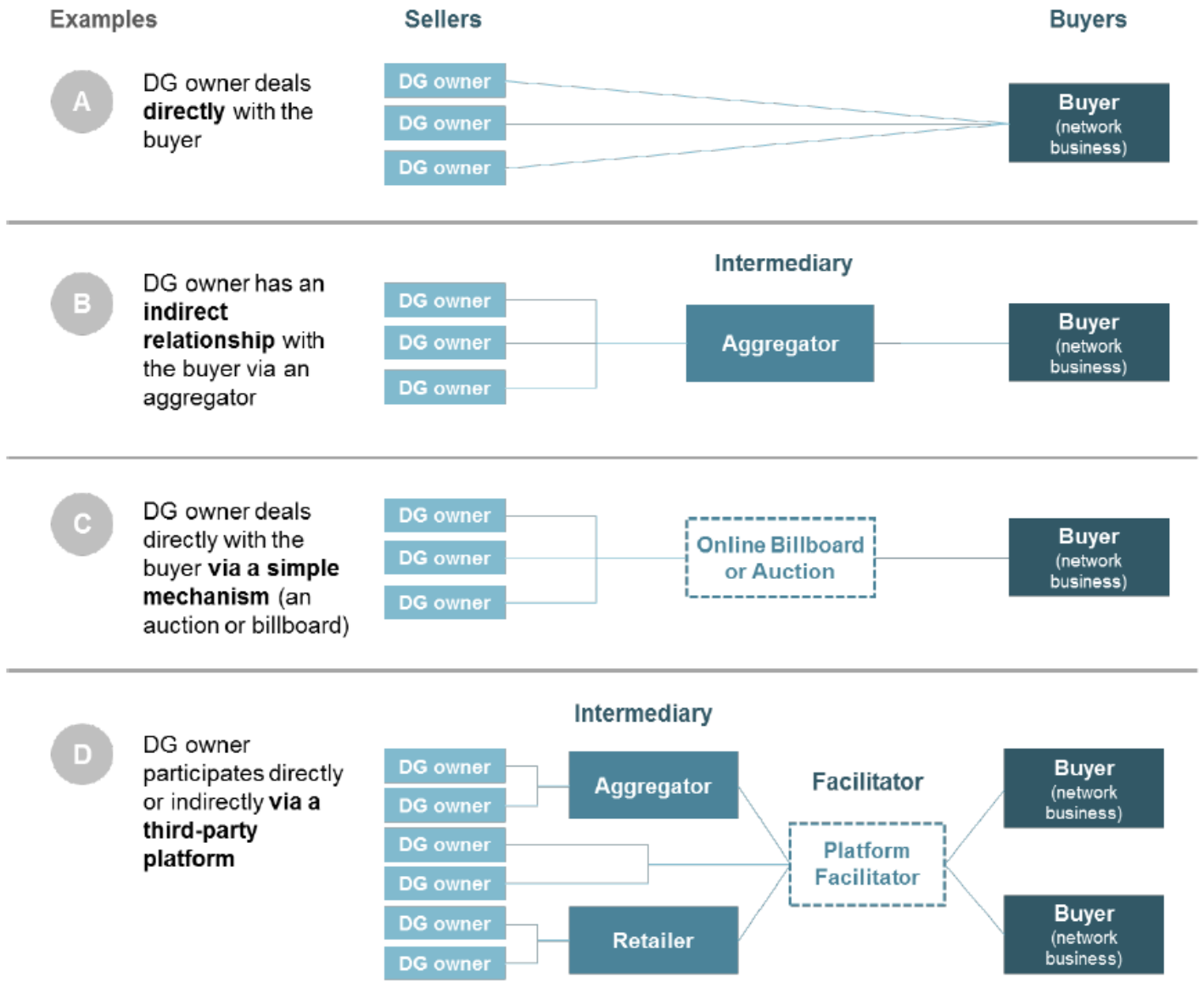
Can distributed generation provide value to the **network**?



How does a market for grid services look like?

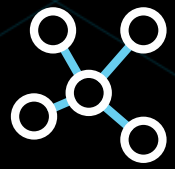
A market where

- network businesses can transact with providers of grid services
- it reveal prices
- it facilitate transactions
- it has multiple players and structures



Distributed
Energy Resources

Market
Operators



Electricity
Networks

deX

Decentralised
Energy Exchange

Technology
Vendors

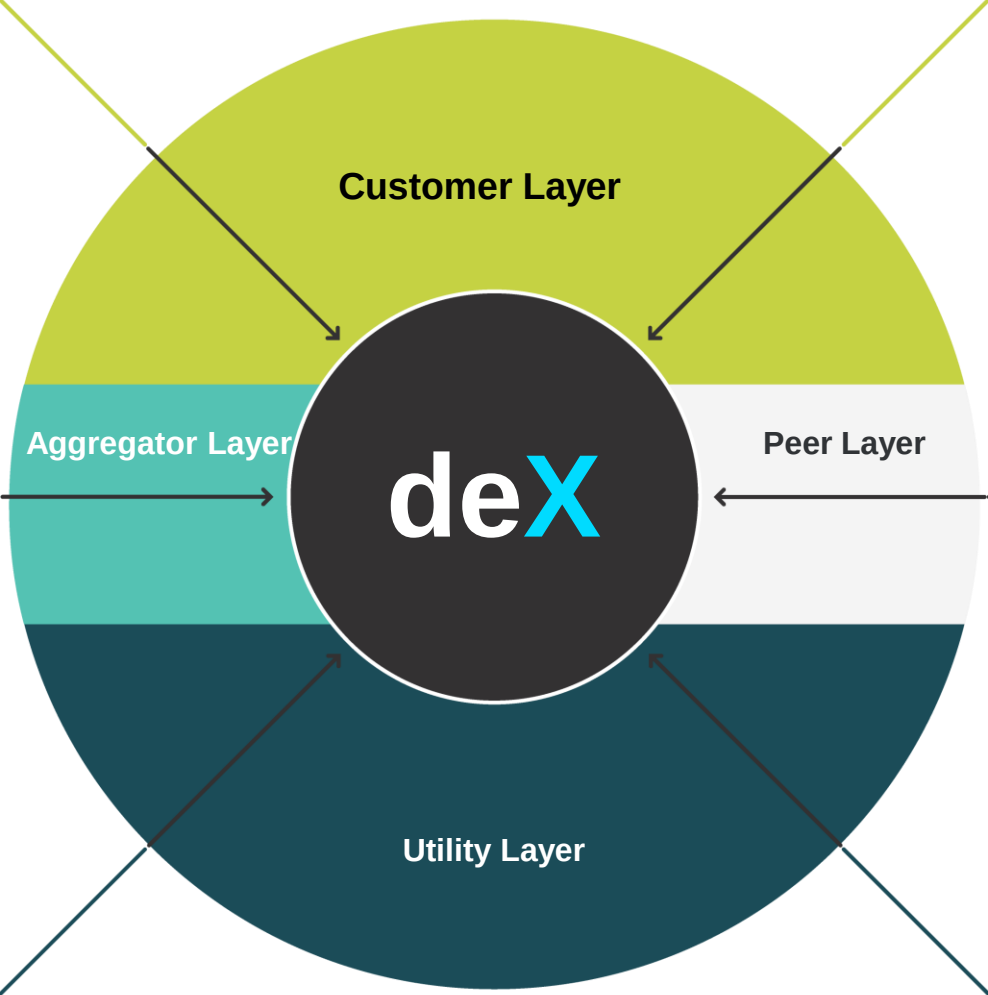
Electricity
Retailers

C&I
Businesses

Residents

New Energy
Services Companies

deX completes the DER ecosystem



Home EMS

Advertise your DERs to counterparties to be in charge of your own energy

Fleet Managers

PR

Manage fleets of DERs for large portfolios or aggregations

Virtual Power Plant

VPP

Contract DERs for wholesale market portfolios, and economic dispatch.

Building / Site EMS

Offer your customer owned DERs to counterparties to improve returns

PR

P2P Trading

Trade your exported energy or capacity to a counterparty

TBA

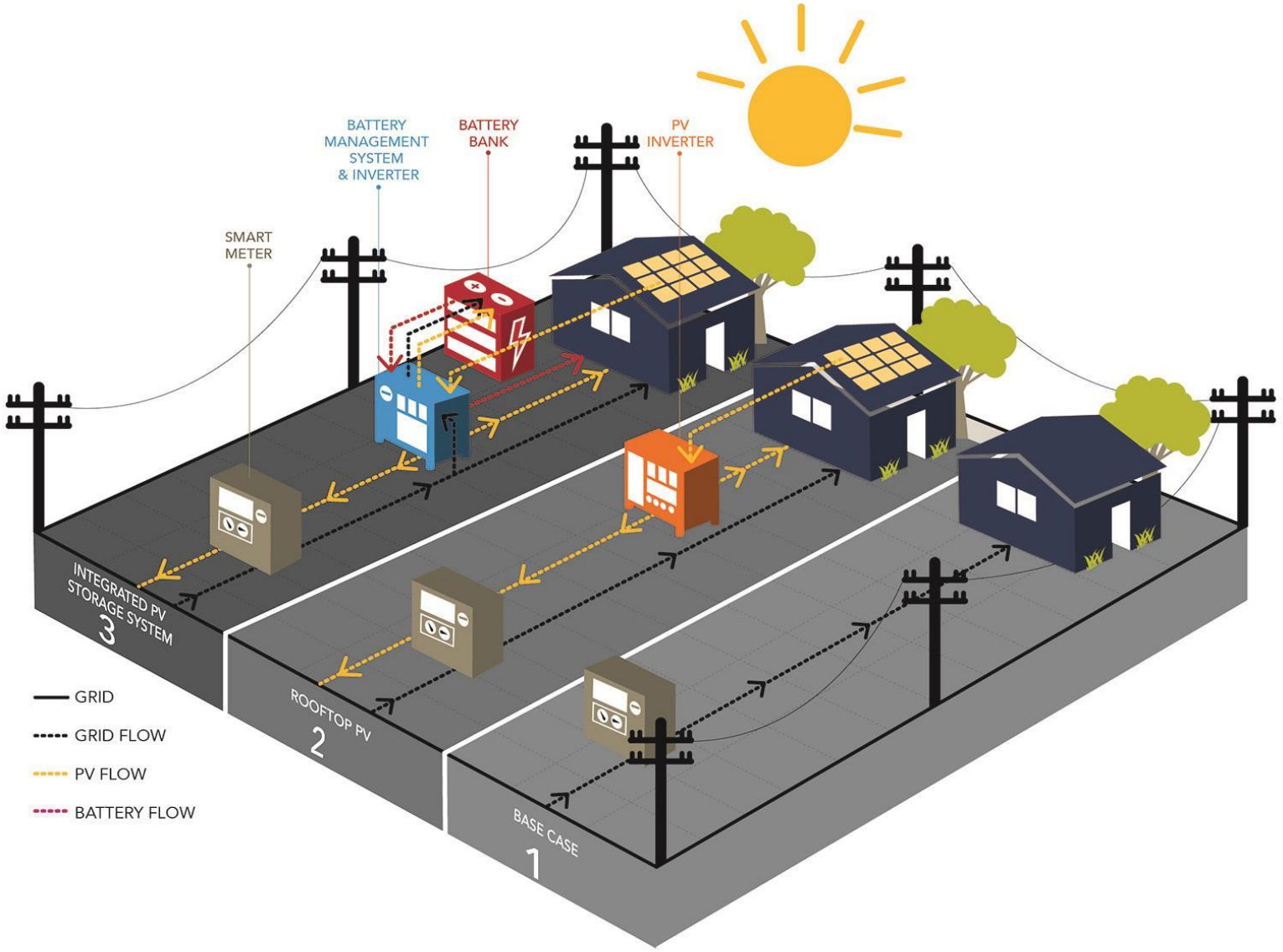
Network DERMS

Contract DERs to electricity network operators to reduce costs and increase reliability.

CM

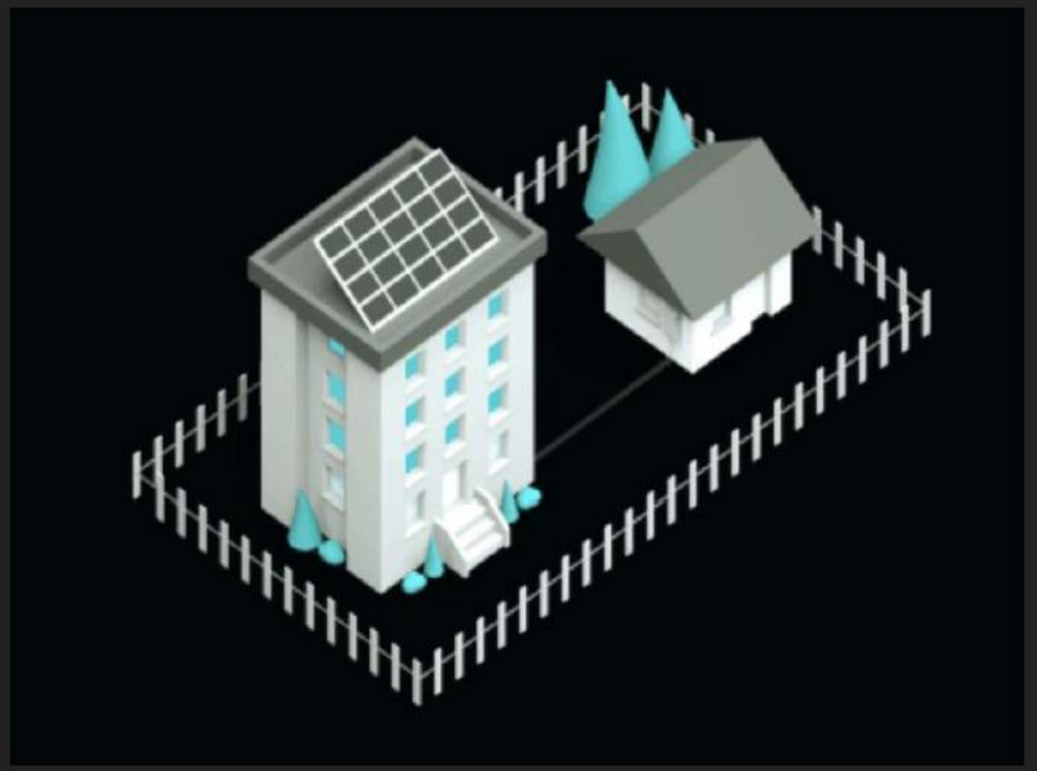
GreenSync

Changing role of grid



Peer-to-Peer electricity trading across the regulated electricity network.

Peer-to-Peer electricity trading behind the regulated electricity mastermeter.



