MINUTES OF TWELFTH MEETING OF FORUM OF REGULATORS (FOR) "TECHNICAL COMMITTEE FOR IMPLEMENTATION OF FRAMEWORK ON RENEWABLES AT THE STATE LEVEL"

Venue	:	The Chancery Pavilion 135 Residency Road Bengaluru
Date	:	30th May 2017
List of Participants	:	At **Annexure – I (enclosed)**

The Twelfth meeting of FOR 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 30th May 2017. He extended a warm welcome to Chairperson KERC, Members of the Committee, special invitee as well as officers from various institutions. He thanked the Karnataka Commission for hosting the meeting in Bengaluru and for the warm hospitality. He stated that the Committee had come a long way in pursuance of its objectives. He also emphasized the need to implement the recommendations of SAMAST report right away, underlining that majority of the items in the final checklist *(copy of the checklist at Annexure – II)* need minimal monetary resources for implementation.

Thereafter, Chairperson KERC also welcomed the dignitaries and the officers, and wished fruitful deliberations over the day. He acknowledged the benefit of SAMAST roadmap to Karnataka SLDC and other stakeholders. He stated that grid integration of renewable energy (RE) and grid management is a challenge, which can be addressed through appropriate regulations and interventions such as SAMAST. He said Karnataka is enthused by the support received by states such as Tamil Nadu and Andhra Pradesh, and his team will speed up the preparation of DPR. He updated the Committee that Forecasting & Scheduling (F&S) Regulations (for solar/wind generators) and Deviation Settlement Mechanism (DSM) were

going to be implemented in the State by June 1st. He also requested the Committee to examine the mismatch between load peak vis-à-vis the supply peak from Solar projects.

Shri A.S.Bakshi thanked Karnataka for leading the States on Regulations for Forecasting, Scheduling (F&S) and Deviation Settlement for Solar/Wind generators. He enlisted the following critical next steps for grid integration of RE in Karnataka and other States:

- Creation of a State Power Committee, on the lines of National Power Committee
- Each State to have a small group to oversee implementation of SAMAST and RE regulations, comprising representatives from SLDC, concerned RLDC and RPC.
- Operationalizing of primary reserves at the State level
- Operationalizing of Ancillary Services at the State level

Discussion

1. Agenda #1: Update on SAMAST for State of Karnataka

   Shri R.Thyagaraj, Superintending Engineer, KPTCL, presented the status of implementation of SAMAST framework in Karnataka *(copy of presentation at Annexure-III)*. He updated that SCADA RTU has been provided to 94% of all stations (sub-stations, receiving and generating stations). KPTCL has submitted a DPR for optical fibre communication to all its major generating stations to CEA for PSDF funding. Additionally, DPR for implementation of all SAMAST recommendations shall be submitted to CEA by June 25th, 2017. The target date for completion of implementation of the framework is July 2018.

2. Agenda #2: Karnataka F&S Regulations for Wind/Solar generators

   Shri Thyagaraj also shared the challenges of RE integration in the State grid *(copy of presentation at Annexure-IV)*. He elaborated on preparedness of SLDC for rolling out

forecasting and scheduling processes. He updated that a State pool account has been opened by SLDC for collection of deviation settlement charges, bids for REMC are in the process of being finalized, and the work is expected to be awarded shortly. It was also stated that real time SCADA data is available from all pooling stations, though manual downloads shall be required for generators. 70 out of 108 state entities are now providing a forecast. Shri Ramakanth, Consultant (Tech), KERC, continued the presentation on important issues of managing RE on the grid, viz control area for balancing, error band, etc. He also presented the demand curve vs RE generation, and brought up associated challenges in the forecasting and scheduling process.

Shri Bakshi appreciated the progress made by the State on both fronts. Some concerns brought up during the presentation were addressed, such as benefit of aggregation and regional cooperation for balancing. Shri Ajit Pandit, Consultant to the Technical Committee, and Shruti Deorah (Advisor-RE, CERC) also highlighted that going forward, it would be advisable to have in the KERC F&S Regulations specific provisions for QCA, treatment of embedded state entities selling power outside the state, and a path to more aggressive deviation bands for new generators.

Other member States also provided an update on the above issues. Tamil Nadu Chairperson Shri. Akshayakumar stated that the State has made progress on implementation of SAMAST. The DPR has been finalized and approved. The tender process would be complete in 3-6 months. Communication infrastructure needs more work. The State wants to ensure that the SLDC is fully equipped before the F&S Regulations for RE are rolled out.

Rajasthan Chairperson Shri Hiremath and member Shri Barwar apprised the Committee that a proposal of INR 11.8 crores for implementation of SAMAST has been approved by PSDF. The F&S Regulations are in advanced stage of finalization.

Telangana State Commission Chairperson Shri Ismail Khan stated that the State is yet to initiate efforts on both fronts. He also requested the Committee for some assistance in preparation of DPR and framing DSM Regulations.

West Bengal Chairperson Shri Rabindra Nath Sen mentioned that the State primarily has biomass and cogeneration plants, and is yet to initiate deployment of solar and wind projects on a large scale. He apprised the Committee about the workshop held in Kolkata on cycling of thermal power plants. Several stakeholders, including companies like GE, Siemens, BHEL etc participated in deliberations on how to operate coal plants in two-shift mode, or at 50%/20% PLF. In this regard, Shri A.S.Bakshi suggested that it is important to adopt a holistic approach to this topic. One way forward is to identify units that are capable of meeting new environmental norms from Ministry of Environment and Forests (MoEF) while operating at low PLFs.

It was also emphasized by Shri Bakshi that an ongoing dialogue with all States needs to be established for keeping track of their progress on these fronts. Specifically a status update on SAMAST and F&S Regulations for RE should be sought from all States before the next meeting. It was reiterated that DPR preparation at the State level should be prioritized, and for implementation, the States shall surely be supported from the Centre via PSDF funding. Additionally, Shri Bakshi and Shri Soonee concurred that

implementation of SAMAST in States shall be coordinated and tracked by the Forum of Load Dispatchers (FOLD).

3. Agenda #3: Update on web portal for RPO compliance

Shri Ajit Pandit,of Idam Infra, updated the Committee on the progress of implementation of the RPO tool in Gujarat *(copy of presentation at Annexure-V)*. He outlined the new features that have been included as per request from GEDA, as well as state-level peculiarities that have necessitated the tool to be more flexible. He underscored that ownership by the State is paramount, and that use of RPO tool must be made mandatory for it to achieve the objectives. Members also debated whether carry forward of RPO allowed by some states should be reflected in the interface. While there was a general consensus that carry forward of RPO was not desirable, Shri S.C.Shrivastav and Shri S.K.Soonee suggested that this capability may be incorporated in the software, which can remain hidden to begin with. They expressed that it would be difficult to add such a requirement retrospectively, in case a State Commission so requires. Nevertheless, it was concluded that this feature should be removed.

The members of the Committee expressed their consent for roll-out of the tool to their States and promised their support for implementation in respective States. Additionally, Shri A.S.Bakshi asked the Consultant to revert with modalities of possible way forward for deployment in all States. This shall be further discussed at the next meeting of the Technical Committee.

4. Agenda #4: Status Update on Sub-Groups

4.1. Sub-group on Regional cooperation for Optimum Utilization of Generation Resources

Shri S.R.Bhat, Member Secretary, SRPC, apprised the Committee on the first meeting held by SRPC in this regard *(copy of presentation at Annexure-VI)* He shared the challenges for regional cooperation under the current framework of merit order dispatch within a control area. Specifically, the issue of audit objection was raised if state-level merit order is not followed or a price for trading power is adopted, which is not linked to the market. Pros and cons of banking amongst states were discussed. Similarly, balancing across the region needs regulatory provisions. He suggested that large wind plants could also be considered as a regional entity.

4.2. Sub-group on 5-minute Scheduling, Metering, Accounting and Settlement

Shri S.K.Soonee, Advisor POSOCO, shared a draft paper *(copy at Annexure- VII)* on imperatives for moving and issues to be tackled while moving from 15-minute to 5-minute dispatch. Specifically, he stated that with a 5-min time-block, ramps will become more manageable, load and RE forecasts will be more accurate and that a 15-min block would be too long to run Automatic Generation Control (AGC) in an effective manner. He recounted that several benefits were obtained by moving from hourly to 15-min dispatch, similarly we expect more efficiency by transitioning to a 5-min time-block. He explained the changes that will be required on forecasting, markets, gate closure, metering standards, various regulations etc. He said that the settlement cycle would continue to be weekly, while the settlement period would now be 5 minutes. He stated that the first meeting of the sub-group is scheduled to be held in June 2017. He sought assistance from CERC staff in obtaining nominations from various member institutions on this sub-group.

5. <u>Agenda #5: Pilots under Greening the Grid (GtG) project</u>

Mr. Mark Newton, Dy. Director USAID presented the overview of goals, project components and progress-to-date under the GtG project *(copy of presentation at Annexure-VIII)*. He then handed over to Chief of Party of GTG-RISE program, Mr. Shubranshu Patnaik to give an overview of the six grid integration pilots being planned under the Renewable Integration and Sustainable Energy (RISE) initiative. Mr. Patnaik gave a brief outline of the six pilots:

(i) Grid Connected Storage System- under this pilot, partnership is proposed with PGCIL to implement and test techno-economic use cases in PGCIL's BESS facility under development at Puducherry, wherein the objective is to conduct technical feasibility and systemic value assessment of energy storage as a solution for India's requirements.

(ii) Dynamic Compensation for Large RE Integration- the pilot envisages load flow study (detailed State level network modeling with regional interconnections), stability study and other technical studies to evaluate impact of grid integration of large solar park such as Bhadla in Rajasthan. It will also evaluate dynamic compensation through inverter specifications and deployment of STATCOMS.

(iii) Coal based flexible generation for Gujarat State Electricity Corporation Ltd. (GSECL) Ramp rate achieved by coal plants in India is lower than CEA's standard of 3% and much lower than international benchmarks. Strategies to improve flexibility of coal plants, such as changes to configuration and control systems shall be examined.

(iv) Automatic Generation Control- a pilot on evaluating AGC in providing secondary response in southern India, which will include development of a suitable compensation mechanism and assist CERC in framing requisite regulations.

