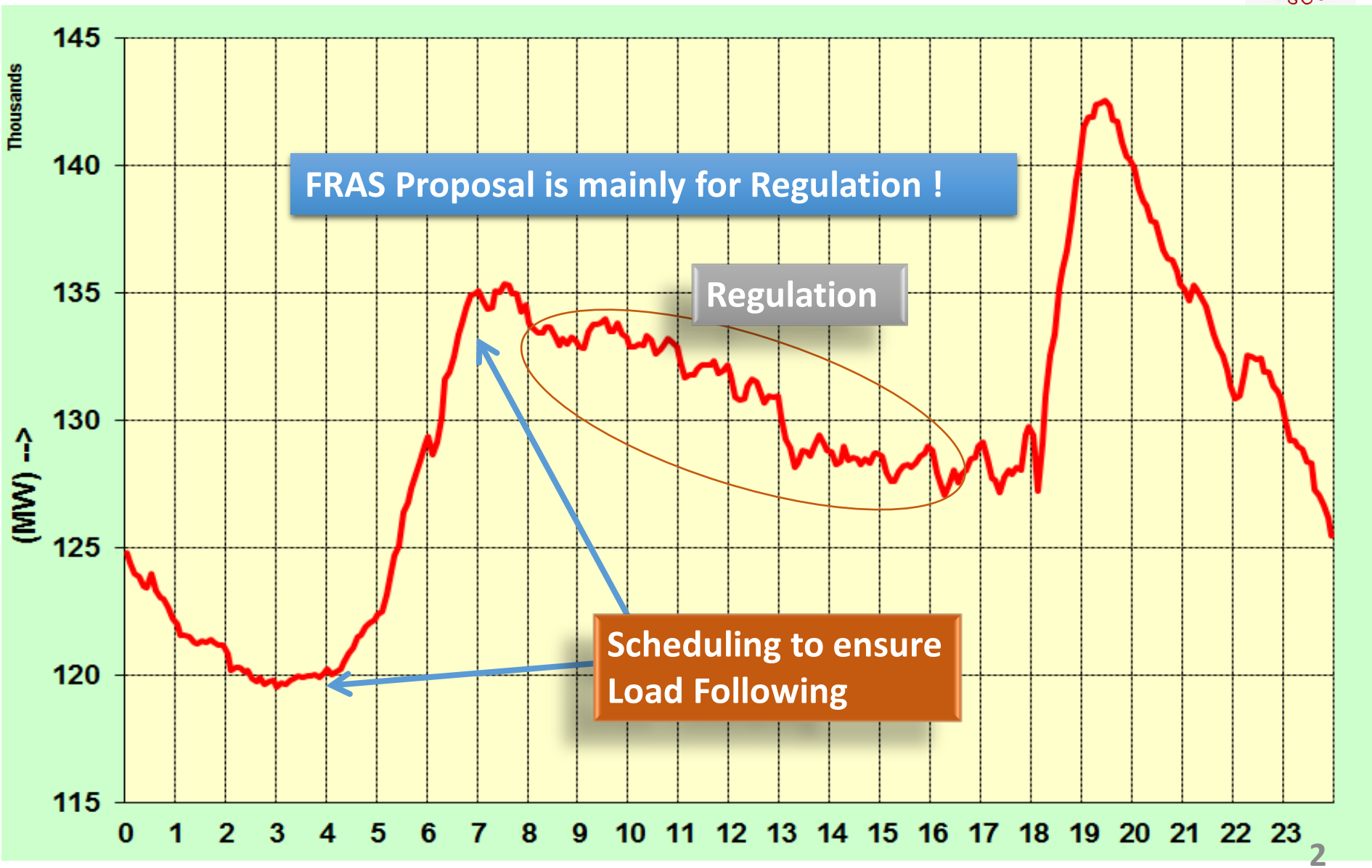
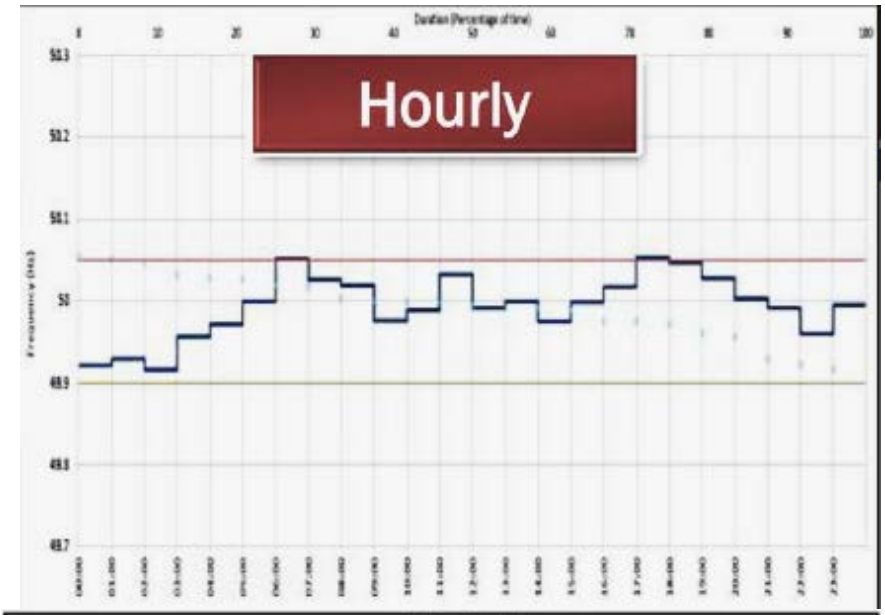
Fast Response Ancillary Services