Possible options to explore

- Tech Mahindra with Power Ledger Australia is working on the concept of making Microgrid Available As A Service (MAAS)
  - To make quality power accessible to remote tribal hamlets/hilly areas
- Need for real time monitoring of the system security with higher planned integration of RE including DER, particularly in RE rich states
  - What is the optimum **synchronous: asynchronous generation ratio**?
  - Mechanism to estimate DER installations including BTM
- Additional market avenues for decentralized trading of DER like DeX need to be studied

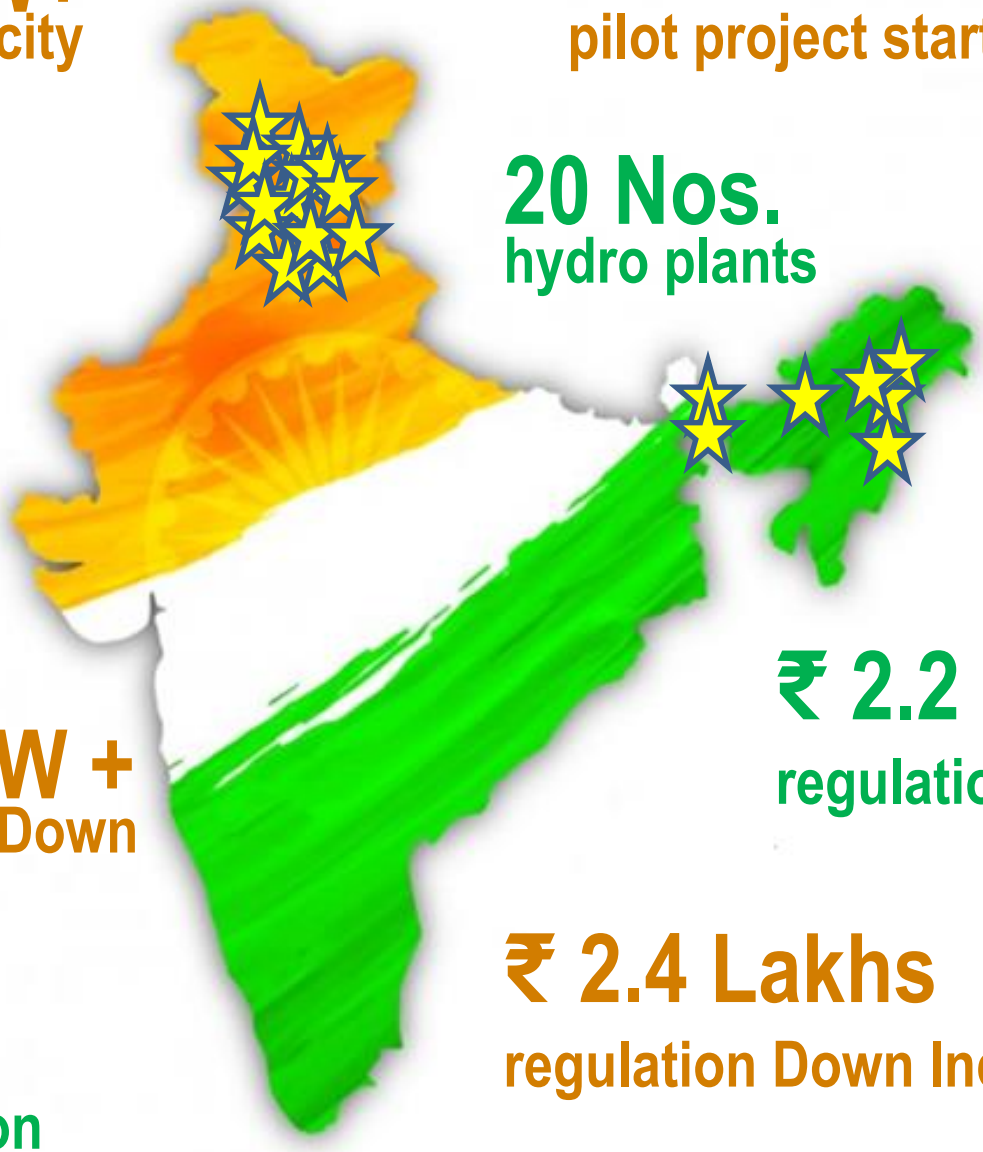
Implementation of Pilot Fast Response Ancillary Services (FRAS)

11th January, 2019

Fast Response Ancillary Services(FRAS)

8600 MW+
generation capacity

26th November, 2018
pilot project start date



20 Nos.
hydro plants

200 +
instructions

~ 75 Nos.
generating units

400 MW +
max. FRAS Up

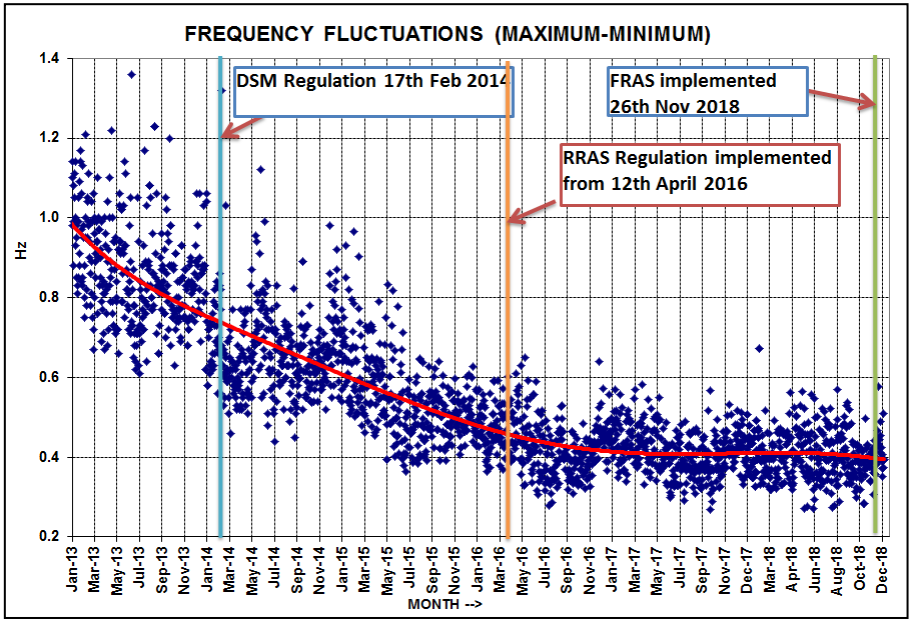
₹ 2.2 Lakhs
regulation Up Incentive

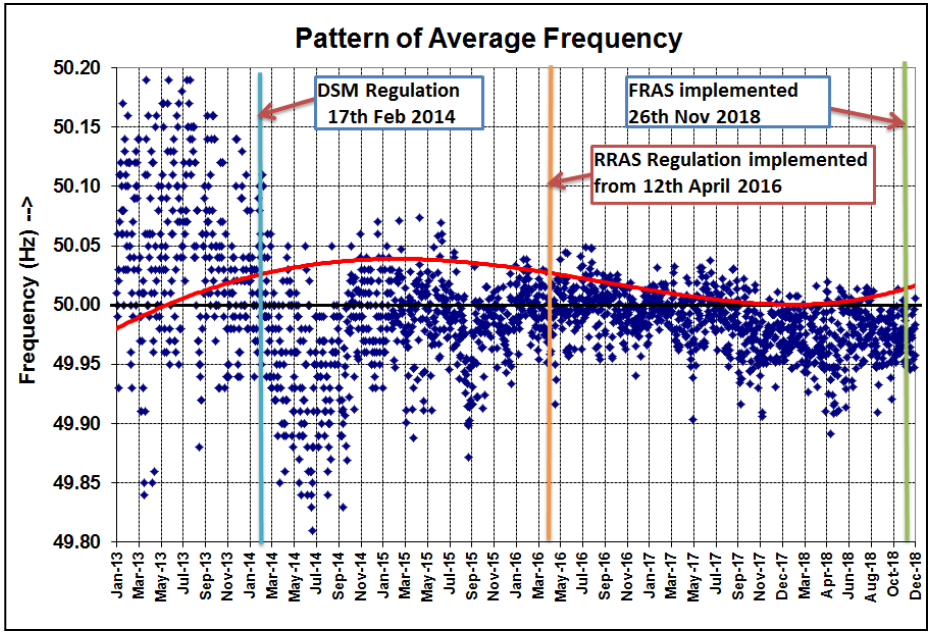
600 MW +
max. FRAS Down

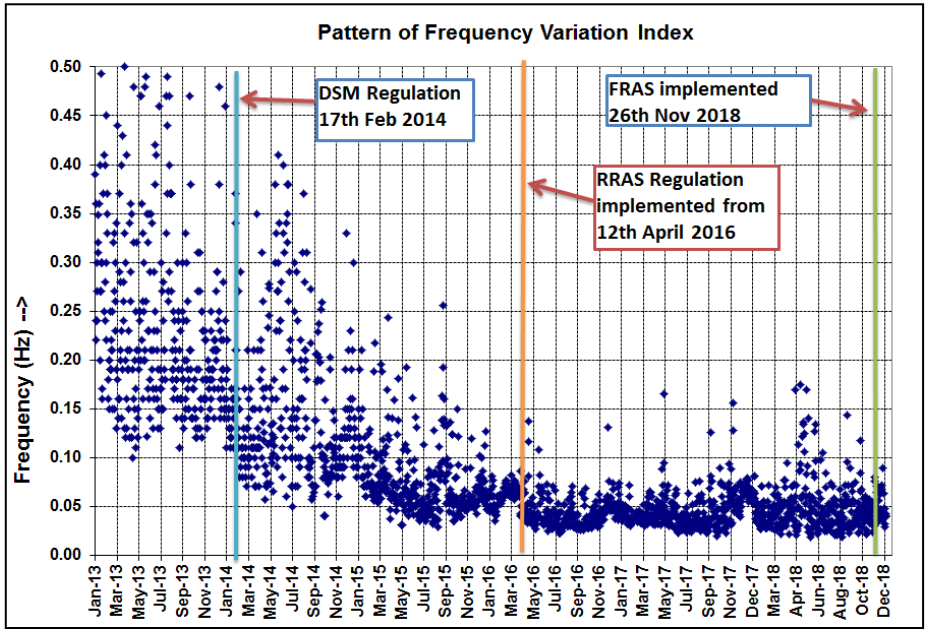
13 plants
Despatched in
Single Instruction