(v) Real-time monitoring of DERs- this pilot will entail real-time monitoring of DERs on a pilot basis and improving net load forecasting ability of Discoms

(vi) Regional platform for day-ahead and intra-day coordination in dispatch. This pilot shall design a mechanism & implement a platform for coordination on day ahead basis with joint dispatch (or similar least cost dispatch mechanism) in intra day timescales for two or more states. The objective is to devise a possible framework but first demonstrate a business case through simulation.

It was observed that the pilot on regional cooperation has a lot of synergy with the objectives and plan of action of the sub-group on optimum utilization of regional resources. Since the Southern Region has already kicked off its activities in this sphere, it was concluded that the same could be undertaken as a pilot under RISE. It was suggested that a joint meeting be held on this so as to brainstorm on a possible framework for the Southern Region.

Furthermore, given the alignment of certain objectives between the GtG program vis-à-vis those of the Technical Committee, and taking into account the request from few members for continued consultancy/professional support on framing regulations pertaining to grid integration of renewables among other activities, USAID offered to provide technical assistance to the Committee and the States on this front. The Committee appreciated this.

A vote of thanks was made by Dr. Siddharamiah, Secretary KERC. Shri A.S.Bakshi thanked Shri D.B.Manival Raju, Member(Technical) and staff of KERC for hosting the meeting.

Annexure – I: List of Participants at the Twelfth Meeting of the Technical Committee for "Implementation of Framework on Renewables at the State Level" held on 30.05.2017 at The Chancery Pavilion, Bengaluru

Sl.No.	Names of Members, Invitees & other participants	Designation
1.	Mr. A.S. Bakshi, Member, CERC	Chairman-Technical Committee
2.	Mr. S. Akshayakumar, Chairperson , TNERC	Member
3.	Mr. Ismail Ali Khan, Chairperson, TSERC	Member
4.	Mr. P.J. Thakkar, Member, GERC	Member
5.	Mr. R.P. Barwar, Member, RERC	Member
6.	Mr. D.B. Manival Raju, Member, KERC	Member
	Special Invitees	
7.	Mr. Vishvanath Hiremath, Chairperson, RERC	
8.	Mr. Rabindra Nath Sen, Chairperson, WBERC	
9.	Dr. M.K. Iyer, Member, CERC	
10.	Mr. S.K. Soonee, Advisor, POSOCO	
11.	Mr. S.R. Bhat, Member Secretary, SRPC, Bangalore	
12.	Mr. Ajit Pandit, Director Consultant – FOR	
13.	Mr. S.C. Shrivastava, Chief (Engg.), CERC	
14.	Ms. Shruti Deorah, Advisor RE, CERC	
15.	Mr. Arun Kumar H.D., Member, KERC	
16.	Dr. Siddaramaiah, Secretary, KERC	
17.	Mr. A.K. Saxena, Director & Senior Fellow (Electricity and Fuels Division), TERI	
18.	Mr. Mark Newton, Dy. Director, Clean Energy & Environment Office, USAID	
19.	Mr. Shubhranshu Patnaik, Chief of Party (Lead), GTG-RISE Team	
20.	Mr. Chandrasekhar Reddy Alta, Technical Specialist,	

	GTG-RISE	
21.	Mr. Anish Mandal, Senior Manager, GTG-Rise	
22.	Mr. M.T. Manjunath, Chief Engineer, SLDC, KPTCL	
23.	Mr. P.S. Jagannath Gupta, Consultant (Tech), KERC	
24.	Mr. J. Ramakantha, Consultant (Tech), KERC	
25.	Mr. Safiulha Khan, Director (Tariff), KERC	
26.	Mr. G. Anbunesan, AGM(I/c), SRLDC, POSOCO	
27.	Mr. V. Balaji, DGM, SRLDC, POSOCO	
28.	Mr. V. Suresh, AGM, SRLDC, POSOCO	
29.	Mr. R. Thyagaraj, KPTCL	
30.	Mr. S.B. Chandrashekar, KPTCL	

Checklist for Implementation of SAMAST in SLDC

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

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

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

Scheduling, Accounting, Metering and Settlement of Transactions (S.A.M.A.S.T)

K.P.T.C.L Status on implementation of the SAMAST report

S.A.M.A.S.T - Preamble

- The Technical committee of the Forum of Regulators adopted the Report on Scheduling, Accounting, Metering and Settlement of Transactions of Electricity in its 5th meeting on 15th July 2016.
- The Samast report provides
  - study of the existing system across the utilities,
  - related regulatory and statutory provisions.
  - Recommendation of various expert committees
  - Challenges faced by utilities.
  - Architecture of a typical system
  - General guidelines for implementation

Samast – A frame work for SLDC operations

Objectives

- Seamless and automated process for Scheduling, Metering and Accounting.
- Computation and Monitoring of Deviation for every time block.
- Introduction of Web based interface for activities such as Open access request processing, scheduling, reporting, Energy accounting including verification and billing reconciliation.
- *Facilitate deviation settlement of Intra State transaction and Renewable Generation as per KERC regulations.*

Samast – A framework for SLDC operations

- SLDC core functions are System Operations & Market Operations
- System operations
  - State Load forecasting based on ESCOM forecast
  - Scheduling all Generation
  - Real time monitoring
  - Monitoring of declared generation availability and injection
  - Switching instructions
  - Outage management and Load curtailment
  - Reserve monitoring and merit order despatch

SCADA system address the needs of majority of the System operations

Samast – A framework for SLDC operation- *Continued*

- SLDC core functions are System Operations and Market Operations
- Market operations
  - Scheduling Other generations
  - Metering
  - Accounting
  - Settlement and Clearing
  - Collecting fees and charges

Samast provides the guidelines and framework for implementation of a robust Energy metering, accounting and settlement system for effective functioning of electricity market as well as large scale integration of Renewables

Samast implementation

Main areas to be addressed

1. Providing standardized Interface point meters
2. Replacement of CTs and PTs of 0.2 accuracy at Interface points.
3. Providing reliable communication & a system for Automated Meter Reading.
4. Providing Real time communication and Data acquisition
5. Hardware and Software for Scheduling, Accounting and Settlement to automate the process, integration to SCADA system, and a Market operations system
6. Human resources and capacity building for system and market operation.

Samast implementation

Status

1. **Providing standardized Interface point meters**

   Replacement of all conventional meters by DLMS meters capable of remote downloading is taken up. The meter shall have a programmable feature for having 5 minute block. Tendering in progress. Work expected to commence in about 2 months

2. **Replacement of CTs and PTs of 0.2 accuracy at Interface points.**

   About 95% of the CTs and PTs are of 0.2 accuracy. Inventory of the balance has been taken. Replacement will be taken up. Provision will be made in the SAMAST DPR.

Samast implementation

Status

3. Providing reliable communication & a system for Automated Meter Reading.

KPTCL has a satellite VSAT network covering every sub-station in the state. KPTCL has submitted a DPR for providing Optical fibre communication to all its 220 kV, 400 kV and Major Generating stations to CEA for PSDF funding

KPTCL has given consent to REC to provide Data Concentrator Units (DCUs) at every station and a Meter Downloading and Accounting system with access to all stakeholders. It is learnt that Bid document preparation is in progress

Samast implementation

Status

4. Providing Real time communication and Data acquisition

KPTCL has provided VSAT communication to every Sub-station, Receiving station and Generation station for voice and data. SCADA RTU is provided to 94% of the stations and action is taken to provide RTUs to the remaining stations.

Visibility of the all Generation including Renewables is available. Remote Control from SLDC control centre, of every breaker from 11 kV to 400 kV is possible. Automatic Demand Side Management scheme to open out 11 kV breakers on SCADA is implemented

Samast implementation

Status

5. Hardware and Software for Scheduling, Accounting and Settlement to automate the process, integration to SCADA system, and a Market operations system

Discussions with MPTRANSCO with respect to their specifications for Scheduling and Accounting system has been initiated. Team to visit MP for further discussions next week.

Preparation of draft requirements for implementation of balance areas of SAMAST is in progress.

Target for completion : 10th June 2017

Samast implementation

Status

6. **Human resources and capacity building for system and market operation.**

Proposal based on SAMAST report and staff as per recommendation of REMC project report is being considered by KPTCL.

Posting of staff and Training for Renewable Management and Market operations will be taken up along with implementation of the hardware and software for Scheduling, Accounting and Settlement system.

KPTCL – Road map to implementation

- Study implemented systems at Gujarat and Madhya Pradesh.

  (In progress)

- *Preparation of Requirements for implementation of the balance part of Samast framework and do a gap analysis*

  (By June 10th 2017)

- *Prepare DPR for submission to CEA for approval and funding from PSDF.*

  (By June 25th 2017)

- Prepare technical specifications for the system

  (By July 30th 2017)

- Implementation of the Samast framework

  (By July 2018, considering metering and accounting system implementation)

Karnataka Electricity Regulatory Commission

Forecasting, Scheduling, Deviation settlement and related matters for Wind and Solar Generation sources Regulations,2015.

1

The Regulations – Preamble, The need and Salient features

Preamble - Typical Wind Power Variations in Karnataka

- Wind Energy : 8% of Total Annual Energy in the State
- Average contribution during windy season
  - (3 months in a year) = 24 MU per day
  - State Average consumption = 192 MU per day
- Intraday variation ranges from 32 MW to 2010 MW as against State demand which varies from 5000MW to 10300 MW.
- Unscheduled Large Wind capacity injections necessitates backing down of wind generators during low demand conditions when only thermal stations are operating.
- Forecasting and Scheduling would avoid such backing down of wind generators.

Need for Regulations !!