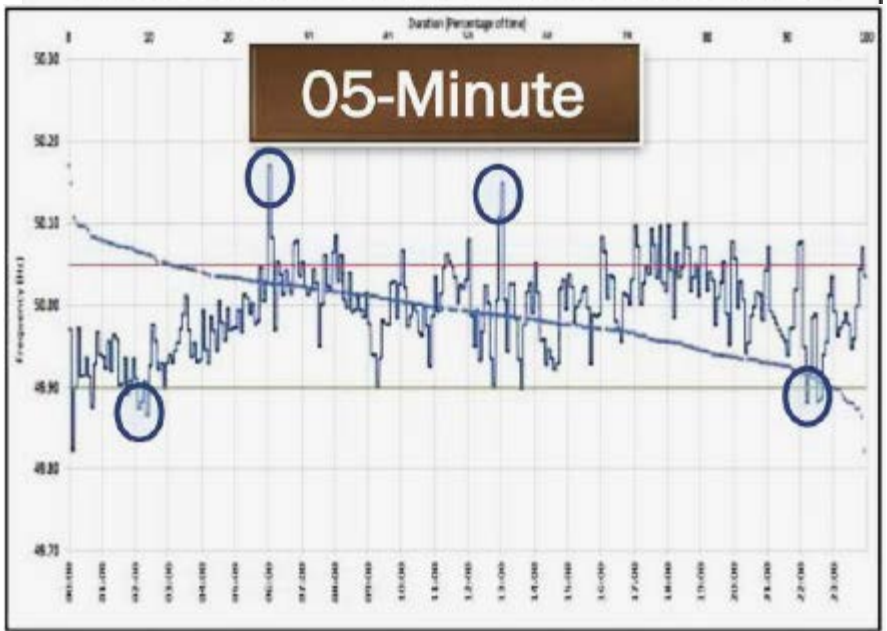
ERLDC, POSOCO

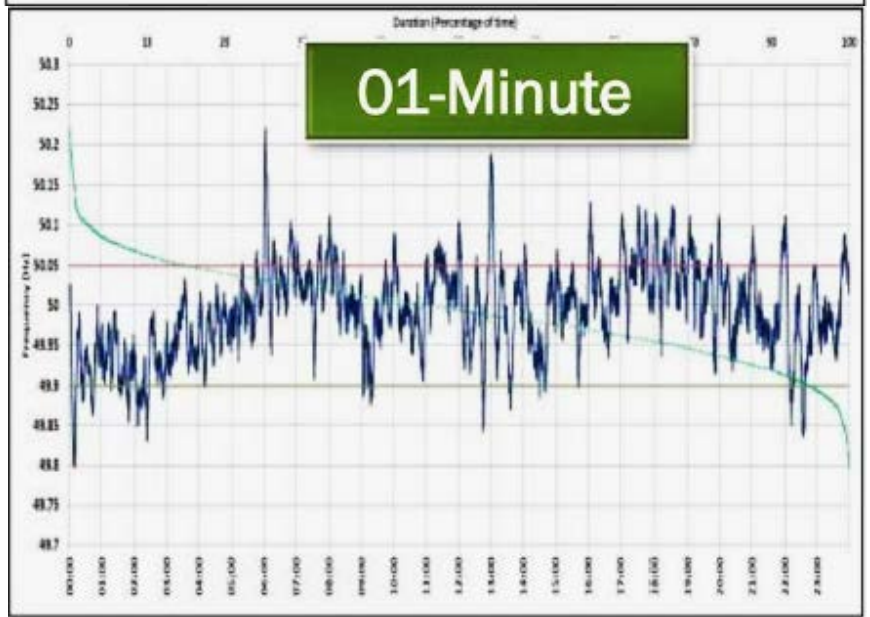
Load Following and Regulation



Frequency Profile – Different Time Scales







Utilization of existing hydro resources

- At the 13th Technical Committee Meeting of FOR POSOCO presented on the topic “Optimization of Hydro resources”. Key highlights:
  - All-India Hydro installed capacity ~45 GW, of which about 12 GW are ISGS projects and balance are within the States
  - With optimum utilization, hydro can be significantly used for peaking demand
  - Can enhance PLF of thermal plants by ensuring hydro plants are not run during off-peak hours