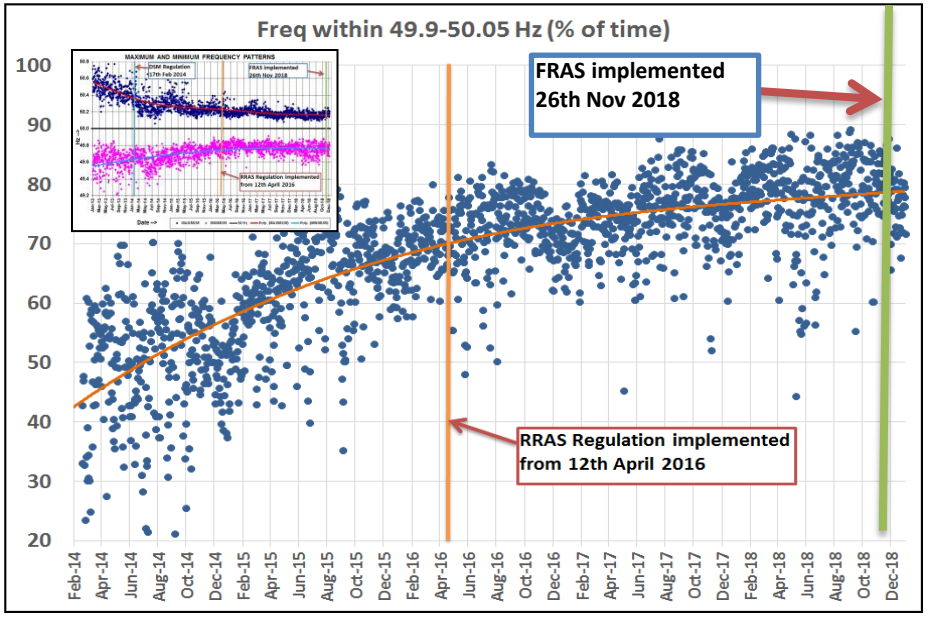
₹ 2.4 Lakhs
regulation Down Incentive

Frequency Improvement



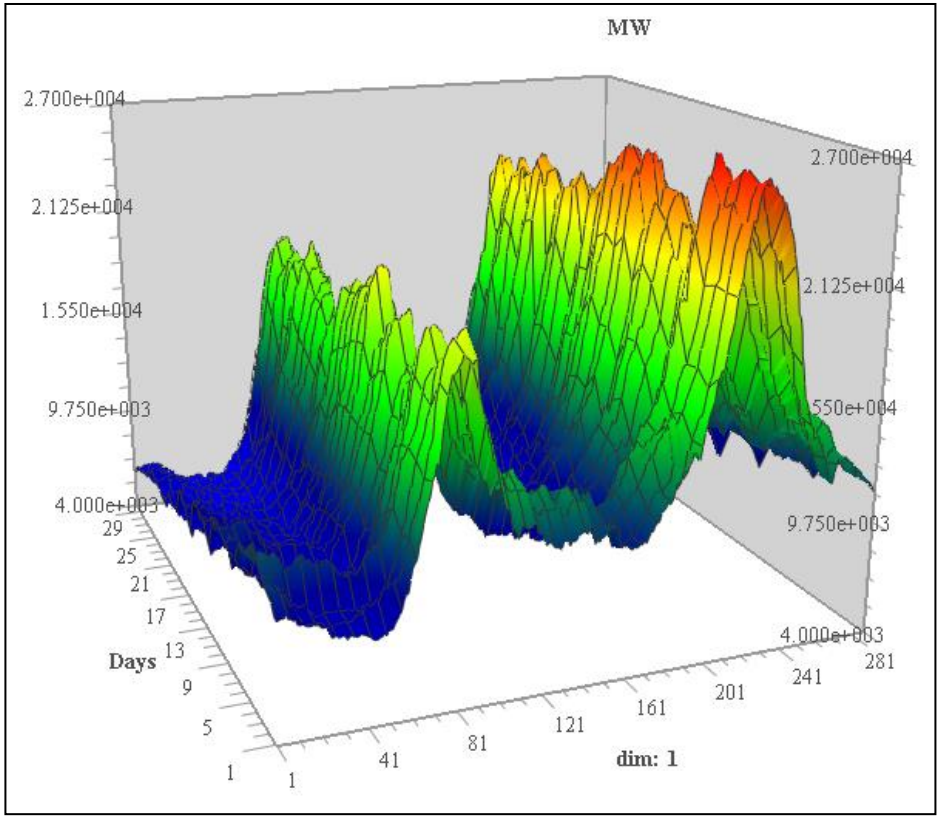




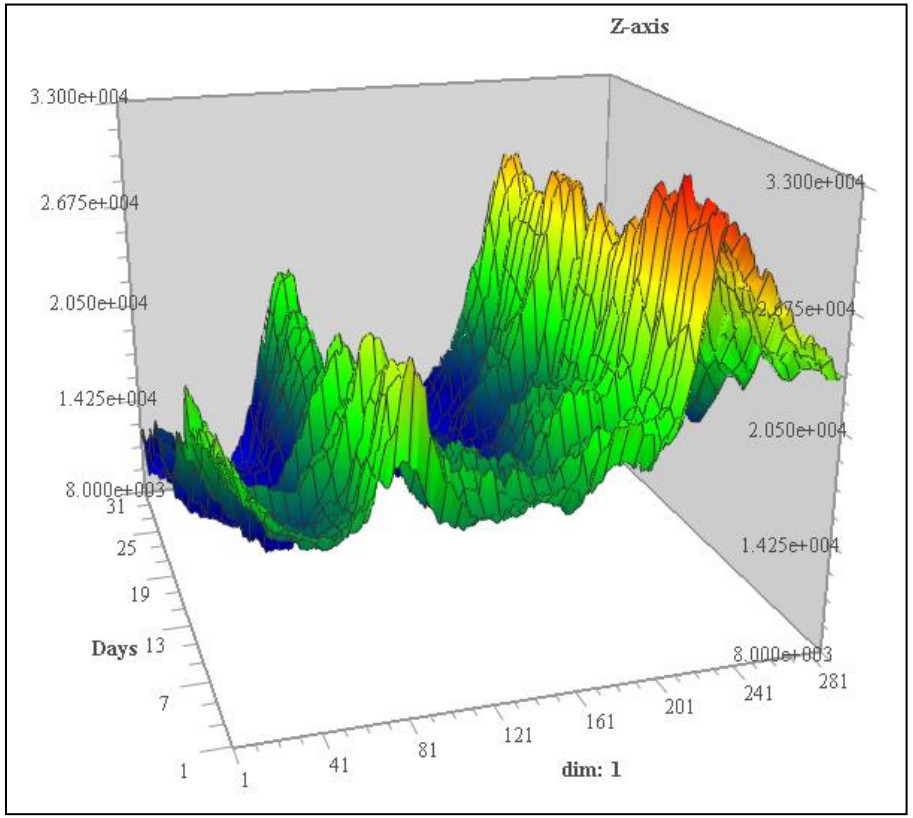


All India Hydro Generation

November-18



December-18



Regulatory Initiative towards FRAS

- CERC order in Petition No. 07/SM/2018 (Suo-Motu) dtd. 16 Jul'18
  - Pilot on 05-Minute Scheduling, Metering, Accounting and Settlement for Thermal/Hydro
    - ***Letter of Award to be placed by CTU by 11th Jan'19 with completion schedule of 3 months.***

26th Nov'18 :Fast Response Ancillary Services (FRAS) started

All constraints declared by the hydro stations shall be honoured

Total energy delivered over the day shall be maintained as declared by the hydro station.

The total energy dispatched under FRAS shall be squared off by the end of the day

The schedules of the beneficiaries shall not be disturbed in the despatch of FRAS

RPCs to issue weekly FRAS accounts along with RRAS accounts

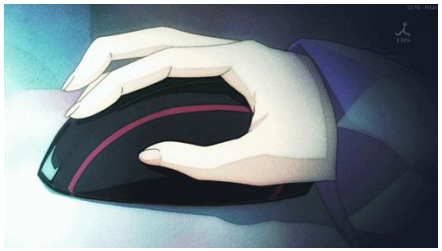
Incentive shall be paid from the DSM Pool on mileage basis at the rate of 10 paisa/kWh both for "up" and "down"

Stakeholder consultations

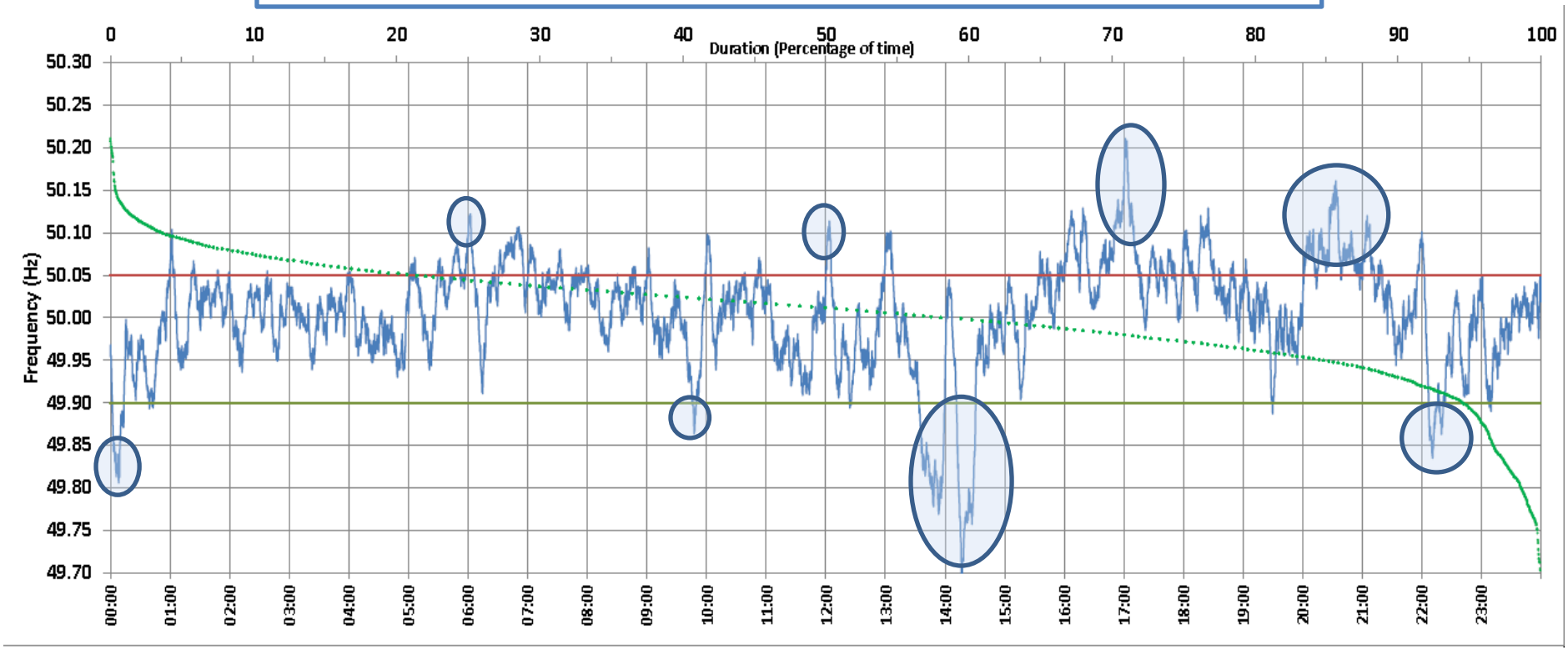
- 31st October, 2018
  - Consultations: NLDC/RLDCs with Hydro generators, Regional Power Committees
  - RPC:NRPC
  - Hydro generation company
    - NHPC
    - THDC
    - BBMB
    - NEEPCO
    - NTPC
    - SJVNL
  - RLDCs
    - NERLDC
    - ERLDC
    - NRLDC
- To understand the complexities of all stakeholders and evolve a consensus for broad based solutions.

Triggering Criteria

- Hour Boundary Frequency Variations
- Sudden Variations in Demand
- Ramp Management
- Grid Contingency
- RE Variation



FRAS Despatch for Every Discrete 5-min Time Block



Hydro Plants under FRAS

Sl	Name	Utility	Region	Type (S/P)	No of Units	Unit Size	I/C (MW)
1	Chamera-I	NHPC	NR	P	3	180	540
2	Dhauliganga			P	4	70	280
3	Chamera-III			P	3	77	231
4	Parbati III			P	4	130	520
5	Sewa-II			P	3	40	120
6	Dulhasti			P	3	130	390
7	Naptha Jhakri	SJVN		P	6	250	1500
8	Rampur			P	6	68.67	412
9	Tehri	THDC		S	4	250	1000
10	Koteshwar			S	4	100	400
11	Koldam	NTPC		P	4	200	800
12	Pong	BBMB		S	6	66	396
13	Dehar			R/P	6	165	990
14	Kopili	NEEPCO	NER	S	4	50	200
15	Kopili-II			S	1	25	25
16	Khandong			S	2	25	50
17	Doyang			S	3	25	75
18	Loktak	NHPC		S	3	35	105
19	Teesta-V	NHPC	ER	R	3	170	510
20	Rangit			R/P	3	20	60
Total					75		8604

Type	MW
Storage (S)	2761
Pondage (P)	5843
Total	**8604**

For Tandem hydro stations like Nathpa-Jhakri & Rampur FRAS instruction are given simultaneously

Operationalization of FRAS…(1)

Annexure-III

To: Nodal Agency — NHPC (LOKTAK POWER STATION)

Concerned RLDC (NERLDC)

Validity of the Information — From: 14/11/2018 To: 31/03/2019

Date:14/11/2018

Hydro Generator Details for Participation in Fast Response Ancillary Services (FRAS - 1)		
S.No.	Title/Parameters	Values/Data/Information
Scheduling and Ancillary Service Related		
1	Number of Generating Units (e.g. 1x 100 MW + 2 x 250 MW)	3X35
2	Type of Plant (RoR,Storage,Pondage or Reservoir)	Storage
3	Installed Capacity of Unit (MW) - P	35
4	Start time for each unit (Standstill to Synchronization of unit to grid) (in minutes)	15
5	Minimum load at which unit can stably run after synchronization Unitwise (P1) (in MW)	3
6	Forbidden zones or high cavitation zones - Unitwise (From MW to MW) - P2 to P3	10 to 24 MW
7	Maximum possible Ex-bus injection (MW) (including overload if any) (P4)	35
8	Cumecs/MW from standstill to synchronization (C0)	1.4
9	Cumecs/MW for P1 generation level (C1)	0.4 Cumecs/MW
10	Cumecs/MW for P3 generation level(C3)	0.4 Cumecs/MW
11	Cumecs/MW for P4 generation level(C4)	0.4 Cumecs/MW
12	Cumecs/MW used for Declared Energy figure given to RLDC (CS)	0.4 Cumecs/MW
13	Cumecs/MW for P generation level (C)	0.4 Cumecs/MW
14	Water Usage/Requirement (in Cumecs) at No Load	1.4
15	Fixed	
16	Varia	
17	Ramp	
18	Ramp	
19	How operation	
20	Requirement of Tandem Operation of the Plant (if Yes, with which plant and details)	NO
Primary Response Related		
21	Present Governor Droop Setting (Unit-wise)	4% in all units
22	Considering all the constraints, how much further droop setting can be improved and range thereof	Upto 3%
Blackstart Related		
23	Blackstart Facility availability (Yes/No)	Yes
24	The date of last mock black start exercise done and the droop setting of the unit kept during the drill	20/04/2010 (droop setting-4%)
Constraints Related		
25	Any Other Information including the constraints (Time-specific, Location- Specific, Event Specific, Unit-Specific, etc.)	1.Siren is to be blown 30 min before starting of units.

Signature of Authorized Signatory (with Stamp)

विजय कुमार सिंहा / Vijay Kumar Sinha
मुख्य अभियन्ता (वित्त) / Chief Engineer (Fin.)
एन एच पी सी लिमिटेड / NHPC Limited
(भारत सरकार का उद्यम / A Govt. of India Enterprise)
सेक्टर-33, फरीदाबाद / Sector - 33, Faridabad

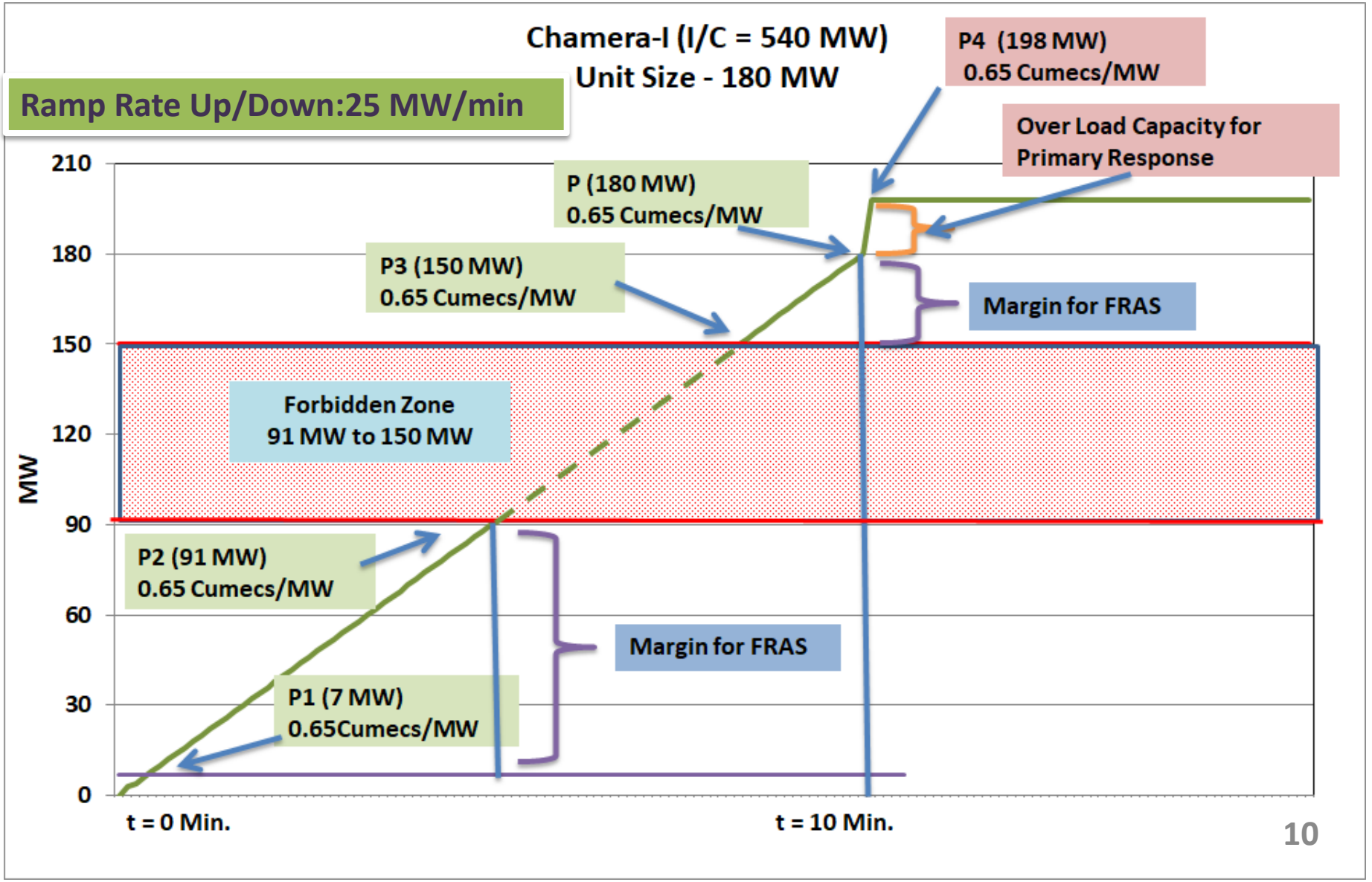
Plant-wise Information for FRAS		
S.No.	General Information	
1	Name	Chamera-II
2	Owner	NHPC
3	Total Installed Capacity (MW)	300
4	Number of Generating Units (e.g. 1 x 100 MW + 2 x 250 MW)	3 x 100 MW
5	Location (District & State)	Chamba, Himachal Pradesh
6	Geographical Coordinates (Lat. & Long.)	32.5079,76.1700
7	River/Water Sources	River Ravi
8	Type of Development (RoR, RoR with Pondage, Reservoir)	RoR with Pondage
	Hydrology	
9	Annual Inflow (Mm^3) (in 90 % dependable year)	300
10	Dam/Barrage/Weir Type	Concrete Gravity Dam
11	FRL (m)	1162
12	MDDL (m)	1152
13	Gross storage (Mm^3)	
14	Live storage (Mm^3)	1.56
15	Hydrological constraints	
	Equipment Details	
16	Turbine Make	Alstom
17	Turbine Type (Francis/Kaplan/Impulse/Pelton/any other)	Vertical Francis
18	Rated Turbine Output (MW)	100
19	Rated Head (m)	243
20	Net Max and Min Head (m)	266.66/244.28
21	Design Discharge (m^3/sec)	145.19
22	Generator Make	GE
23	Rated Generator Output (MW)	100
24	Rated Voltage (kV)	11
25	Rated P.F	0.9
26	Excitation System Type	Digital
27	Governing System Type	
28	Generator Transformer Nos./Type (1-phase/3-phase)	9/1-phase
29	GT Rating (MVA)	41