- Mitigation of imbalance in grid caused by large capacity additions of infirm sources of RE Generation
- System Operator can accommodate maximum infirm RE Generation if they are forecast and scheduled in advance.
- Discipline in injection by RE generators
- Reduces burden of payment of DSM charges by DISCOMs
- Enables DISCOMs to plan timing of Power supply to IP Sets to absorb RE power without affecting other consumers.
- Maintain Grid Stability, Reliability & Security

Regulations : The path

- Model Regulations issued by Forum of Regulators in August, 2015
- Draft KERC Regulations notified on 16th November, 2015
- Written comments/Suggestions received from 28 stakeholders
- Public Hearing held on 21st April, 2016
- 11 Stakeholders appeared in person before the Commission
- Final Regulations notified on 31st May, 2016
- Implementation from 1st June 2017

Regulations- Salient Features

- Objective
  - Large scale integration of Wind & Solar Generation
  - Maintain Grid Stability, Reliability & Security
  - Institute Commercial Mechanism to settle DSM charges
- Applicability
  - Wind Generators with combined installed capacity of 10 MW and above
  - Solar Generators with installed capacity of 5 MW and above
- Effective from 1st June 2017

Salient Features- Forecasting & Scheduling

Option :

- Generators – Individual/Combined
- Aggregator / Qualified Co-ordinating Agency
- Renewable Energy Management Centers (REMC)
- Pooling station level or Multiple pooling stations

Periodicity

- Week Ahead
- Day- Ahead
- Intra Day For Each 15 Min Block

Revision

- 16 per day

De-pooling arrangement

- Aggregators to do

Salient features - Metering, Telemetry, Communication & Data sharing

Metering

- Special Energy Meters @ Interface Points

Telemetry

- Wind Generators to provide Parameters such as turbine availability, power output and real-time weather measurements (wind speed, temperature, pressure etc.) and full data and communication facilities

Communication.

- A preparatory window shall be provided by the SLDC to the wind and solar generators for ensuring installation and use of data measurement and telemetry.

Data Sharing

- SLDC to enable data sharing

Deviation Settlement Mechanism

- Absolute Error =(Actual Generation – Scheduled Generation)/ (Available Capacity) x 100
- Error is up to ± 15%. : **No Penalty**
- Error From ± 15% Up to ± 25% : **Penalty of Paisa- 50/Unit**.
- Error From ± 25% Up to ± 35% : **Penalty Re.1.00 /Unit**.
- Error Above ± 35% : **Penalty Rs.1.50 /Unit.**

Commercial Arrangements

- Energy charges as per actuals for Intra State transactions
- Energy charges as per Schedule for Inter State transactions
- Timely Payments of DSM Charges by generators
- Interest for delayed payments
- Collection to Power System Development Fund
- Utilisation of Fund to be specified by KERC

Karnataka Electricity Regulatory Commission

Forecasting, Scheduling, Deviation settlement and related matters for Wind and Solar Generation sources Regulations,2015.

Status of Implementation & Preparedness of KPTCL SLDC

Preamble

- *Three meetings were held between SLDC and the Wind and Solar Generators in the past 4 months.*
- *The Regulations were discussed in details with emphasis on understanding the roles to ensure smooth implementation*
- *Generators are finalising the Aggregators/QCA*
- *SLDC is prepared to handle the Deviation settlement mechanism*
- *Few challenges are foreseen as it is first time for the Generators.*
- *At present, 66 Wind pooling stations and 42 solar pooling stations, totalling 108 come under the ambit of the regulations.*

Preparedness of SLDC – Data and Telemetry requirements

1. Real time Data and Energy meter data : STU/ESCOM pooling stations

- As KPTCL has SCADA infrastructure covering all KPTCL and ESCOMs stations the process of Real time data access from all STU/ESCOM pooling stations is already established.
- All Wind and Solar generators connected to KPTCL stations have paid SCADA connectivity charges.
- The respective bays are connected to the RTUs in the stations covered by SCADA and real time data is already available. The panel Energy meters are also integrated to the Energy meter downloading system.
- ABT Energy meters are provided at the pooling points and Arrangements are made to download the readings of the Tariff meters manually.

Preparedness of SLDC – Data and Telemetry requirements

2. Data of Turbines/ generators/ Weather data

- Technical discussions were held during the meeting with the Generators
- The older turbines/Generators do not have real time data access or SCADA.
- The Generators have been informed to provide data of turbines/Generators and weather data as per the regulations.
- A meeting on the technicalities is scheduled during the 1st week of June 2017 to finalise the process.
- However, deviation settlement mechanism will be in place as the Generators are directed to provide the day ahead schedules

Preparedness of SLDC – Formats

- Static formats for providing details of turbines, Invertors and generators have been given to the generators
- About 75 % of the Generators have provided the details although some are incomplete.
- A meeting has been scheduled during the first week of June 2017 to discuss and update all data that is required.
- The formats for Day ahead and week ahead schedules have already been given to the Generators.

Preparedness of SLDC –Scheduling

- Process of Schedule is in place with 70 out of 108 generators are furnishing day ahead Schedules as on 25th May 2017.
- The schedules are presently taken over email and automatically uploaded into the SCADA system. The SCADA system will provide real time visualisation of the schedule, actual and the deviation.
- Web based scheduling mechanism has also been developed wherein the Generators/Aggregators can enter directly and also incorporate revisions if any.
- The revision of schedules will be handled by the Scheduling team and later passed on for Deviation settlement team.

Preparedness of SLDC –Metering and Deviation settlement

- Monthly reading of the Energy meters at the STU/ESCOM pooling stations will be jointly taken by the Generator/Aggregator/QCA.
- The authorised personnel of KPTCL and ESCOMs have been directed to download the data from the Energy meter in coordination with the respective Generator/Aggregator/QCA.
- Pooling account for Deviation settlement has been opened by SLDC for collection of the Deviation settlement charges.
- The first reading of June 2017are expected during the 1st week of July, after which the deviation will be calculated by SLDC and bills will be raised and sent.

Preparedness of SLDC –Renewable Energy Management Centre

- Karnataka will be establishing a Renewable Energy Management Centre.
- Bids are finalised and PGCIL, the implementing agency is likely to award the work to the successful bidder shortly.
- Construction of REMC building has commenced and the centre will be adjacent to the existing SLDC control centre.
- As real time SCADA data is already available from all the pooling stations, the REMC system can be effectively put into use once commissioned.

Karnataka Electricity Regulatory Commission

Forecasting, Scheduling, Deviation settlement and related matters for Wind and Solar Generation sources Regulations,2015.

Challenges and points for future thought

Issues to be addressed

- Balancing mechanism for Ramp up and Ramp Down Rate (Variance) of RE Source.
- Managing Minimum system demand with maximum RE Generation.
- Managing within 15% Error for CGS – CERC - DSM Regulation and Congestion Regulation.
- Grid Integration with Renewables & Thermal Sources of Generation

The Karnataka Experience

- Acceptable absolute error as per KERC Regulation for RE generators is ± 15% of 3355 MW (1006 MW).
- CERC allowed deviation from schedule is 250 MW.
- Karnataka is bearing the commercial loss due to deviation beyond 250 MW.
- To ensure maximum RE evacuation due to unavoidable circumstances resulting from forecasting error / low demand , the ancillary support from RLDC to be brought in, prior to declaring corridor congestion.
- Declaring corridor congestion in the network should be the last resort (prevailing congestion charges Rs. 5.50/unit).

Ramp Up & Ramp Down ?

- The capacity of Hydro /Gas Generators available in the Control area needs to match with (absorb) the ramp up/ down (Variability) rate of RE ramp up and ramp down rates.
- The cumulative ramp up/down rates depends on the Installed capacity on bar in the control Area.
- As the percentage of RE Generators increases within the control Area, it would not be technically possible to match the ramp up/down rates of RE Generators with available Conventional Source within the control Area.

Ramp Up & Ramp Down – Mitigation

- Make separate Control area for High capacity RE Source.
- CERC has already made Solar generation above 500 MW at a point as Regional Entity.
- Similar approach for Wind Generation also required by CERC, say 200 MW connected to a pooling station as regional entity.
- Schedule RE power to other states by RLDC to meet RPO. With this other State's Conventional Sources also would participate in ramp up and ramp down (absorbing variance).
- With the above, the effective percentage of RE injection would be shared by other States leading to better grid management.

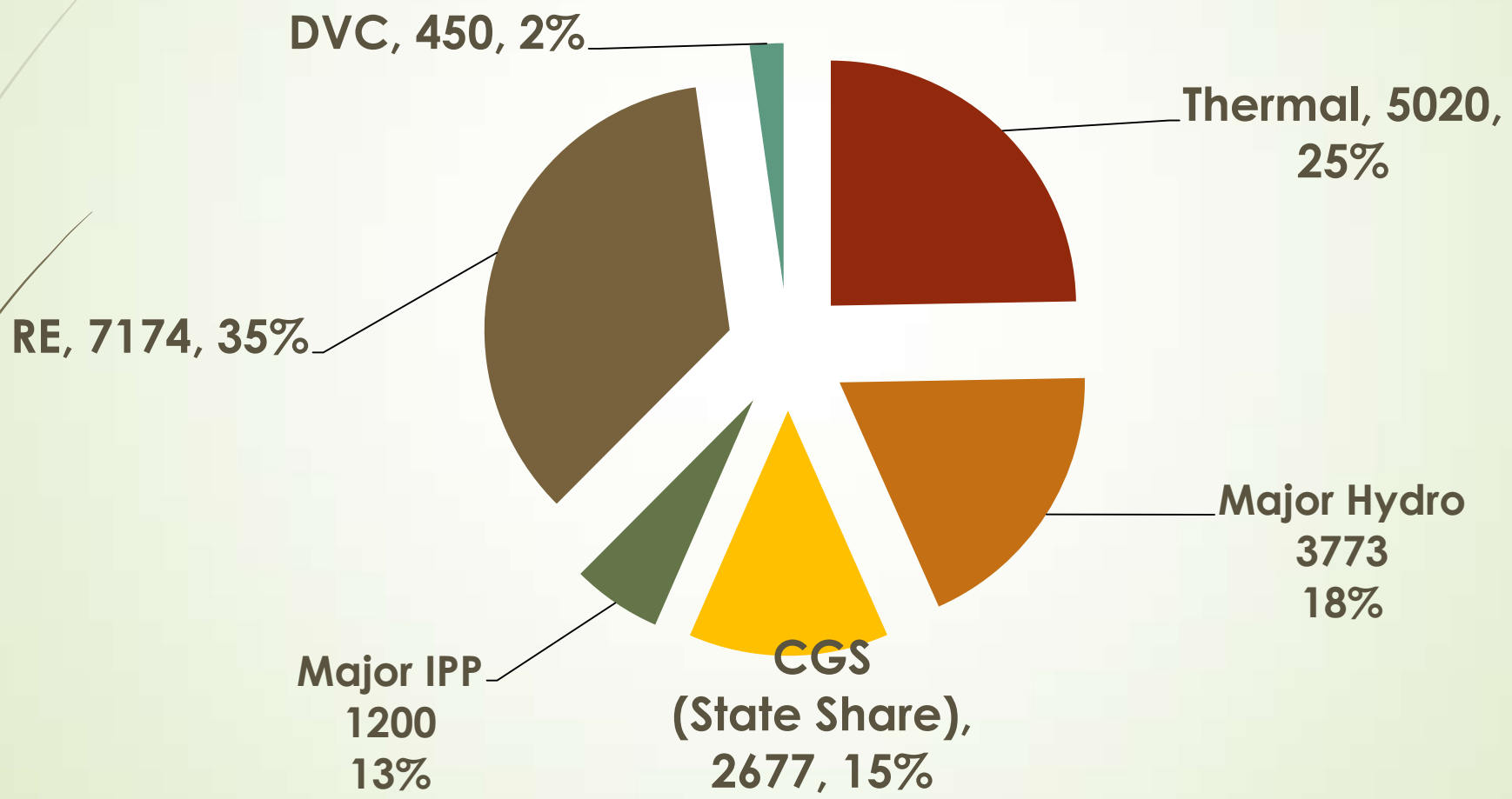
Karnataka Electricity Regulatory Commission

Forecasting, Scheduling, Deviation settlement and related matters for Wind and Solar Generation sources Regulations,2015.