  - States are also required to adopt aforementioned CERC principles in the state-level hydro tariff regulations

Endorsing the role of hydro plants

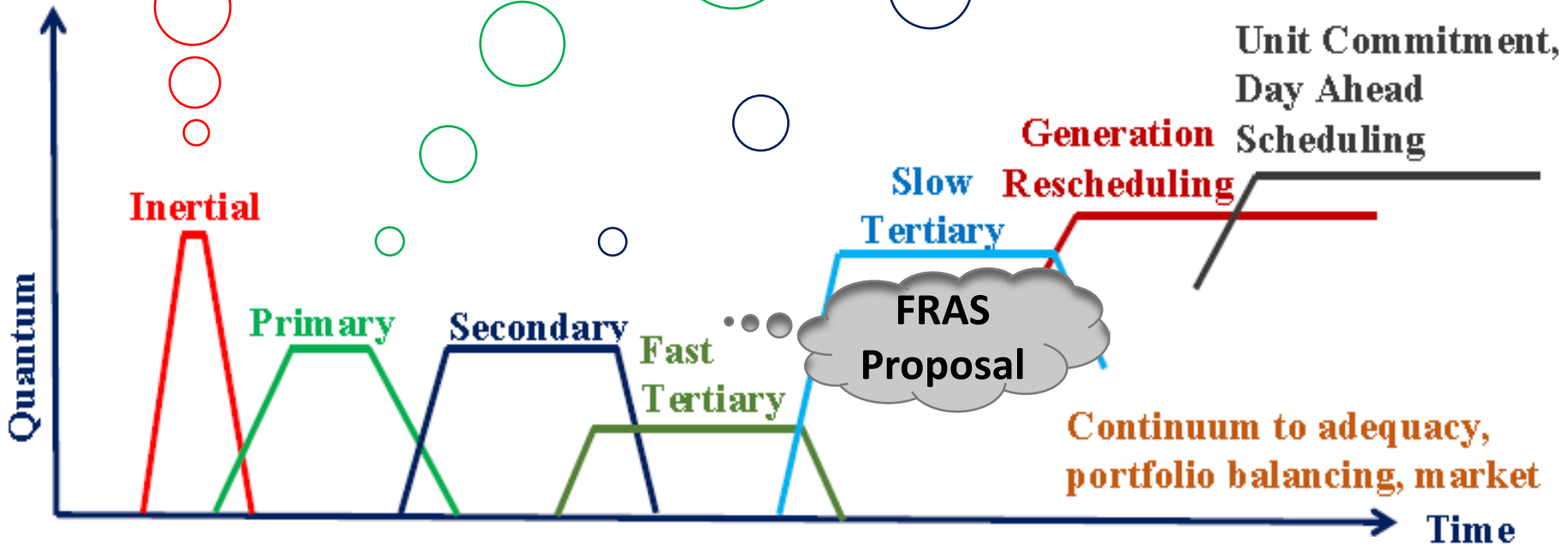
- Hydro generating stations are capable of providing a fast ramping capability
- Can be gainfully utilized for frequency regulation services to meet the system requirements
- The total energy despatched for hydro under FRAS is to be made zero and hence, no energy charges shall be payable
- A presentation on FRAS from Hydro Generators was made at the 63rd Meeting of FOR
- The Forum endorsed the recommendations of the Technical Committee for pilot studies on FRAS for Hydro, along with pilot studies on 5-Minutes Scheduling, Metering, Accounting and Settlement