Collected Basic Information from FRAS Providers

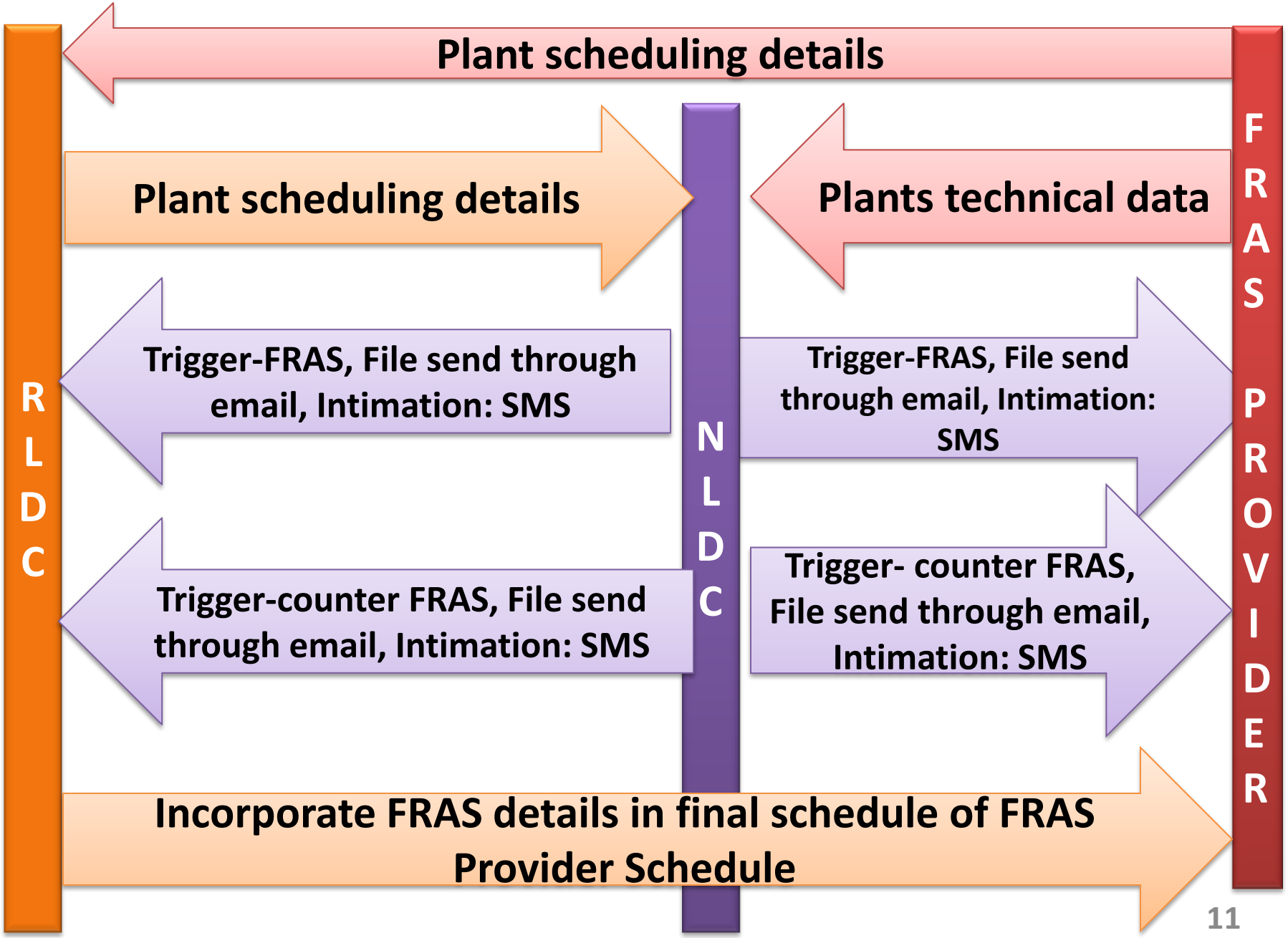
34	Transmission Line Details	
35	Transmission Constraints (if any)	
	Operational Data	
36	Design Energy (MU)	1499.89
37	Annual Energy for last five years (in MU)	
	2013-14	
	2014-15	
	2015-16	
	2016-17	
	2017-18	
38	Installed Capacity of Unit (MW) - P	100 MW
39	Start time for each unit (Standstill to Synchronization of unit to grid)	15 Min
40	Which value (Cumecs/MW) is used for declaring MWh capability?	0.45 Cumecs/MW
41	Minimum load at which unit can stably run after synchronization - U	10 MW
42	Forbidden zones or high cavitation zones - Unitwise (From MW to M	30 MW to 70 MW
43	Maximum loading possible on unit (continuous) (P4)	110 MW
44	Unitwise Cumecs/MW for P, P1,P2,P3 and P4 generation level as well as cumecs from standstill to synchronization.	Discharge for all the units are same and are calculative P: 0.45 Cumecs/MW P1: 0.45 Cumecs/MW P2: 0.45 Cumecs/MW P3: 0.45 Cumecs/MW P4: 0.45 Cumecs/MW 7.53 Cumecs from Standstill to Synchronization
45	Water Usage/Requirement (in Cumecs) at No Load	7.53 Cumecs
46	Maximum possible Ex-bus injection (MW) (including overload if any)	320 MW
47	Ramp-Up Rate (MW/Min) for each unit	70 MW / min

Operationalization of FRAS…(2)

Sample Hydro Station Data

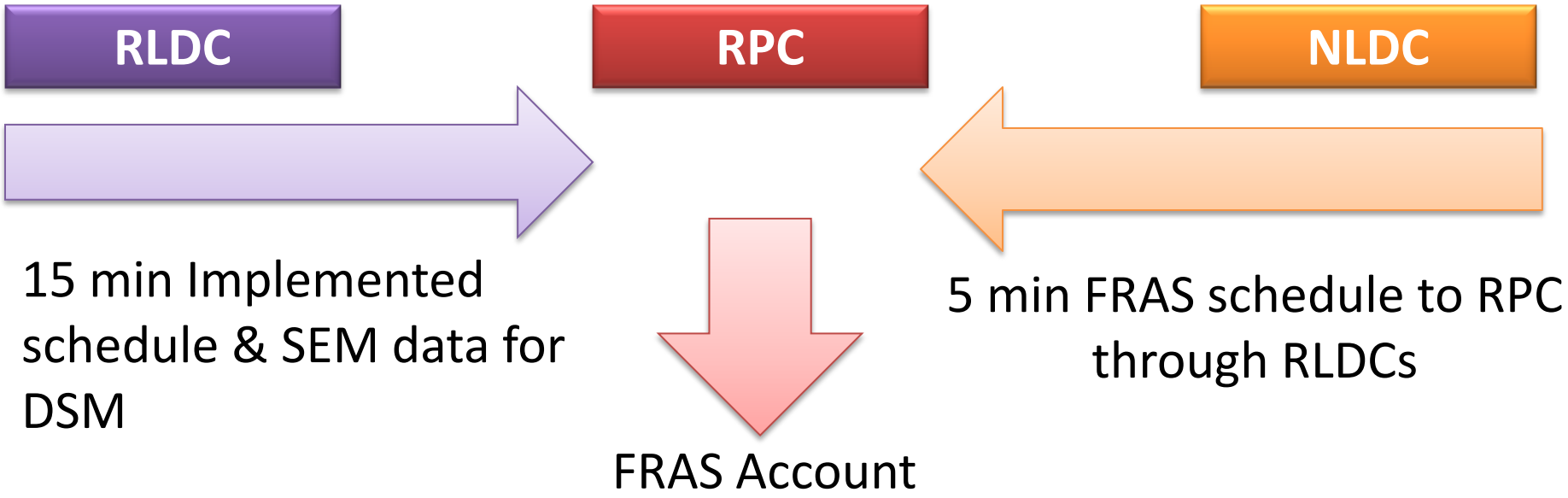


FRAS Information Process Overview



Accounting & Settlement

Respective RPC publishing FRAS Account along with DSM & RRAS Account



No fixed charge or variable charges to be paid

Mark-up on mileage basis

$$E_m = \Sigma \mid E_{up} \mid + \Sigma \mid E_{down} \mid \text{ (10 paisa/kWh)}$$

Sample Instruction to FRAS Provider

FRAS dispatched Details

Alerts

If there are problems with how this message is displayed, click here to view it in a web browser.

Sent: Tue 08-01-2019 05:41

To: cps2operation@gmail.com; koldam.eemg@gmail.com; ncrcrhq@gmail.com; Rishabh Pandey (ऋषभ पांडे); sewa2ph.nhpc@gmail.com; nhpcdulhastielec@gmail.com; parbati3@gmail.com; pccont@bbmb.nic.in; pbt3operation@gmail.com; dhauligangapho@gmail.com; phelectrical.maint@gmail.com; rhep.phoperation@gmail.com; controlroomcps1@gmail.com; controlroomchamera1@gmail.com; operation.koteshwar@gmail.com; Nitesh Kumar (नितेश कुमार); cps3ph@gmail.com; atul98894@gmail.com; crgmc2016@gmail.com; rk_raina@sjvn.nic.in;

Message | 1NR08012019.csv (10 KB) | 1NR(15)08012019.csv (4 KB) | 1NRNET08012019.csv (13 KB)

Gen	Regulation	05:55-06:00	06:00-06:05
CHAMERA1	UP/DOWN	-7	-14
CHAMERA3	UP/DOWN	0	0
PARBATI3	UP/DOWN	0	0
SEWA2	UP/DOWN	-27	-55
DULHASTI	UP/DOWN	0	0
RAMPUR	UP/DOWN	-28	-75
TEHRI	UP/DOWN	0	-20
KOTESHWR	UP/DOWN	0	0
KOLDAM	UP/DOWN	-80	-120
PONG	UP/DOWN	0	0
DEHAR	UP/DOWN	-9	-29
NJPC	UP/DOWN	-155	-161

	A	BU	BV	BW	BX	BY	BZ	CA	CB
1	GEN	05:55-06:0	06:00-06:0	06:05-06:1	06:10-06:1	06:15-06:2	06:20-06:2	06:25-06:3	06:30-06:3
2	CHAMERA1	-7	-14	0	0	0	0	0	0
3	CHAMERA3	0	0	0	0	0	0	0	0
4	PARBATI3	0	0	0	0	0	0	0	0
5	SEWA2	-27	-55	0	0	0	0	0	0
6	DULHASTI	0	0	0	0	0	0	0	0
7	RAMPUR	-28	-75	0	0	0	0	0	0
8	TEHRI	0	-20	0	0	0	0	0	0
9	KOTESHWR	0	0	0	0	0	0	0	0
10	KOLDAM	-80	-120	0	0	0	0	0	0
11	PONG	0	0	0	0	0	0	0	0
12	DEHAR	-9	-29	0	0	0	0	0	0
13	NJPC	-155	-161	0	0	0	0	0	0
14									

FRAS Information Display

FRAS(Fast Response Ancillary Services)

NLDC Home Apply FRAS Inverse FRAS Generators

DATE SHOW

08-01-2019 SHOW

Instruction id	MW	Generators
FID2019-01-0854123	-337	KOPILI,KOPILI2,KHANDONG,DOYANG,TEESTA,RANGIT
FID2019-01-087540	102	RAMPUR,NJPC
FID2019-01-087629	21	CHAMERA1
FID2019-01-08779	30	KOLDAM
FID2019-01-087822	20	TEHRI

FID2019-01-0854123 ×

Details of This dipatch are as Follows.