Wind and Solar Generation Scenario in Karnataka

Source Wise Installed Capacity- in MW

(as on 31.03.2017)



Source:KREDEL

Renewable Energy Installed Capacity

Source	Potential in MW	Capacity in MW (April 2017)
Wind (89 pooling stn)	13983	3354.68
Co-Generation	1500	1952.4
Mini Hydel	3000	806.9
Biomass	1000	136.86
Solar (115 Pooling stn)	10000	1050
Total	**29483**	**7300.84**
About 6000 MW solar power is anticipated by the end of 2022.		

Progress of RE Contribution in MU – FY10-FY17

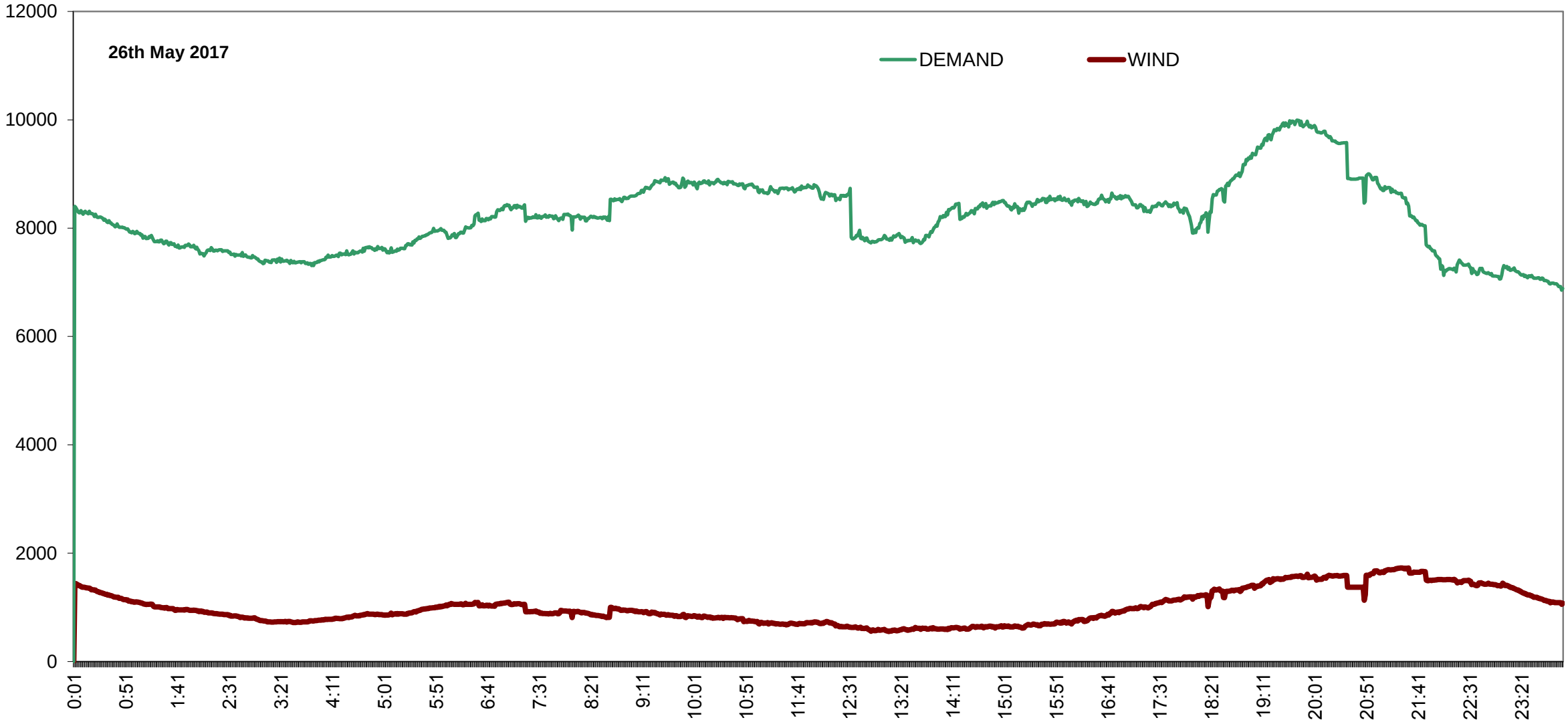
Source	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17
Wind	2764	2800	3597	4329	4541	4655	4804	6017
Co-Generation	775	1862	1895	2527	2526	2886	3375	1550
Mini Hydel	1180	1645	1861	1201	1713	1735	1418	1257
Biomass	301	331	214	240	144	208	192	160
Solar	0	0	0	0	20	85	187	493
TOTAL	**5020**	**6638**	**7567**	**8297**	**8944**	**9569**	**9976**	**9477**

RE contribution in the State has doubled in the last 8 years

Wind and Solar in Karnataka

	Wind	Solar
●INSTALLED CAPACITY	: 3355 MW	1050 MW
● MAXIMUM POWER INJECTED	: 1980 MW	537 MW
● MAXIMUM ENERGY INJECTED	: 40 MU	4.07 MU
● DAILY AVERAGE ENERGY DURING SEASON	: 24 MU	