Role of Hydro in System Balancing in India

Inertia Decreasing, 175 GW RE, Need to have more hydro machines

Mandated as per Grid Code for all; Need for faster response from Hydro

AGC Pilot Project Operational; Hydro stations may be put on AGC on pilot basis



Present Issues in Hydro Scheduling under RRAS

Need for fast regulation service and ramping support

Hydro : Energy limited Resource

Thermal: Ramp limited Resource

Other than power generation commitments

Marginal Cost is zero

And hence, FRAS Proposal…

Sl No	Name	Utility	Region	Type (S/R/P)	I/C (MW)
1	Teesta-V	NHPC	ER	P	510
2	Rangit			P	60
3	Bairasiul		NR	P	180
4	Chamera-II			P	300
5	Chamera-I			P	540
6	Uri Stage – I			R	480
7	Salal			R	690
8	Dhauliganga			P	280
9	Tanakpur			R	94.2
10	Chamera-III			P	231
11	Parbati III			P	520
12	Sewa-II			P	120
13	Dulhasti			P	390
14	Uri Stage – II			R	240
15	Naptha Jhakri	SJVN		P	1500
16	Rampur			P	412
17	Tehri	THDC		S	1000
18	Koteshwar			S	400
19	Koldam	NTPC		P	800
20	Kopili	NEEPCO	NER	S	200
21	Kopili-II			S	25
22	Khandong			S	50
23	Ranganadi			P	405
24	Loktak	NHPC		S	105
25	Pong	BBMB	NR	S	396
26	Dehar			R	990
27	Bhakra complex			S	1379
			Total		**12297**

ISGS Hydro Plants in different regions - their capacity and type

Type	MW
Storage (S)	3555
RoR with Pondage (P)	6248
RoR (R)	2494
Total	12297

Proposal - Fast Response Ancillary Service (1)

- Stack of hydropower stations
  - Based on MW regulation possible by plant, balance energy etc.
  - Factoring congestion

- Despatch Instructions from Nodal Agency
  - FRAS Regulation Up (maximum available balance energy/reserve/MW)
  - FRAS Regulation Down (minimum available balance energy/reserve/MW)
  - Net energy squared off for each hydro station same day
    [Net energy $E_{net} = \Sigma E_{up} - \Sigma E_{down}$(in MWh) should be zero over the day]
  - Combination of FRAS Regulation Up and Down despatch instructions

- Only for short durations ($\not>$5-6 dispatches in a day)

- Reservoir based stations priority over pondage based stations

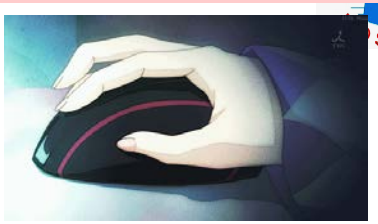
Proposal - Fast Response Ancillary Service (2)