Gen	Region	05:55-06:00	06:00-06:05
KOPILI	NER	-31	-31
KOPILI2	NER	0	0
KHANDONG	NER	0	0
DOYANG	NER	0	0
TEESTA	ER	0	0
RANGIT	ER	0	0
CHAMERA1	NR	-7	-14
CHAMERA3	NR	0	0
PARBATI3	NR	0	0
SEWA2	NR	-27	-55
DULHASTI	NR	0	0
RAMPUR	NR	-28	-75

FRAS Software……(1)

Plant under FRAS

5 min block schedule

FRAS(Fast Response Ancillary Services)

NLDC | Home | Apply FRAS | Inverse FRAS | Generators | Applied Instructions | Reports

Data Status

ALL India Available Margin For FRAS

	GEN	Declared Energy	Scheduled Energy	00:00-00:05	00:05-00:10	00:10-00:15	00:15-00:20	00:20-00:25	00:25-00:30	00:30-00:35	00:35-00:40	00:40-00:45	00:45-
1	TEESTA	6	2	100	100	100	100	100	100	0	0	0	0
2	CHAMERA2	2	0	0	0	0				0	0	0	0
3	CHAMERA1	3	1	0	0	0				0	0	0	0
4	CHAMERA3	1	0							0	0	0	0
5	PARBATI3	1	0	0	0	0				0			
6	SEWA2	0	0	0	0	0				0			
7	DULHASTI	5	2	71	71	71	71	71	71	71			
8	NJPC	11	4	0	0	0	0	0	0	0			
9	RAMPUR	3	1	0	0			0	0	0			
10	TEHRI	7	2	0	0			0	0	0	0	0	0
11	KOTESHWR	2	1	10	10			10	10	10	10	10	10
12	KOLDAM	4	1	0	0			0	0	0	0	0	0
13	KOPILI	4	2	0	0			0	0	0	0	0	0
14	KOPILI2	0	0	0	0	0	0	0	0	0	0	0	0
15	KHANDONG	0	0	0	0	0	0	0	0	0	0	0	0
16	DOYANG	0	0	0	0	0	0	0	0	0	0	0	0

Schedule energy up to current block

Declared energy of station

Block wise available margin for Up regulation

FRAS Software……(2)

Option to select or deselect Region

(Fast Response Ancillary Services)

Inverse FRAS | Generators | Applied Instructions | Accounting | Reports

Kindly Deselect Generators getting Share Less than five and recalculate Despath.(No generators should be despathed with quantum less than 5MW.)

Regions:

AR ☑, ER ☑, NR ☑, SR ☐, WR ☐

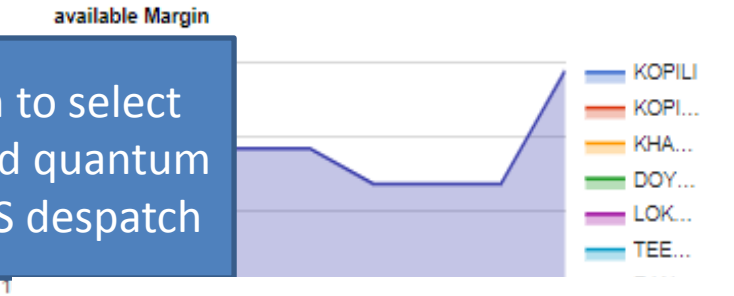
Start Time: 19:05 | End Time: 19:10 | Quantum: 100 | Calculate Dispatch

Option to select or deselect hydro station

Option to select Time and quantum for FRAS despatch

All India Available Margin For FRAS (Region Wise).

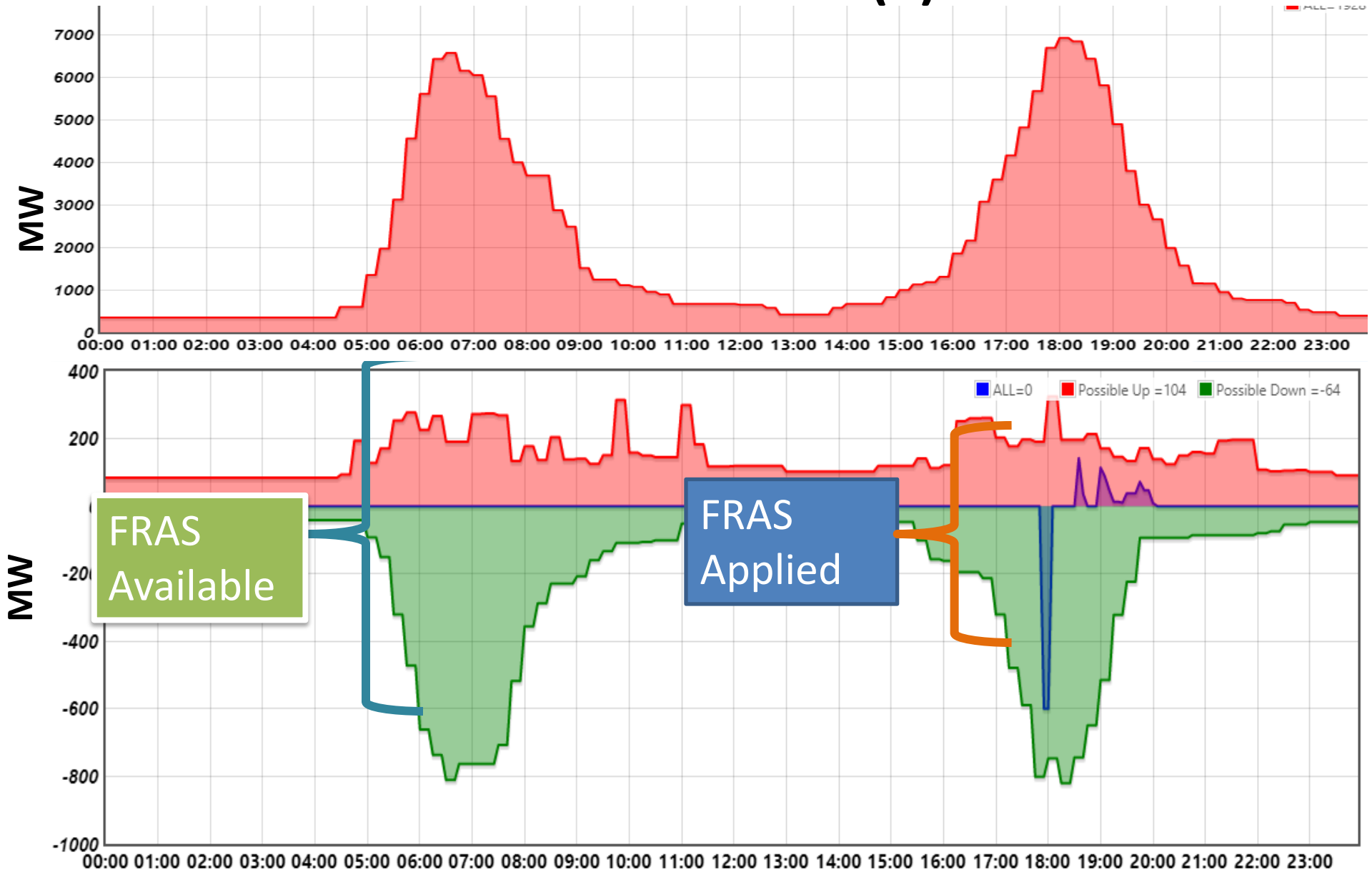
	in	gener	itor	19:0	19:1	19:1	19:2	19:2	19:30-1	19:35-1	19:40-1	19:45-1
1	☑	KOPI	I	0	0	0	0	0	0	0	0	0
2	☑	KOPI	I2	0	0	0	0	0	0	0	0	0
3	☑	KHA	DOI	0	0	0	0	0	0	0	0	0
4	☑	DOY	NG	0	0	0	0	0	0	0	0	0
5	☑	LOKT	AK	2								9
6	☑	TEES		0								0
7	☑	RAN	IT	2								2
8	☑	CHA	ERA	2								0
9	☑	CHA	ERA	0								0
10	☑	PARE	ATI3	0								0
11	☑	SEWA	2	0	0	0	0	0	0	0	0	0
12	☑	DULH	AST	7	7	7	7	7	7	7	7	7
13	☑	RAMPUR		14	14	8	8	8	3	3	3	0
14	☑	TEHRI		40	40	2	2	2	2	2	2	53
15	☑	KOTESHW		48	48	81	81	81	84	84	84	84
16	☑	KOLDAM		0	0	0	0	0	0	0	0	0
17	☑	PONG		0	0	0	0	0	0	0	0	0
18	☑	DEHAR		5	5	5	5	5	17	17	17	17
19	☑	NJPC		51	51	26	26	26	13	13	13	0



Final Dispatched

	Generator	UP/DOWN	19:05-19:10	19:10-19:15	19:15-19:20	19:20-19:25	19:25-19:30
1	CHAMERA1	NHPC	-59	-59	-27	-27	-27
2	SEWA2	NHPC	-27	-27	0	0	0
3	RAMPUR	SJVNL	-23	-23	-11	-11	-11
4	TEHRI	THDC	0	0	-15	-15	-15
5	KOLDAM	NTPC	-40	-40	0	0	0
6	DEHAR	BBMB	-29	-29	-29	-29	-29
7	NJPC	SJVNL	-124	-124	-62	-62	-62
8	KOPILI	NEEPCO	-31	-31	-31	-31	-31
9	KOPILI2	NEEPCO	-3	-3	-3	-3	-3
10	LOKTAK	NHPC	-27	-27	-27	-27	-27
11	Total	UP/DOWN	-363	-363	-205	-205	-205

FRAS Software……(3)



SCADA Display

08-Jan-2019 17:21:45 FAST RESPONSE ANCILLARY SER

THERMAL	124784	NUCLEAR	3662	TOTAL	151553
HYDRO	15117	WIND	1644		
GAS	6143	SOLAR	1510	NET DEMAND	148399

S. NO.	PLANT NAME	REG.	STATE	TYPE *	INSTALLED CAPACITY	TOTAL (MW)	DC (MW) A	SCH (MW) B	ACTUAL (MW) C	UI (D=C-B)	FRAS Applied	Average (Daily) E	Maximum (Daily) F	Minimum (Daily) G	Declared Energy (Daily) H (MWh)	Generated Energy (Daily) (sch) I (MWh)	Available Margin (Daily) (MU) J=H-I
1	NATHPA-JHAKRI	N	HP	P	6x250	1500	1350	630	623	-7	0	262	1278	0	6800	8800	2517
2	BHAKRA	N	PUNJAB	S	5x108+5x157	1379	1129	1129	1134	5	0	571	1161	421	15129	10296	5910
3	TEHRI-I	N	UT 'KND	S	4x250	1000	1032	988	1012	24	0	401	1036	4	9880	6800	3302
4	KOLDAM	N	HP	P	4x200	800	872	396	387	-9	0	86	848	-9	2616	3544	1175
5	CHAMERA-I	N	HP	P	3x180	540	550	0	-3	0	0	69	547	0	2000	2300	-300
6	PARBATI-III	N	HP	P	4x130	520	0	0	0	0	0	0	0	0	0	507	-507
7	TEESTA	E	SIKKIM	R	3x170	510	314	314	315	1	0	58	357	-2	2529	937	1592
8	RAMPUR	N	HP	P	6x68.7	412	375	176	183	7	0	73	369	0	1891	2446	702
9	KOTESHWAR	N	UT 'KND	S	4x100	400	350	180	155	-25	0	142	402	54	3455	2340	1143
10	PONG	N	HP	S	6x66	396	260	260	265	4	0	234	267	119	5753	5866	1993
11	DULHASTI	N	J&K	P	3x130	390	265	257	262	5	0	3	262	0	1855	3700	1838
12	CHAMERA-II	N	HP	P	3x100	300	200	198	198	0	0	53	204	0	1338	1696	538
13	DHAULI GANGA	N	UT 'KND	P	4x70	280	291	138	138	0	0	34	284	0	1028	1349	479
14	CHAMERA-III	N	HP	P	3x77	231	0	0	0	0	0	0	0	0	0	913	-913
15	KOPILI-I	NE	ASSAM	S	4x50	200	96	96	97	1	0	97	97	97	2304	1564	740
16	SEWA-II	N	J&K	P	3x40	120	130	40	37	-3	0	14	127	0	390	390	0
17	LOKTAK	NE	MANIPUR	S	3x35	97	105	95	107	12	0	35	106	0	1097	538	559
18	DOYANG	NE	AP	S	3x25	75	36	33	18	-15	0	1	23	-2	153	15	137
19	KHANDONG	NE	ASSAM	S	2x25	50	0	0	0	0	0	0	0	0	0	0	0
20	KOPILI-II	NE	ASSAM	S	1x25	25	22	22	23	1	0	0	8	0	132	2	130
NORTHERN REGION					63 UNITS	8268	6804	4391	4255	1	0	0	0	0	52135	50946	17672
EASTERN REGION					3 UNITS	510	314	314	315	1	0	0	0	0	2529	0	1206
NORTH-EASTERN REGION					13 UNITS	447	259	246	245	-1	0	0	0	0	1382	0	1772
ALL INDIA					79 UNITS	9225	7377	4951	4815	1	0	0	0	0	56046	50946	20651

Sample FRAS Accounts

ERPC

EASTERN REGIONAL POWER COMMITTEE, KOLKATA-700033

FRAS Settlement Account by ERPC

Date: 14/12/2018

FRAS Account for Week: 26-Nov-18 to 02-Dec-18

Payments to the FRAS Provider(s) from the DSM pool

Sr.No	FRAS Provider Name	FRAS UP Esp(MWH)	FRAS DOWN Edown(MWH)	Mileage En(MWH)	Incentive as per CERC Order(Rs)	Total Charges (Rs)
1	TEESTA-V	9.583333	9.583333	19.166667	1916.67	1917
2	RANGIT	0	0	0	0	0

A) FRAS settlement account for the week 26-Nov-18 to 02-Dec-18 has been prepared based on the CERC order in petition No.07/SM/2018/Suo-Motu, dated 16.07.2018.

B) The incentive has been calculated at the rate of 10 Paisa/Kwh for mileage Energy.