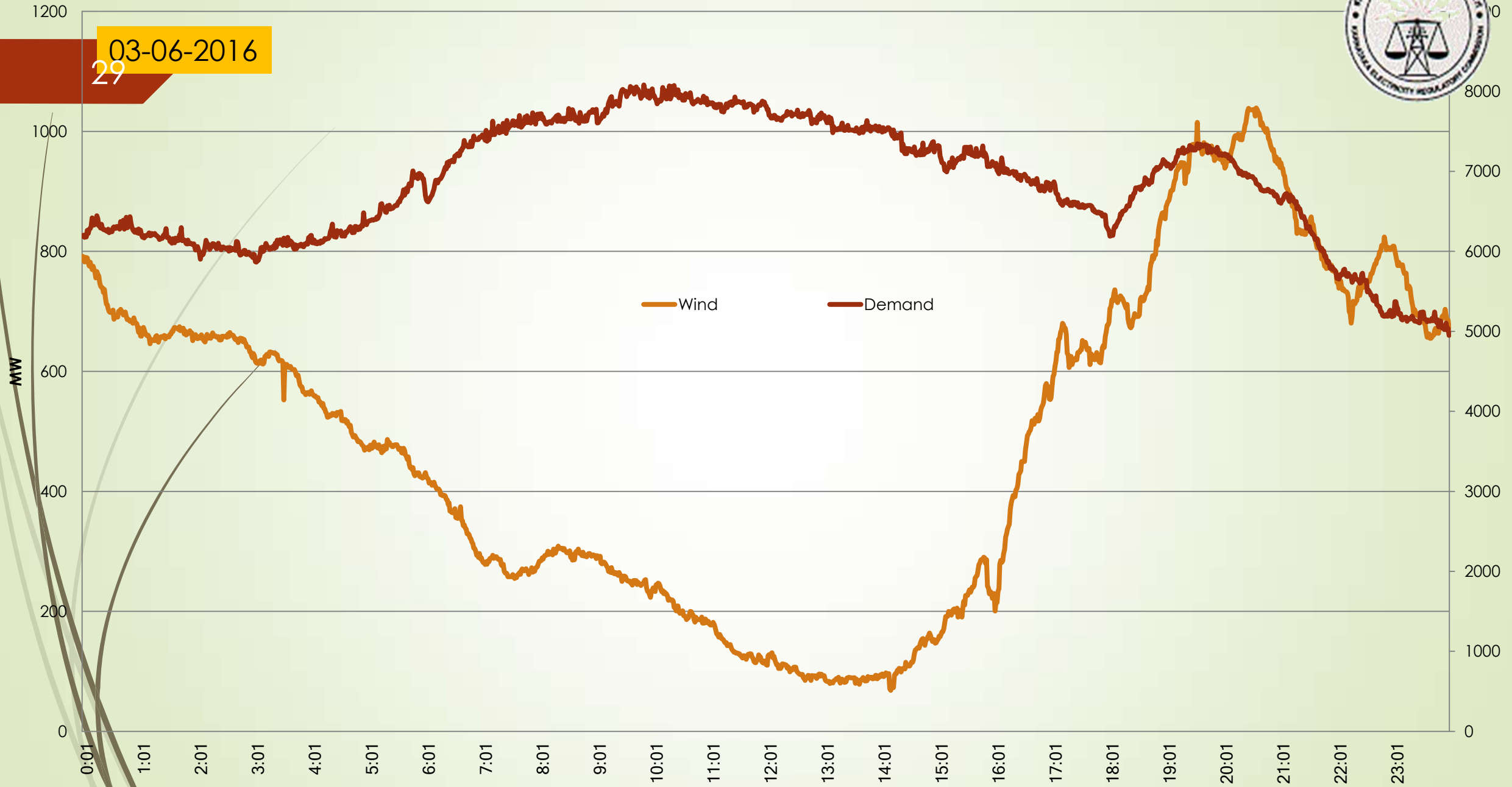
WIND ENERGY v/s STATE DEMAND

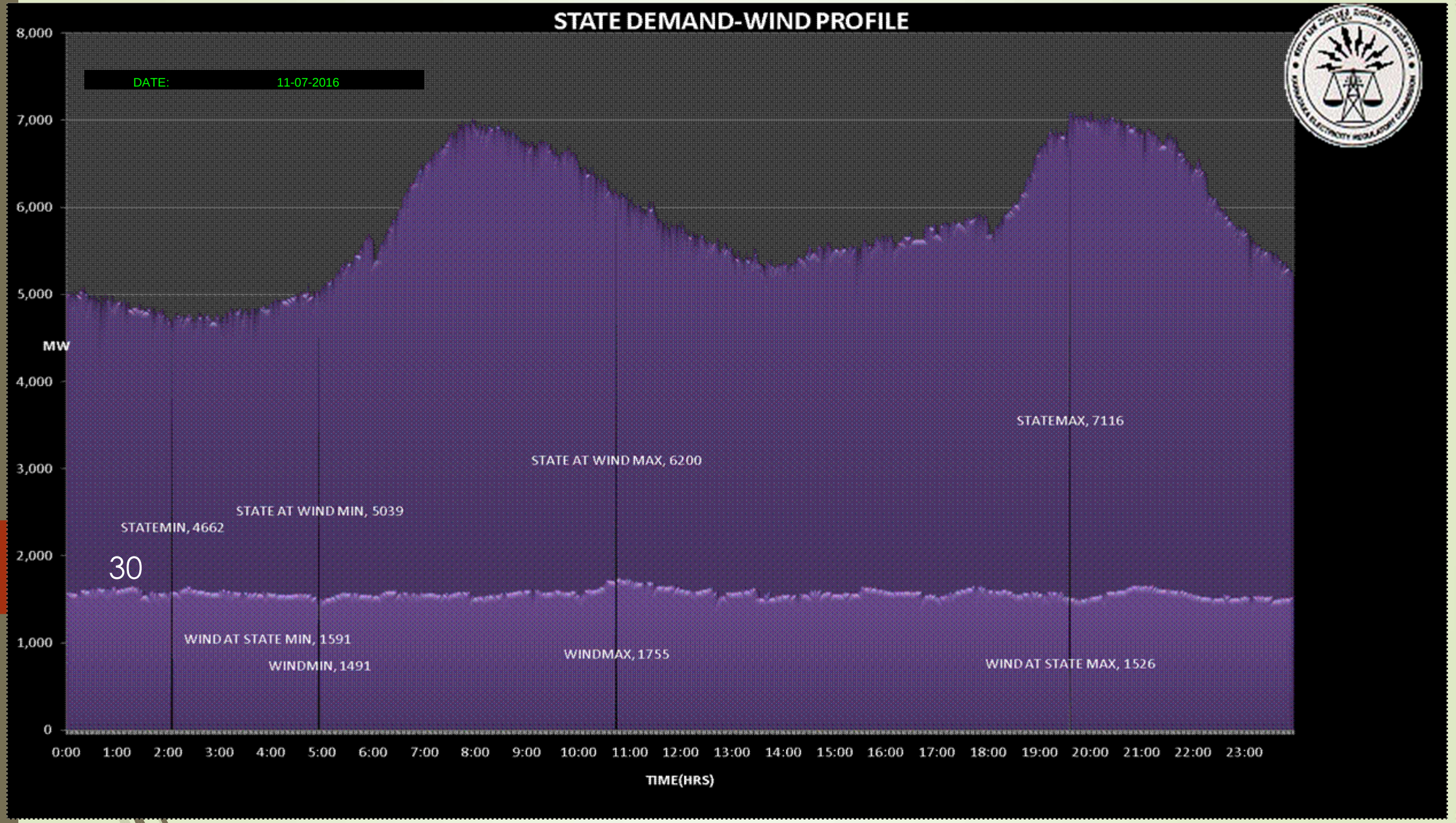


WIND Vs STATE DEMAND CURVE

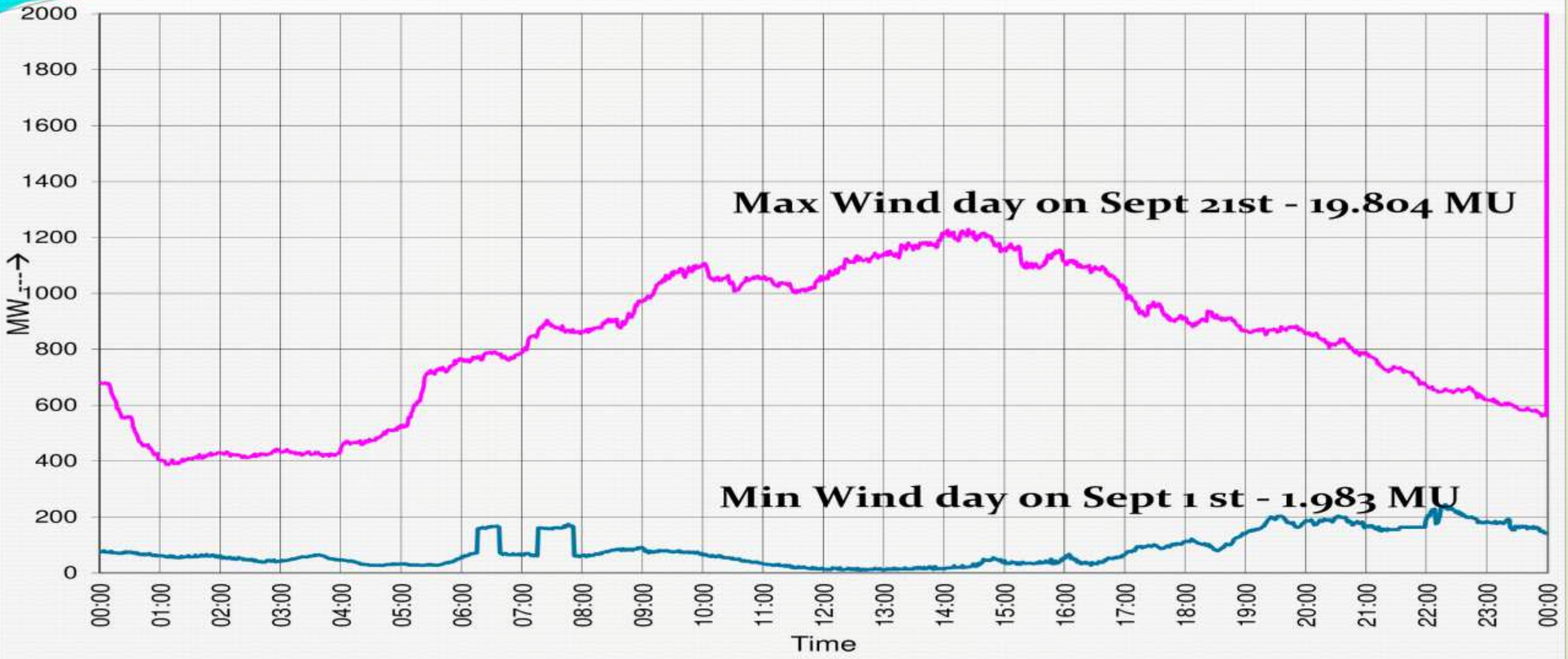
29

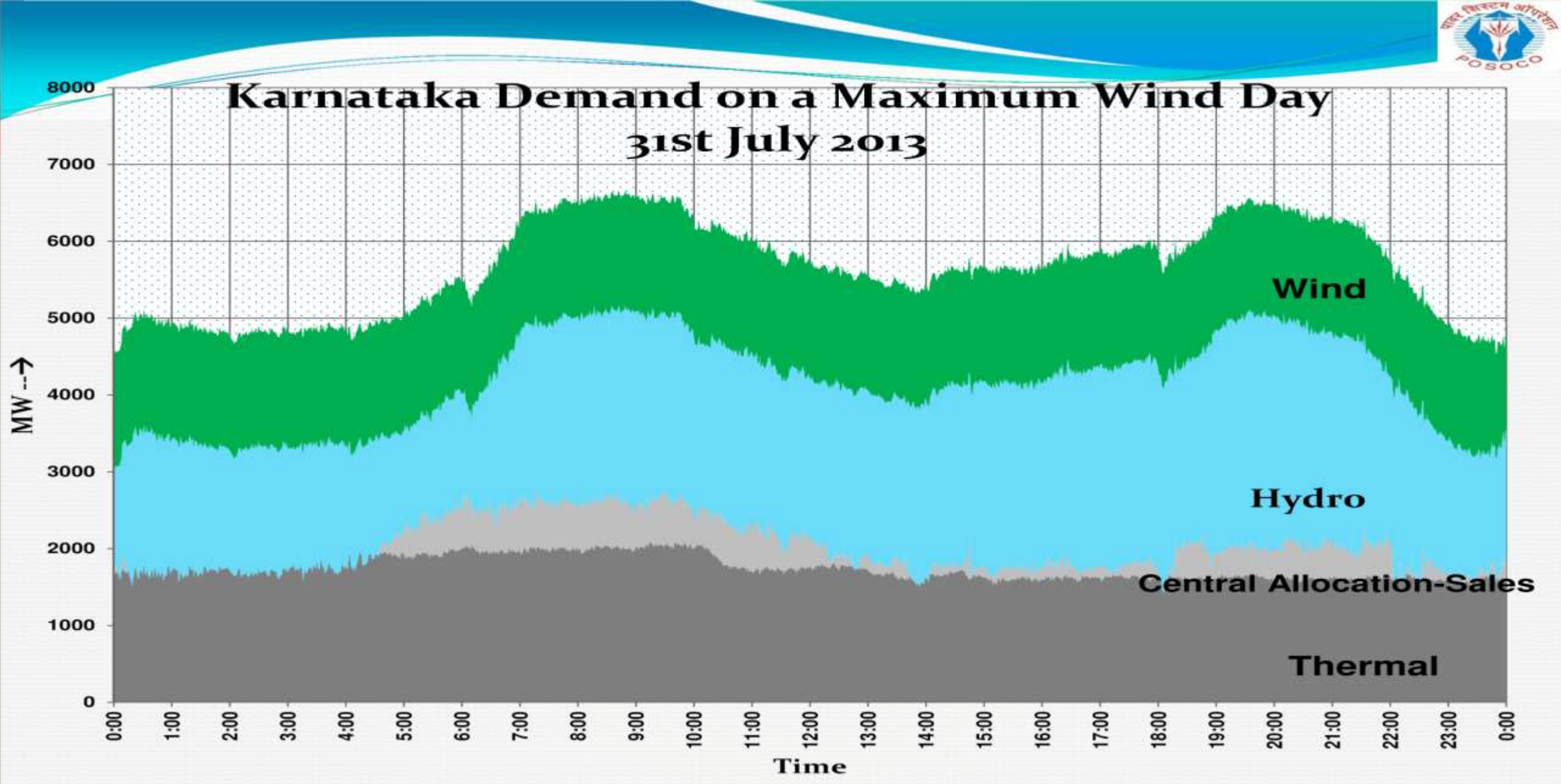
03-06-2016

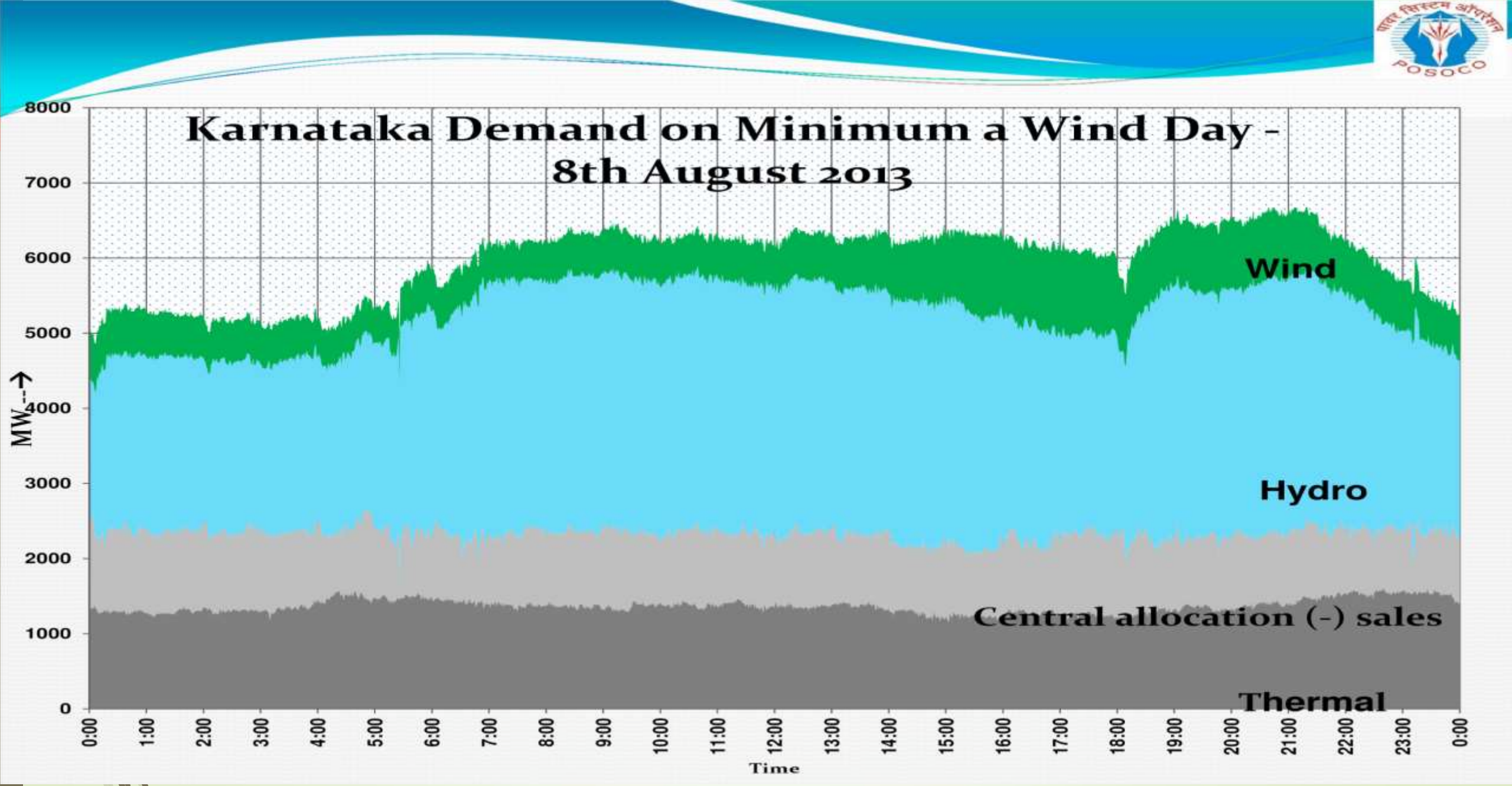



STATE DEMAND-WIND PROFILE
DATE: 11-07-2016
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
MW
STATEMAX, 7116
STATE AT WIND MAX, 6200
STATE AT WIND MIN, 5039
STATEMIN, 4662
30
WIND AT STATE MIN, 1591