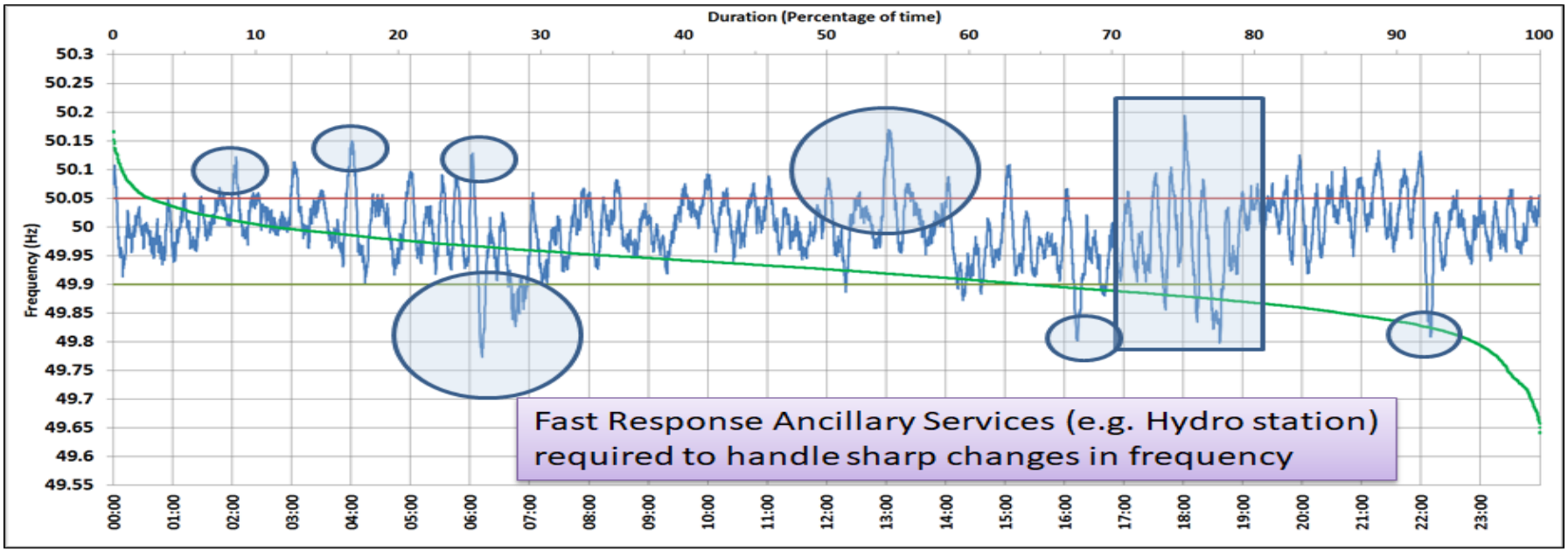
- Scheduling
  - 5 - minute FRAS despatch schedules by Nodal Agency
    - Aggregated (3 five minute blocks)
    - Compatibility with the existing scheduling philosophy
    - Settlement and deviation accounting purposes
  - Regional Virtual Ancillary Entity – Hydro or VAE-H
    - Counterparty to FRAS despatch instructions

- Accounting and Settlement
  - No fixed charge or variable charges to be paid
  - Incentive on mileage basis
    - $E_m = \Sigma \mid E_{up} \mid + \Sigma \mid E_{down} \mid$
    - To start with, 10p/kWh for both regulation UP & DOWN services

Triggering Criteria

- Hour boundary frequency changes
- Sudden changes in demand
- Ramp management
- Grid contingency
- RE Variation