NRPC

Northern Regional Power Committee

RRAS Settlement Account For The Week 26/11/2018 To 2/12/2018

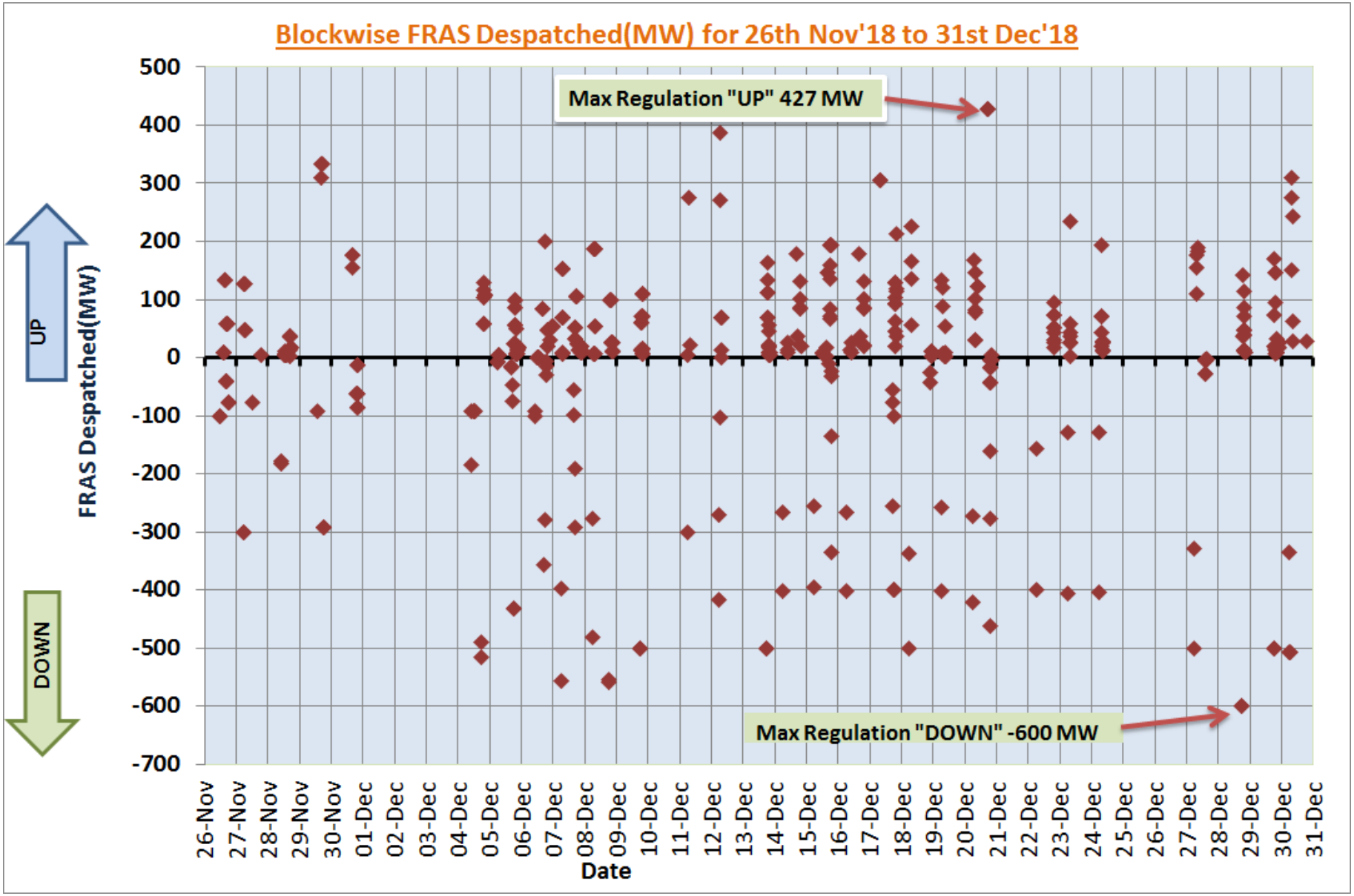
E. Payment to the FRAS Provider from the DSM Pool

Sr. No.	FRAS Provider Name	Up regulation due to FRAS (MWh)	Down regulation due to FRAS (MWh)	Markup Charges as per CERC order (Rs)
1	CHAMERA HEP	8.583333	8.499999	1708
2	CHAMERA-II HEP	1.666666	1.666666	333
3	CHAMERA-III HEP	4.166670	4.666666	883
4	DEHAR HEP	0.000000	0	0
5	DULHASTI HEP	28.083334	27.249999	5533
6	KOLDAM HEP	16.416668	16.083334	3250
7	KOTESHWAR	6.999999	6.749997	1375
8	NATHPA JHAKRI HEP	44.333336	44.500000	8883
9	PONG HEP	43.916665	63.500001	10742
10	PARBATI-III	0.000000	0	0
11	RAMPUR HEP	9.500002	9.249999	1875
12	SEWA-II HEP	0.000000	0	0
13	TEHRI HEP	42.916667	42.500002	8542
Total				43124

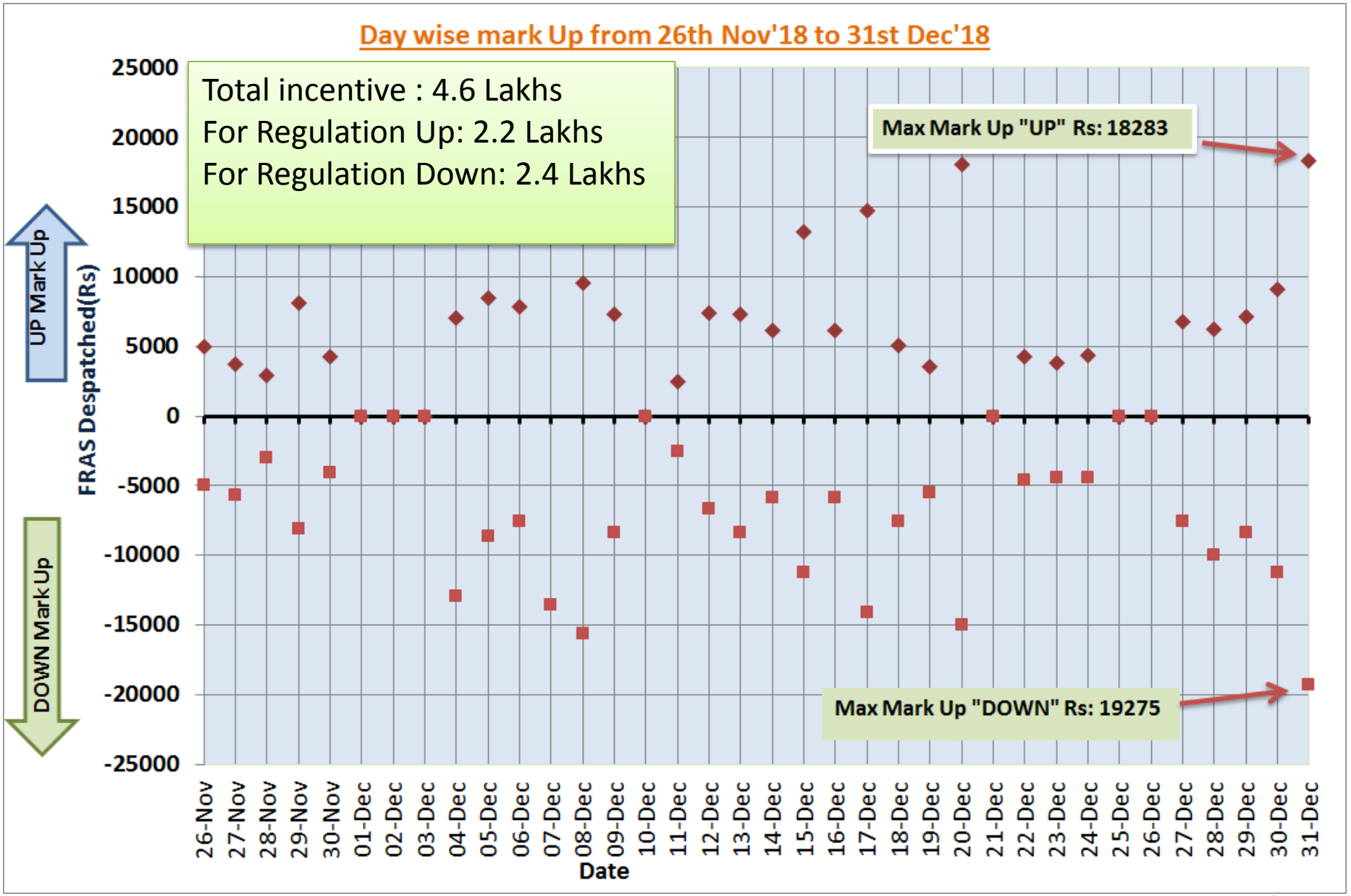
Note: Above calculations are based on the directions of Hon'ble CERC in order dated 16.07.2018 in Petition No. 07/SM/2018