WINDMIN, 1491
WINDMAX, 1755
WIND AT STATE MAX, 1526
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
TIME(HRS)

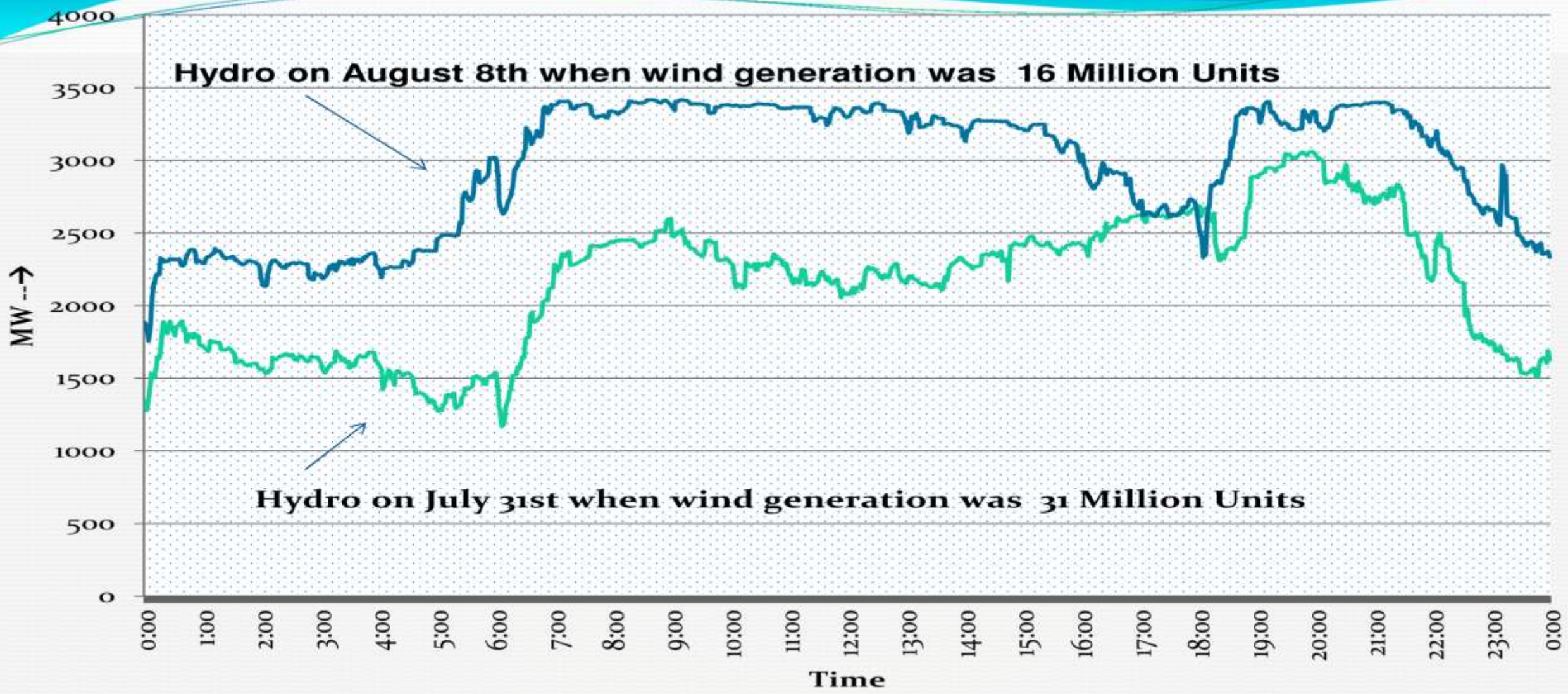
KARNATAKA MAXIMUM AND MINIMUM WIND GENERATION DAYS SEPTEMBER 2013



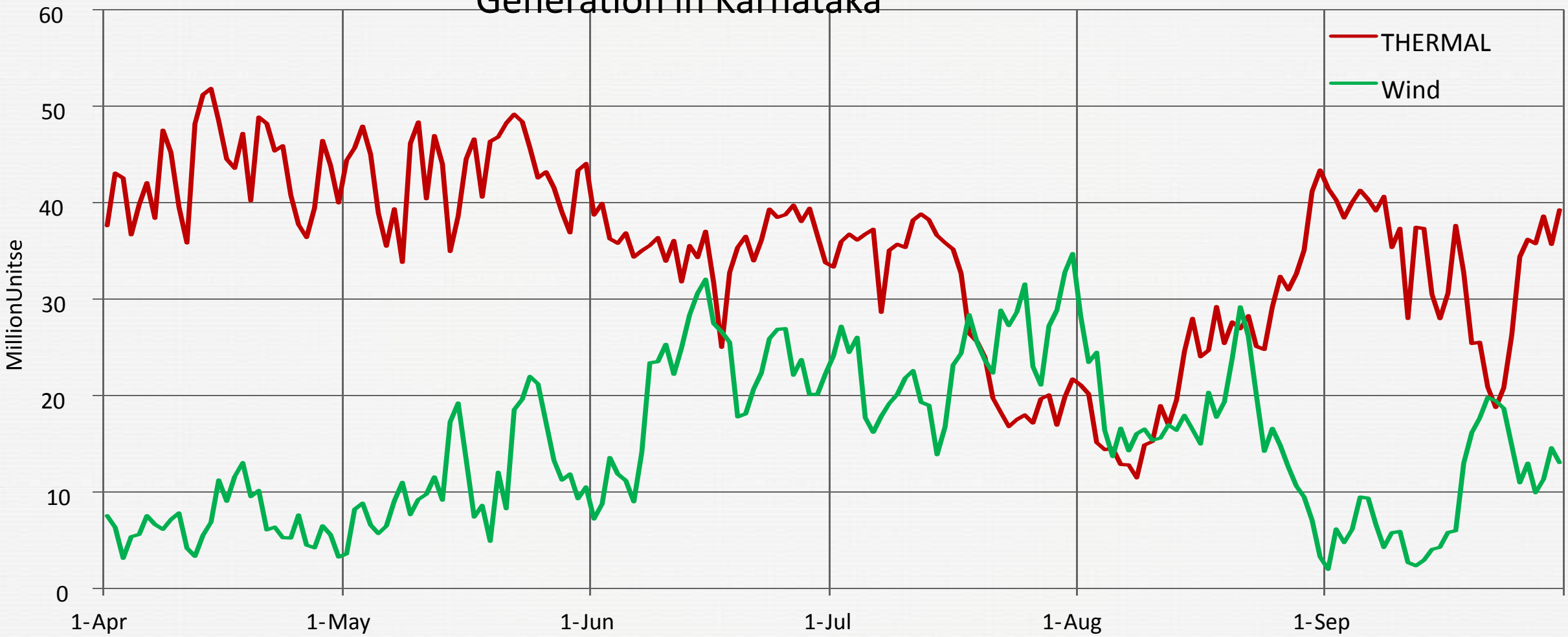

Karnataka Demand on a Maximum Wind Day
31st July 2013
MW -->
8000
7000
6000
5000
4000
3000
2000
1000
0
Wind
Hydro
Central Allocation-Sales
Thermal
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time