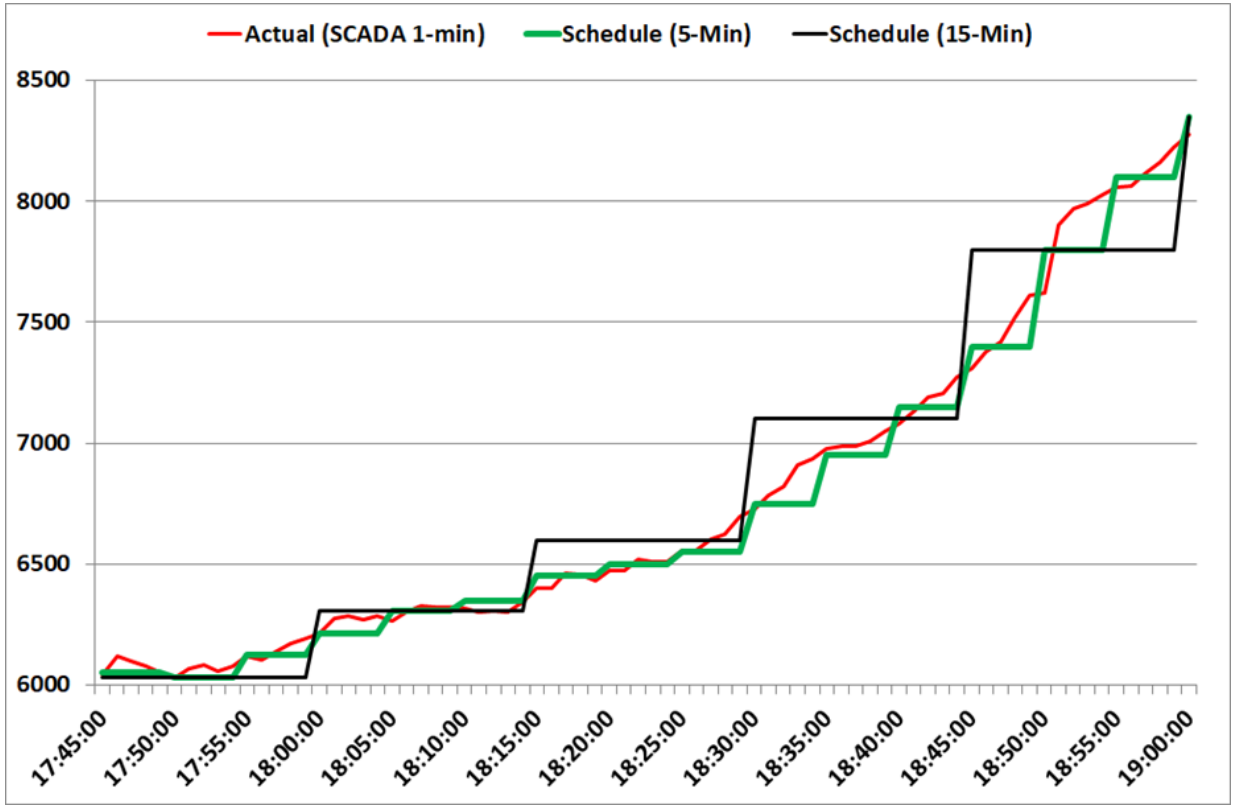


<49.7	<49.90	<49.97	49.7-49.8	49.8-49.9	49.9-50.0	50.0-50.1	50.1-50.2	49.90-50.05	49.7-50.2	49.97-50.03	50.05-50.1	>50	>50.03	>50.05	>50.2
0.00	4.61	29.05	0.21	4.40	44.47	48.37	2.56	79.22	100.00	43.31	13.65	50.86	27.64	16.17	0.00

Average Frequency :	49.997	Frequency Variation Index :	0.032	Standard Deviation :	0.056	Mileage	45.61

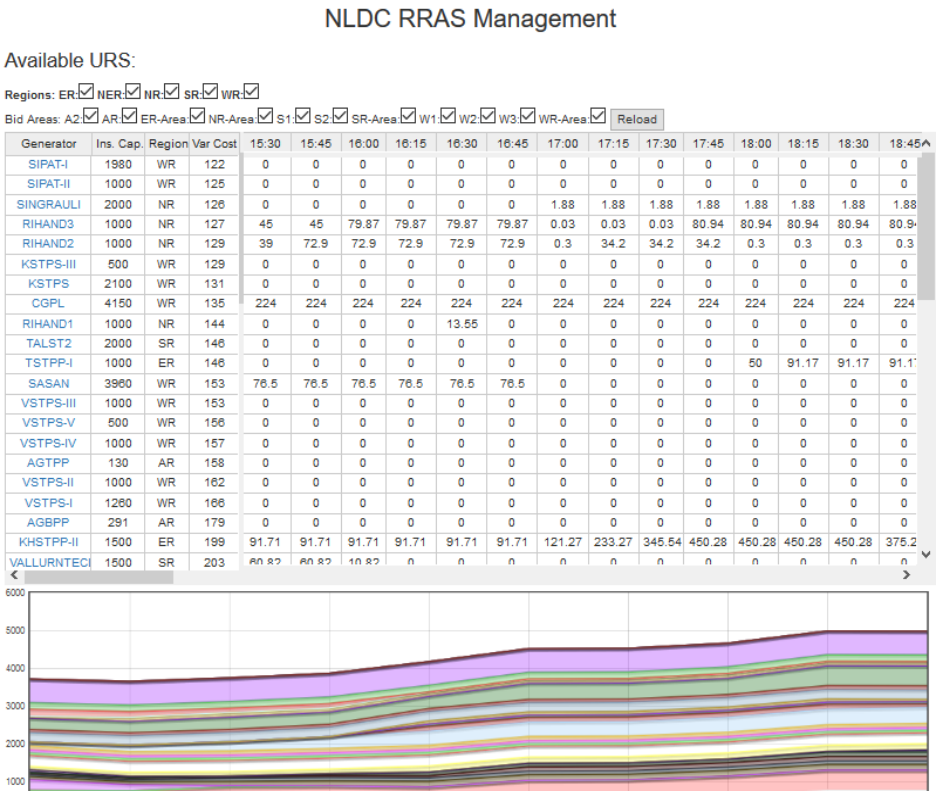
Scheduling and Settlement

- FOR Technical Committee Sub-Group
  - Introduction of Five Minute Scheduling, Metering, Accounting and Settlement in Indian Electricity Market
  - Pilot Project Envisaged - in Parallel with 15-Minute Framework
- Three Regions (NR, ER and NER) – Central Sector Hydro Stations
  - 05 Minute Scheduling, 05 Minute Metering, 05 Minute Deviation Settlement