NERPC yet to release FRAS account

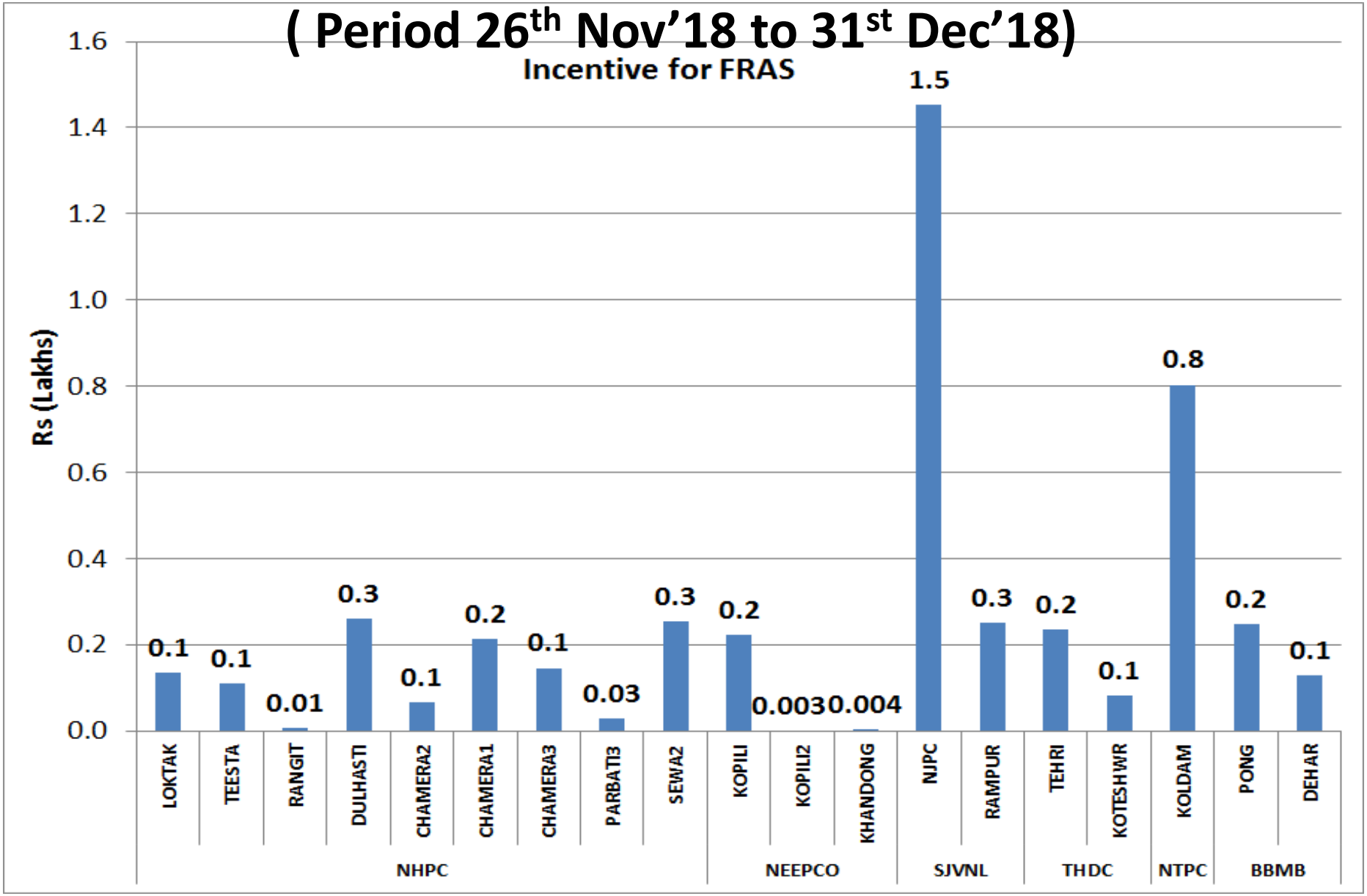
FRAS despatch



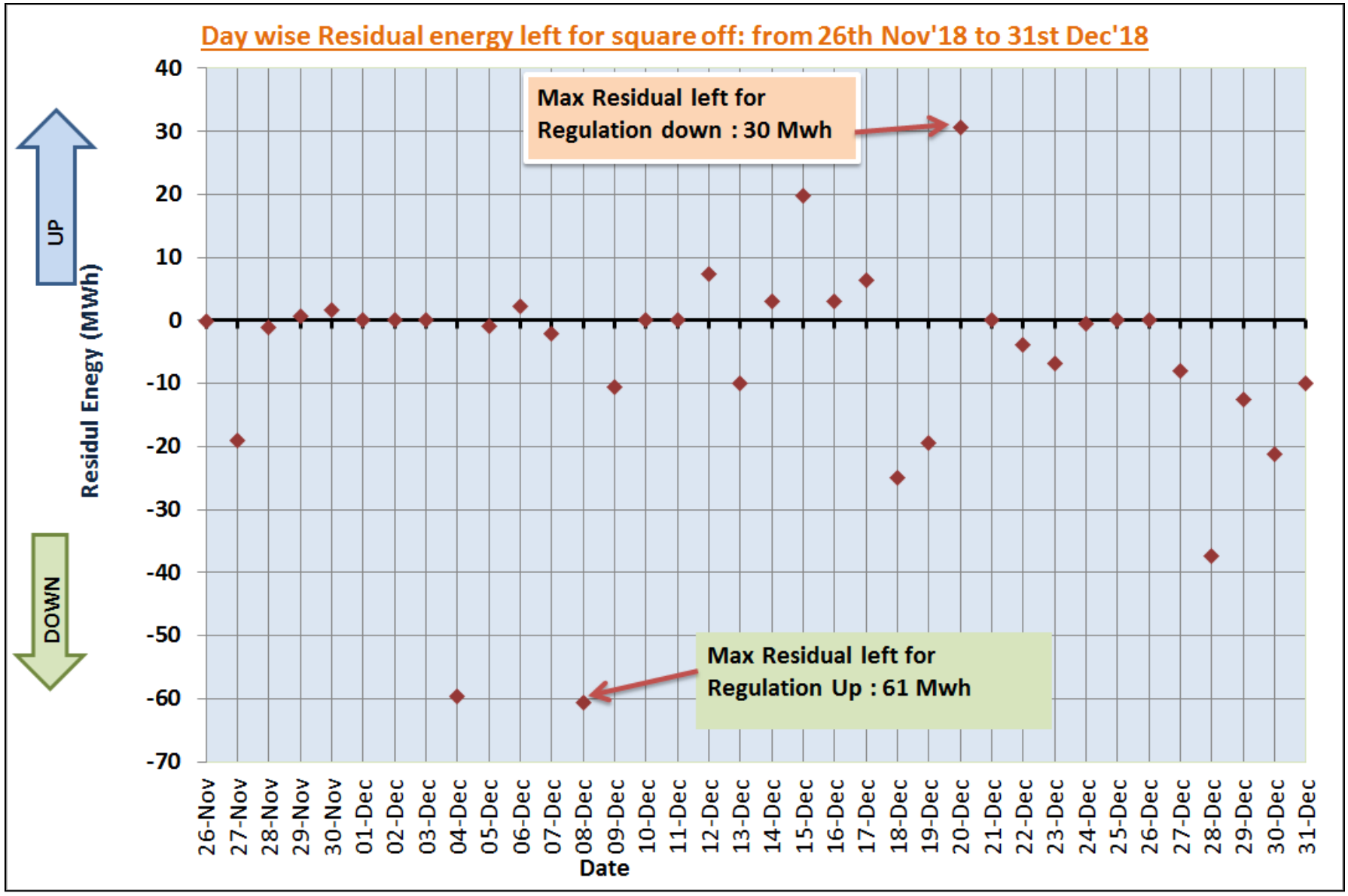
Incentive for FRAS



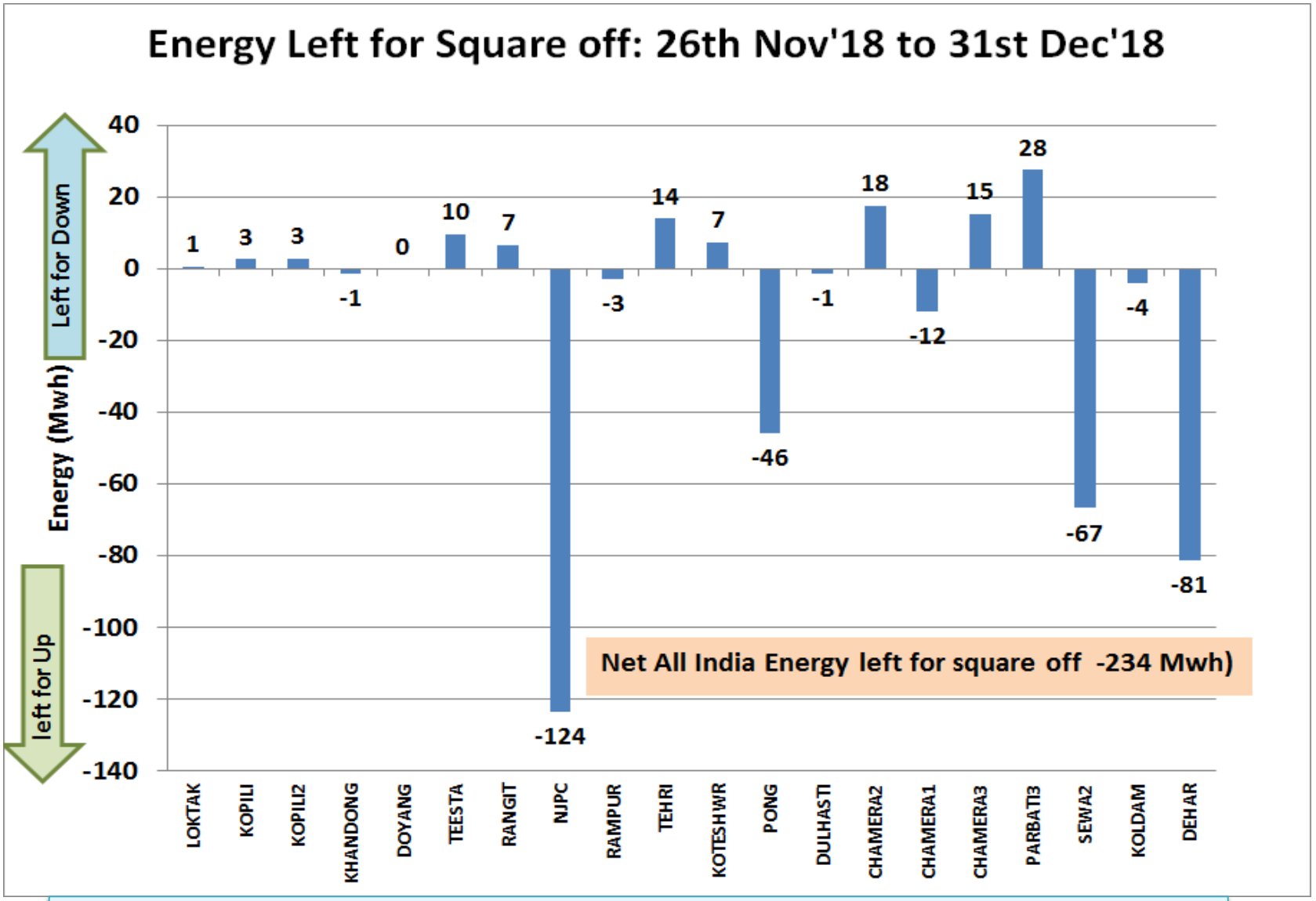
Plant wise Incentive for FRAS
(Period 26th Nov'18 to 31st Dec'18)



Daily energy left for square off



FRAS provider energy left for square off

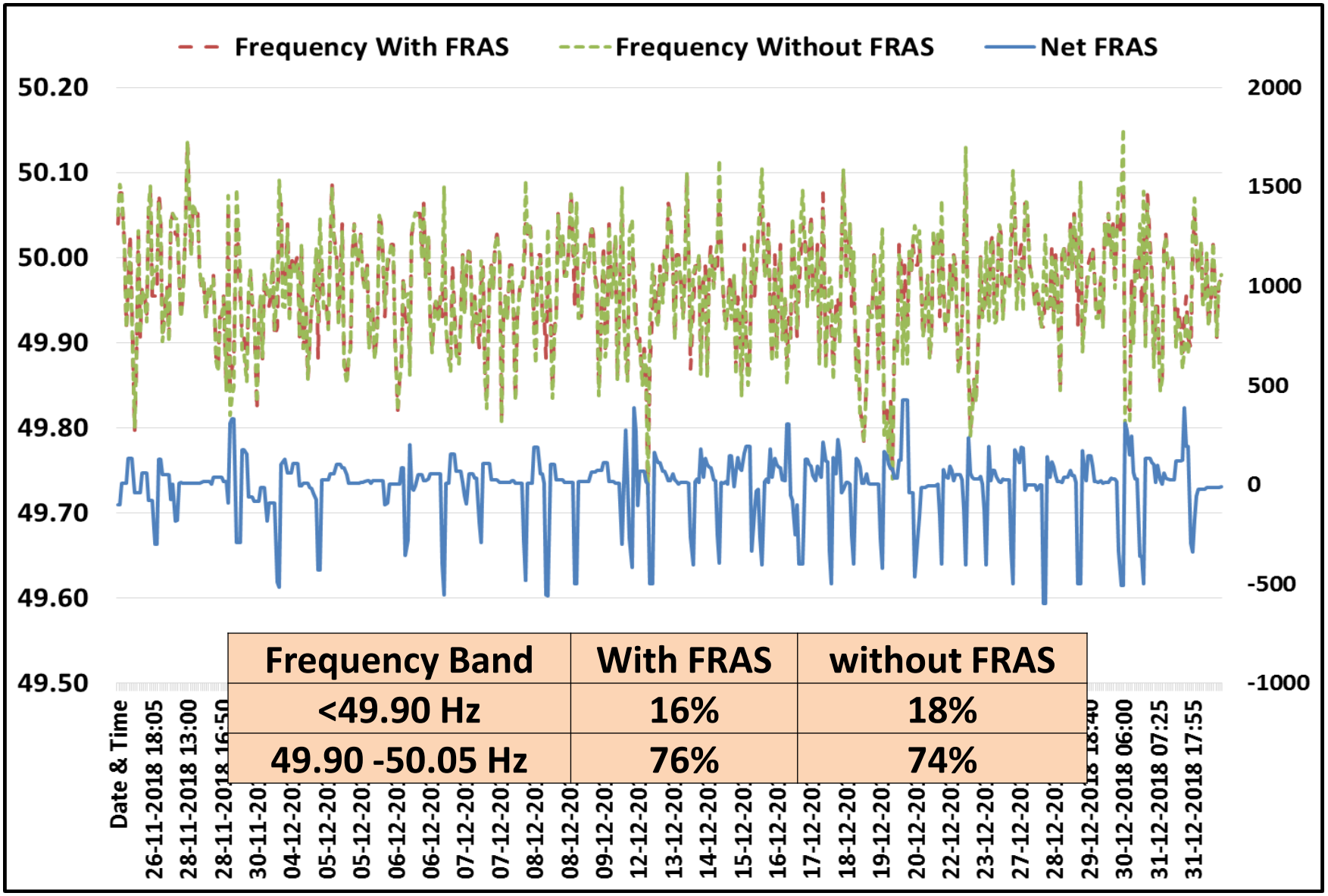


Left for Down : Counter instruction for decreasing the generation

Left for Up : Counter instruction for increasing the generation

Case study..(1)

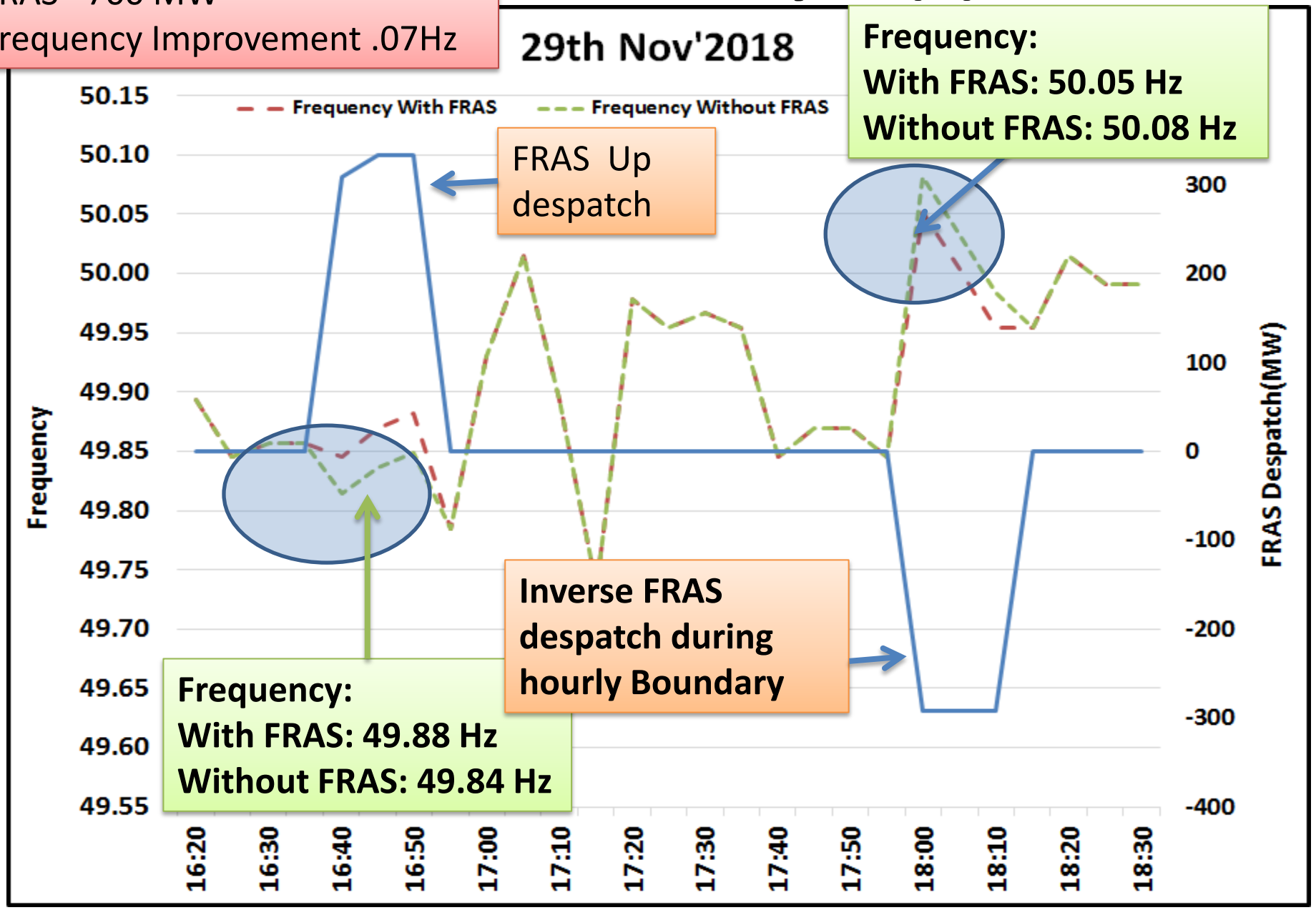
FRAS Despatch from 26th Nov to 31st Dec'18



Frequency Band	With FRAS	without FRAS
<49.90 Hz	16%	18%
49.90 -50.05 Hz	76%	74%

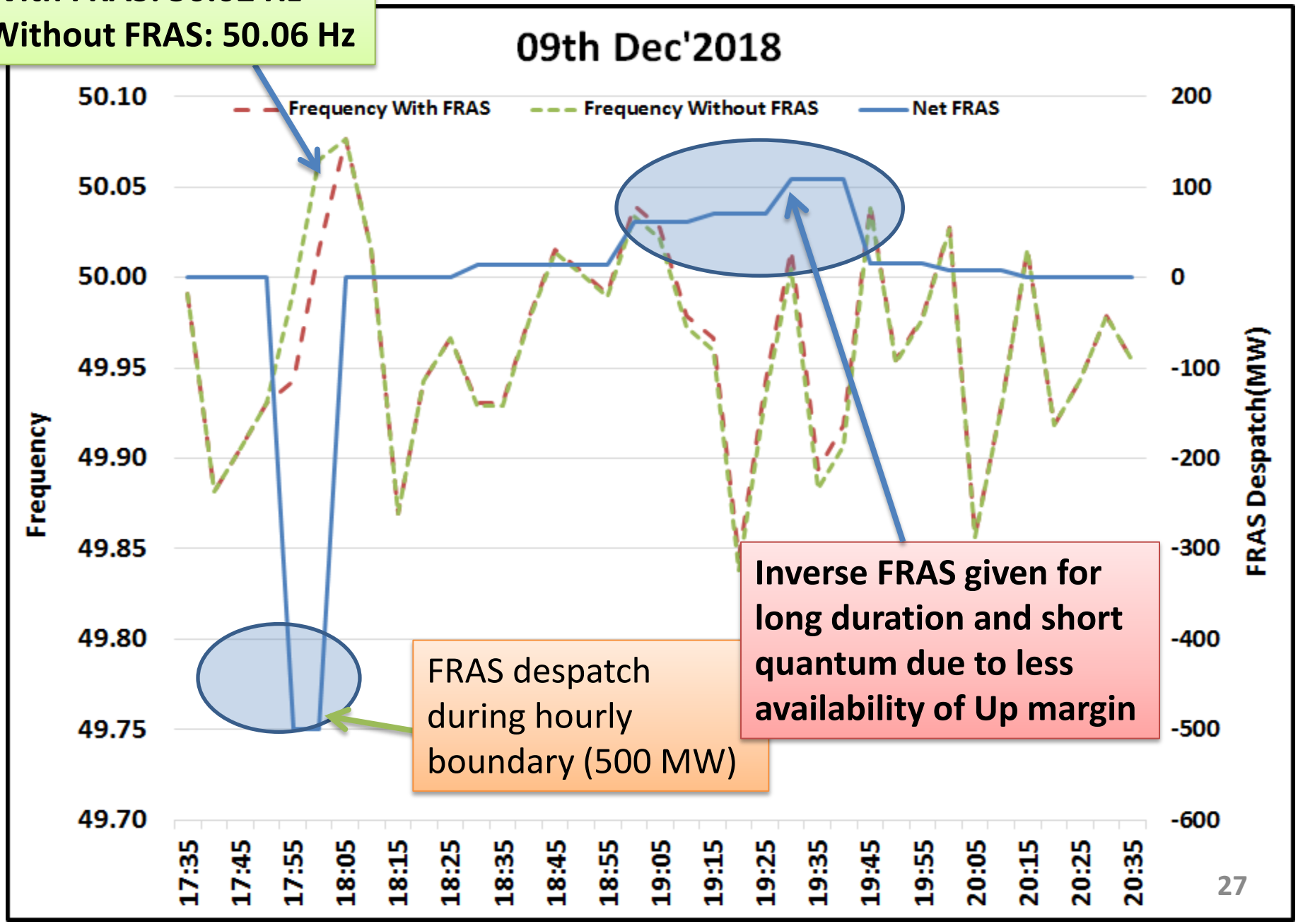
Case Study.....(2)