Karnataka Demand on Minimum a Wind Day - 8th August 2013
Wind
Hydro
Central allocation (-) sales
Thermal
MW-->
Time
8000
7000
6000
5000
4000
3000
2000
1000
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00

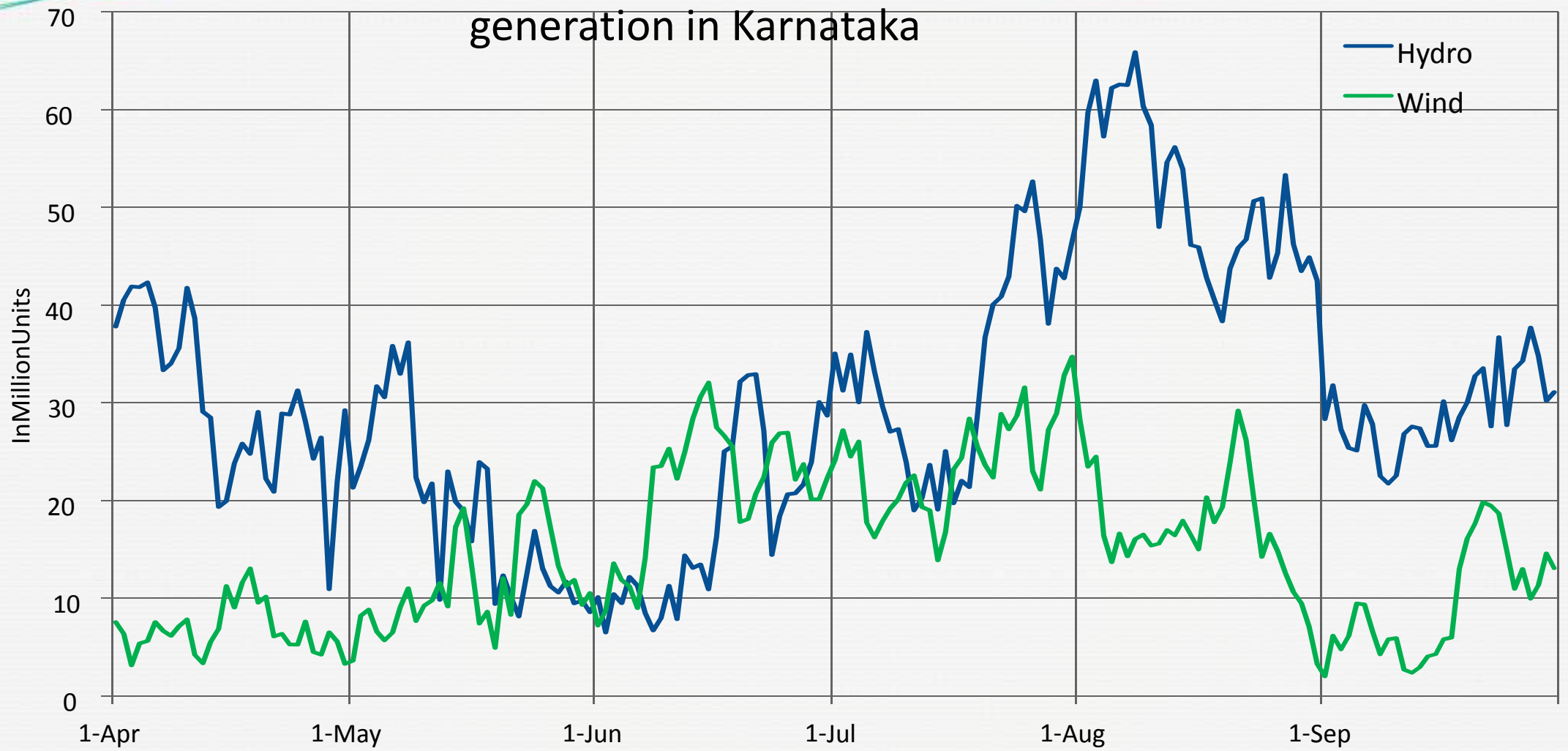
Karnataka Hydro on Maximum and Minimum wind Day