Data Exchanges

- **NLDC/RLDCs with FRAS Providers**
  - Web based Automated Solution
  - Technical Details for FRAS Despatch
  - Telephonic/SMS/E-mail
- **FRAS Providers and RPCs**
  - Ancillary Services information
  - Accounting & Settlement
- **Information on NLDC Website**
  - FRAS Instruction Summary
  - Monthly report
  - FRAS Providers details

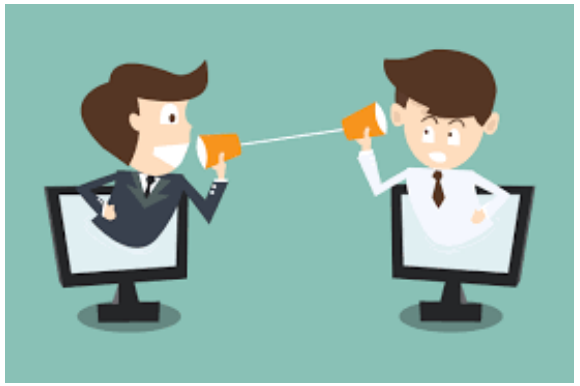

NLDC RRAS Management

Available URS:

Regions: ER:☑ NER:☑ NR:☑ SR:☑ WR:☑

Bid Areas: A2:☑ AR:☑ ER-Area:☑ NR-Area:☑ S1:☑ S2:☑ SR-Area:☑ W1:☑ W2:☑ W3:☑ WR-Area:☑ Reload

Generator	Ins. Cap.	Region	Var Cost	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45
SIPAT-I	1980	WR	122	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SIPAT-II	1000	WR	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SINGRAULI	2000	NR	126	0	0	0	0	0	0	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
RIHAND3	1000	NR	127	45	45	79.87	79.87	79.87	79.87	0.03	0.03	0.03	80.94	80.94	80.94	80.94	80.9
RIHAND2	1000	NR	129	39	72.9	72.9	72.9	72.9	72.9	0.3	34.2	34.2	34.2	0.3	0.3	0.3	0.3
KSTPS-III	500	WR	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KSTPS	2100	WR	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CGPL	4150	WR	135	224	224	224	224	224	224	224	224	224	224	224	224	224	224
RIHAND1	1000	NR	144	0	0	0	0	13.55	0	0	0	0	0	0	0	0	0
TALST2	2000	SR	146	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TSTPP-I	1000	ER	146	0	0	0	0	0	0	0	0	0	0	50	91.17	91.17	91.1
SASAN	3960	WR	153	76.5	76.5	76.5	76.5	76.5	76.5	0	0	0	0	0	0	0	0
VSTPS-III	1000	WR	153	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSTPS-V	500	WR	156	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSTPS-IV	1000	WR	157	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AGTPP	130	AR	158	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSTPS-II	1000	WR	162	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSTPS-I	1260	WR	166	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AGBPP	291	AR	179	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KHSTPP-II	1500	ER	199	91.71	91.71	91.71	91.71	91.71	91.71	121.27	233.27	345.54	450.28	450.28	450.28	450.28	375.2
VALLURNTECI	1500	SR	203	60.82	60.82	10.82	0	0	0	0	0	0	0	0	0	0	0