FRAS ~700 MW
Frequency Improvement .07Hz

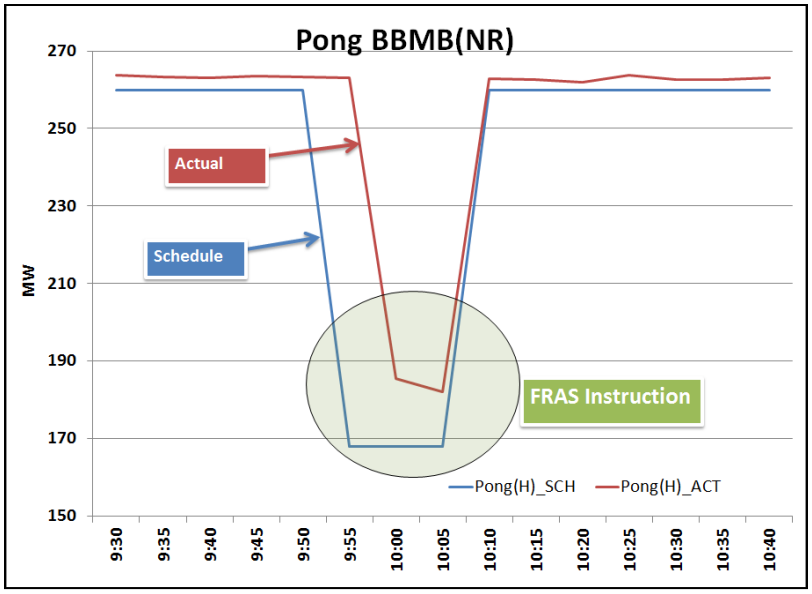


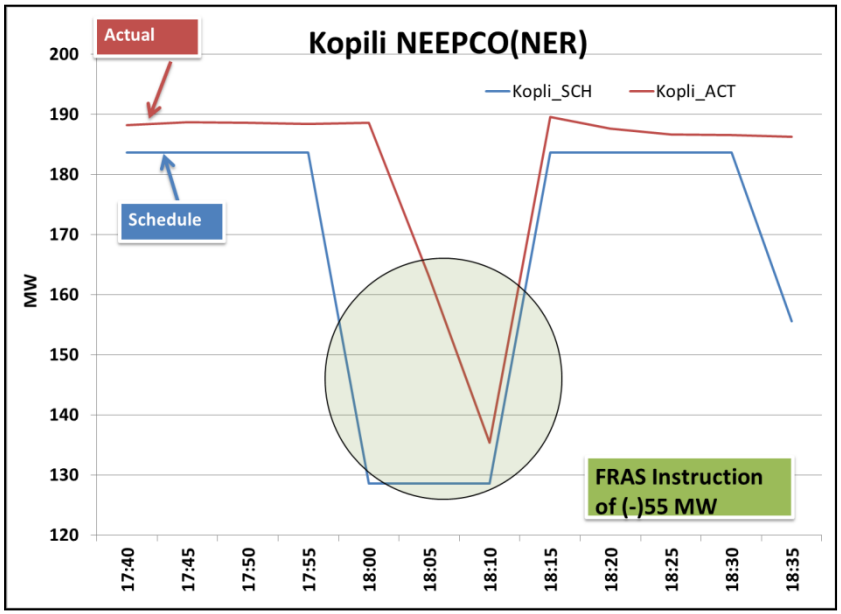
Case Study…..(3)

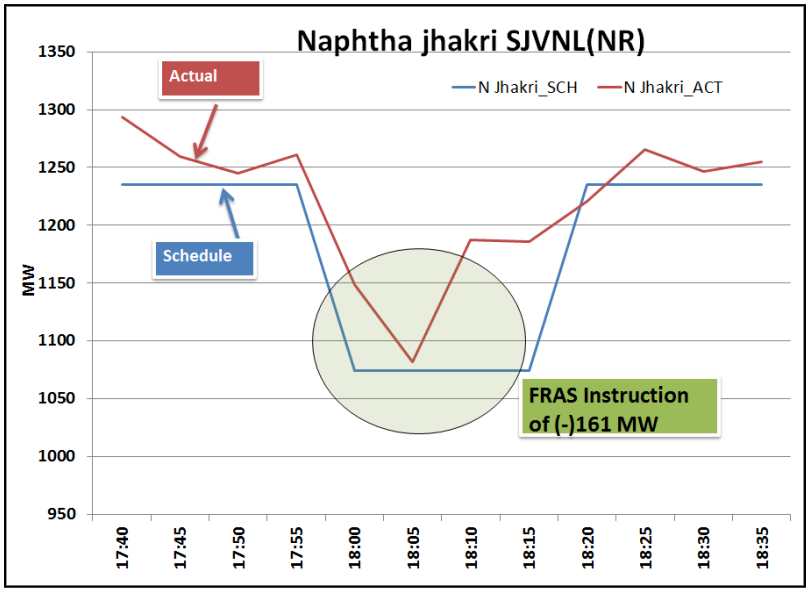
Frequency:
With FRAS: 50.02 Hz
Without FRAS: 50.06 Hz

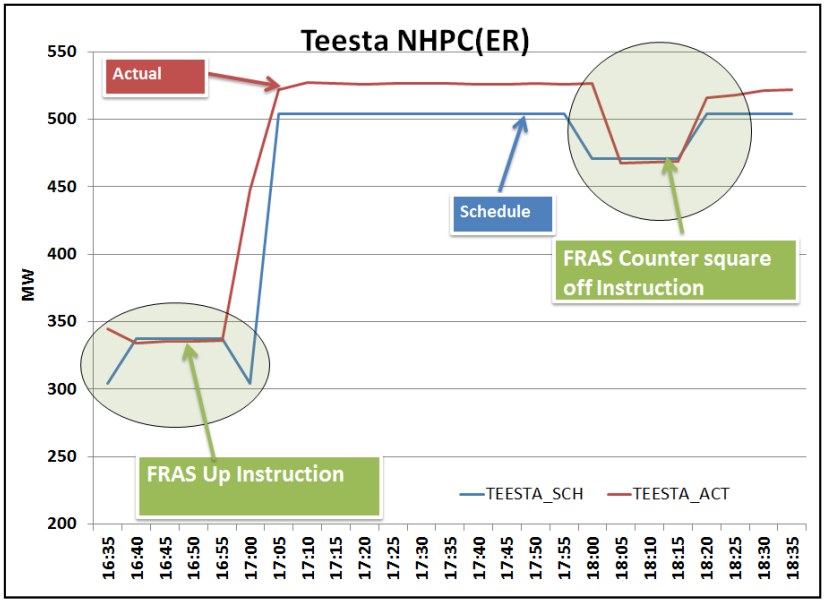


Sample Plant Response to FRAS



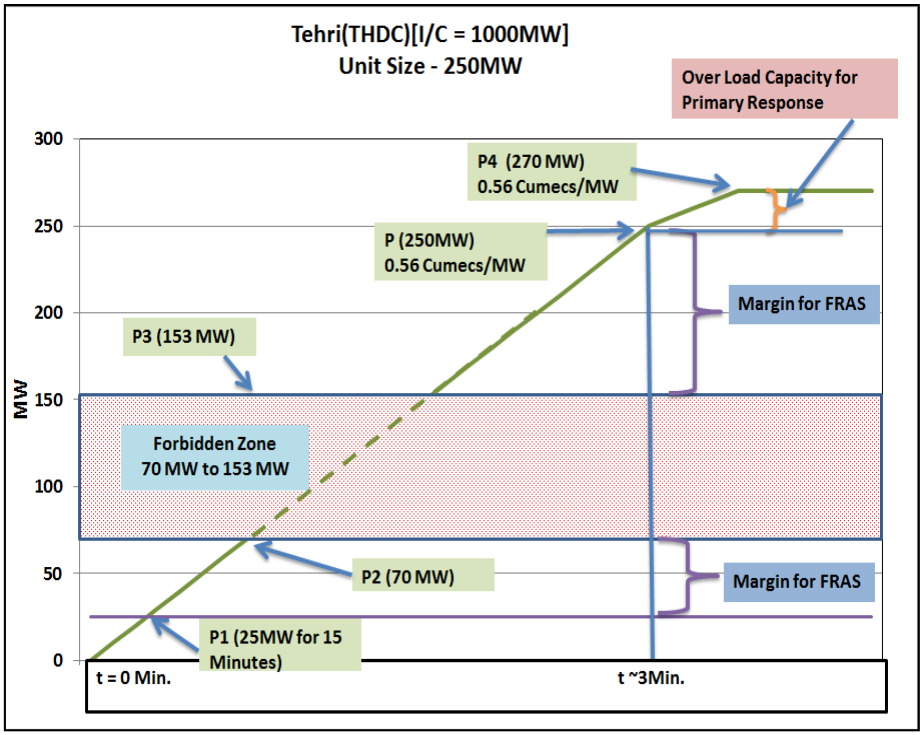




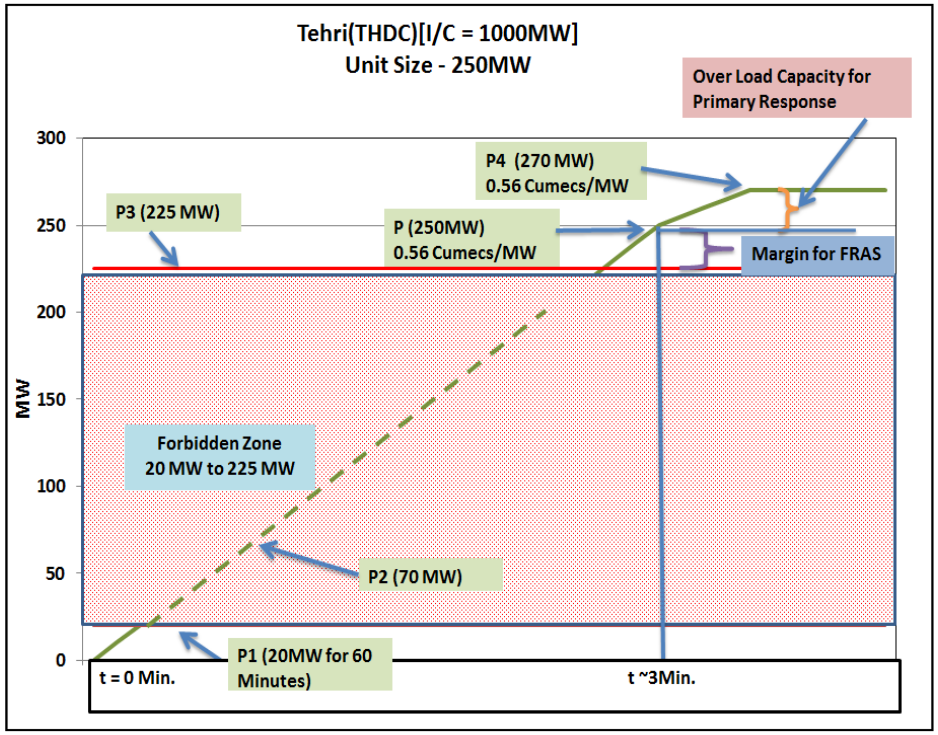


Variation in Plant Parameters

Data Submitted during FRAS Implementation stage



Revised Data Submitted



Draft CERC Terms and Conditions of Tariff) Regulations, 2019

"Norms of operation for hydro generating stations:

In case of storage and pondage type plants with head variation between full reservoir level and minimum draw down level is more than 8% and when 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."

Key Learnings

- Introduction of fast tertiary response in India
- Layer of Centralized Fast Response Ancillary Despatch (from regional to national level) over Decentralized Layer of Scheduling Process
- First time 5-minute scheduling, despatch, accounting and settlement
- Customised FRAS software solution developed In-house.
- Optimization of Hydro generation
- Improved Handling of Frequency Spikes
- Benefits to stakeholders – Hydro Generators & State Utilities
- Freedom and Choice available to states retained
- Cost of Implementation low
- All constraints honoured in FRAS despatch
- Information Dissemination
- Communication between FRAS Providers and NLDC

Challenges

- Lead Time for Communication of Instructions
- Dilemma of Reserves in Hydro plants
  - Need for Streamlining of Scheduling Process
  - Need for More Hydro machines on Bar
  - Need for 15-Minute block wise unit commitment by FRAS Provider schedule to the respective RLDCs.
- Non-squaring off
  - Minor variations in terms of schedule energy vis-a-vis the declared energy
  - Need for HEPs to provide 10-day assessment of energy to be generated based on the projected reservoir levels and water release/discharge requirements.
- Non-availability of FRAS at peak times
  - Scheduling of generation at the peak hours is at the maximum.
- Variation in Plant Parameters with variation in head leads to less flexibility
- Better Hydro generation forecasting
- Gate Closure for Scheduling Process
- Automation, IT Infrastructure and Manpower
- Metrics for Performance Monitoring – 05 Minute Metering

Way Forward

- Unit commitment : More machines to be kept on bar.
- Treatment for residual small energy
  - Plant to be compensated with Energy charge.
  - Square of in D+1.
- Gate Closure for Scheduling Process.
- 5-minute hydro scheduling.
- Performance monitoring of Hydro station.
- Pilot to continue for say 6 months.
- Review of hydro station data submitted for better utilization of flexibility of station.

DISCUSSION