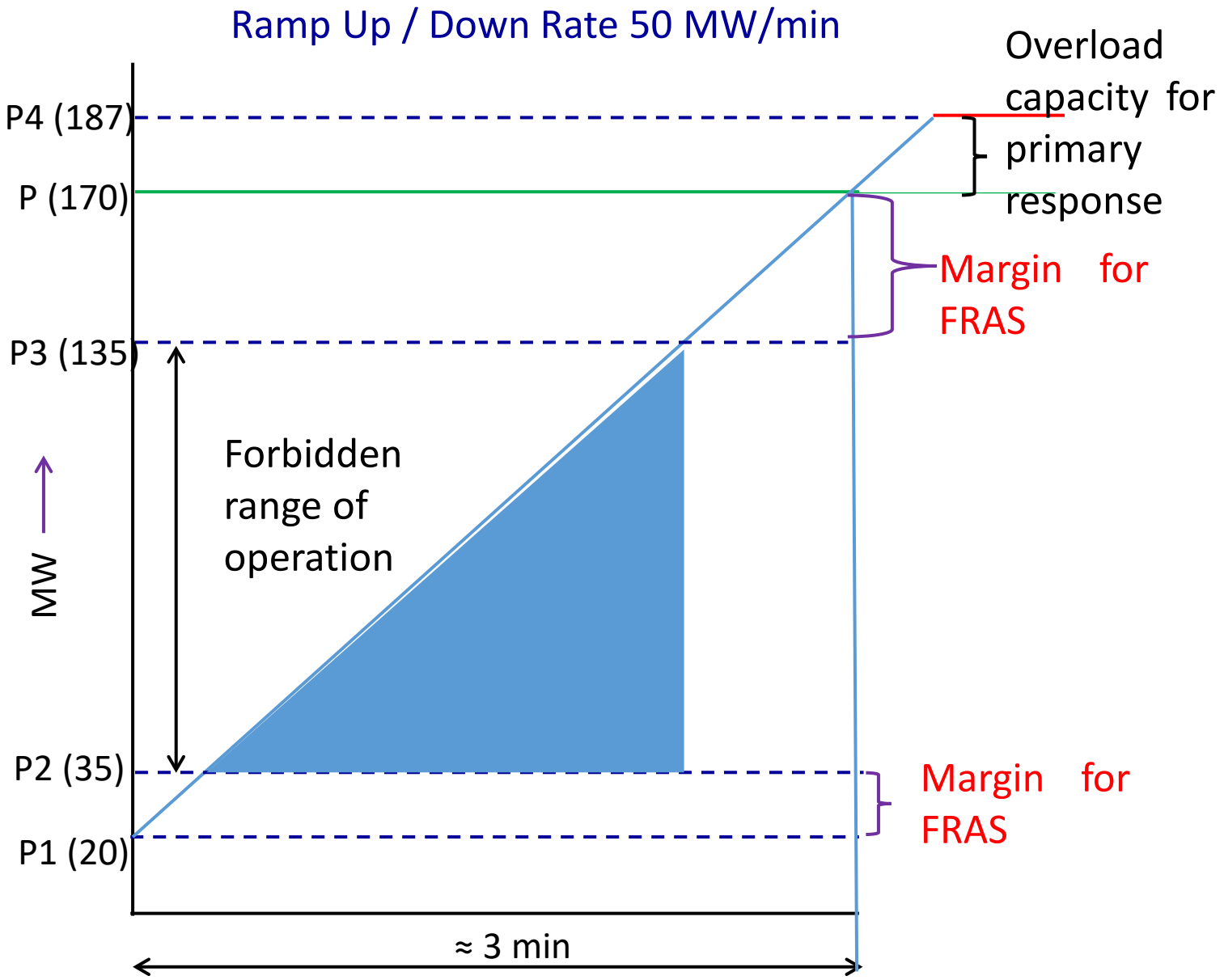
Discussion with Central Sector Hydro Generators

- Meeting held on 09th March, 2018 at NLDC, Delhi
- Participants
  - CEA, NHPC, SJVN, BBMB, THDC, NEEPCO, NTPC and POSOCO
- Deliberations held & broad consensus achieved
  - FRAS Implementation
  - Primary Response improvement through droop settings
  - 5-Minute scheduling, despatch and settlement on pilot basis
  - Other ancillary services – reactive power, black start
  - Need for fast communication of instructions
  - Mark up for regulation– to be decided by CERC

Information Requirement of Hydro Units

- Installed capacity of unit =P
- Start time; standstill to synchronization of unit to grid (in minutes)
- Minimum load at which unit stably run after synchronization (MW) - P1
- Ramp rate (MW/min)
- Forbidden zone or high cavitation zone (From MW to MW) - P2 to P3
- Maximum loading possible on unit (continuous) P4 (Note; range from P to P4 should be normally available for primary response unless it is a case of overflowing hydro)
- Cumecs/MW for P1, P3, P and P4 generation level as well as cumecs from standstill to synchronization. Which value is used for declaring MWh capability?
- How many units can be started simultaneously or is it sequential operation? The constraints in this regard.

Teesta-V HPS; Unit size 170 MW



Honouring Constraints

- Drinking Water
- Irrigation
- Contractual Obligations with State Government
- Weather Phenomena, Monsoon etc.
- Legacy Control System
- Wildlife
- Water level and Head
- High Silt, flash floods, Cloud burst, Land slides
- Shortage of Skilled and Unskilled Manpower
- Acidic Corrosion and Erosion
- Special Occasions like Water Sport activities, Snan, Mela etc.
- Any other…

A Small Step for Hydro….

A Giant Leap for Indian Power System