Flexing of Thermal for Balancing Wind Generation in Karnataka

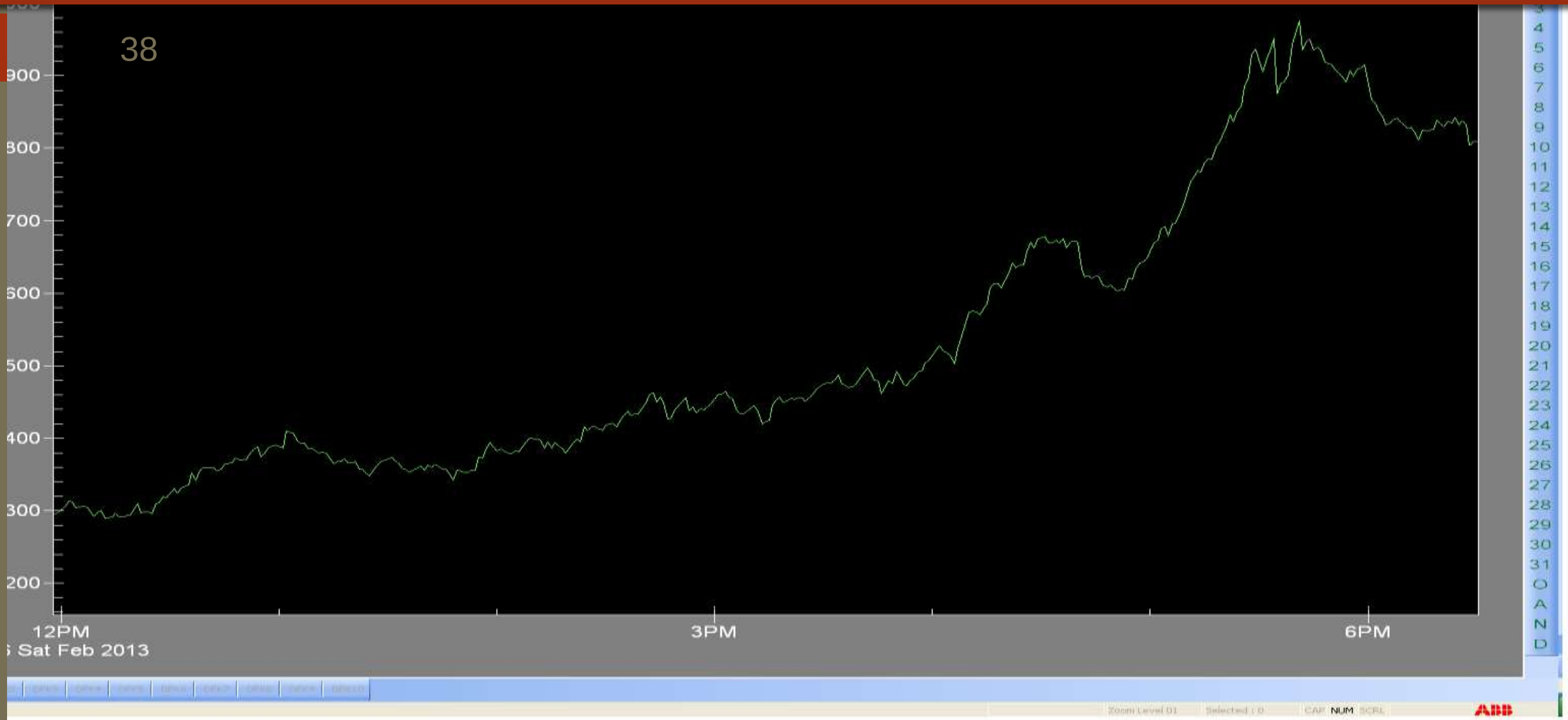


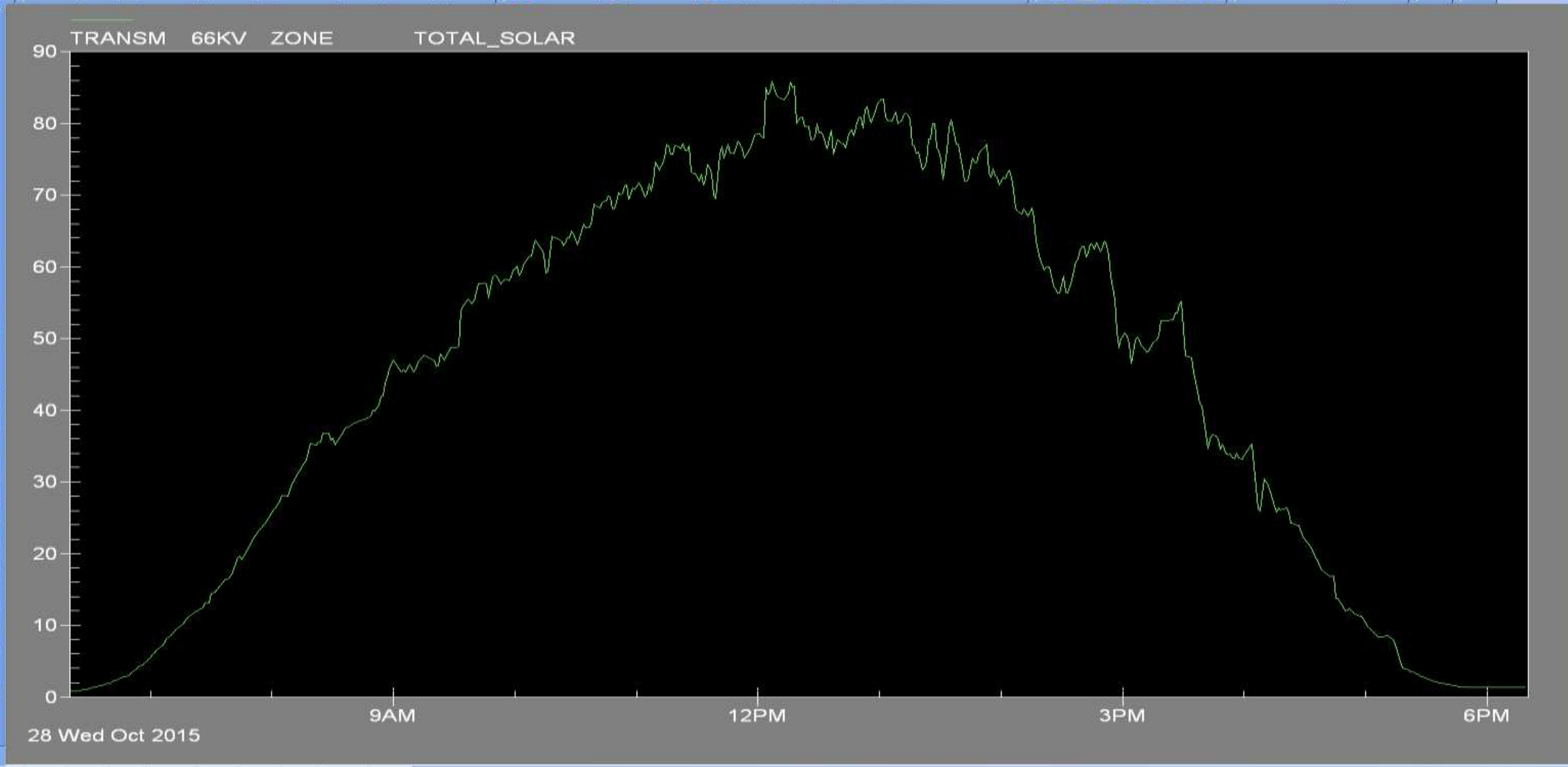
Flexing the Hydro for Balancing the wind generation in Karnataka

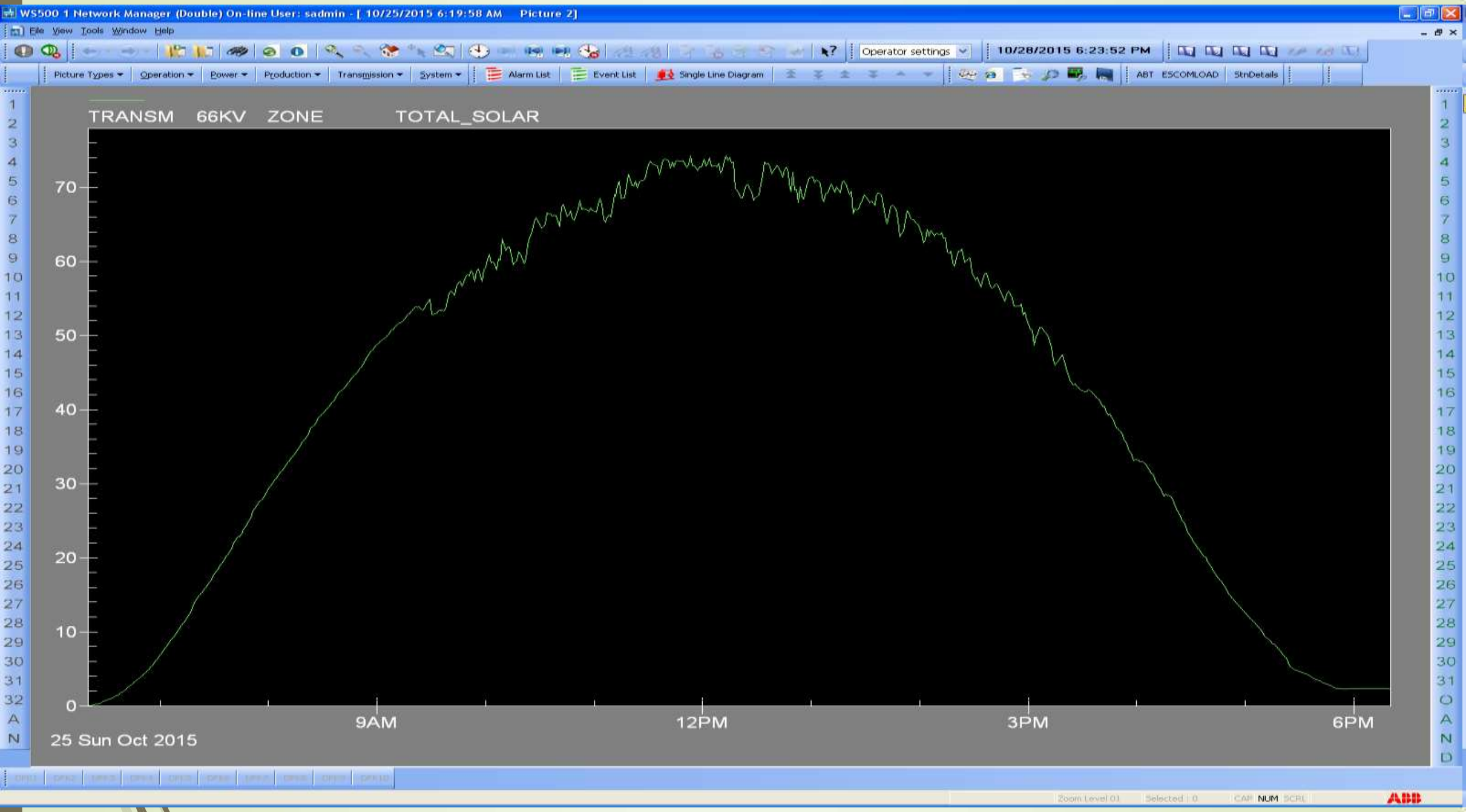


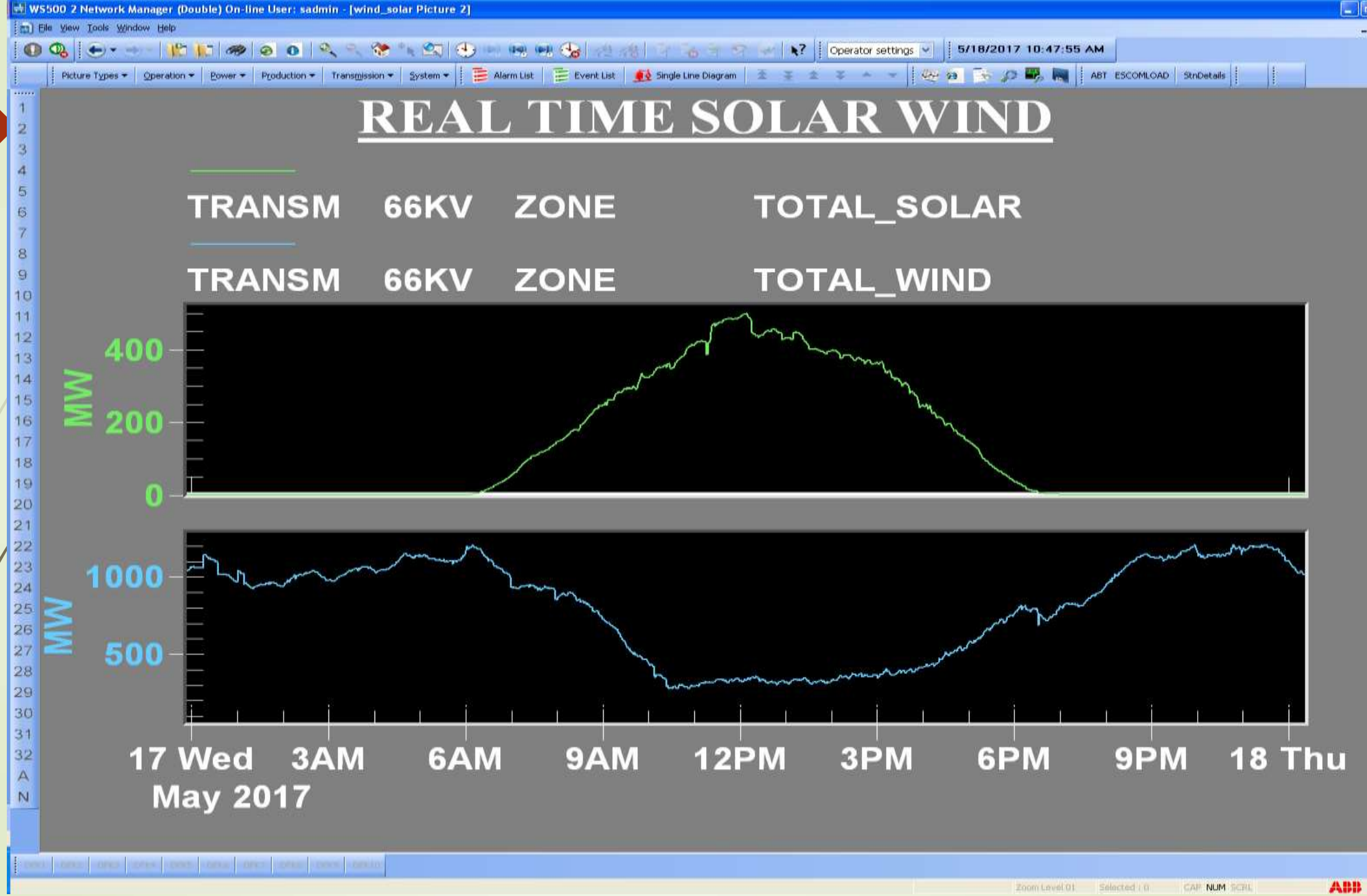
WIND VARIATION IN A DAY

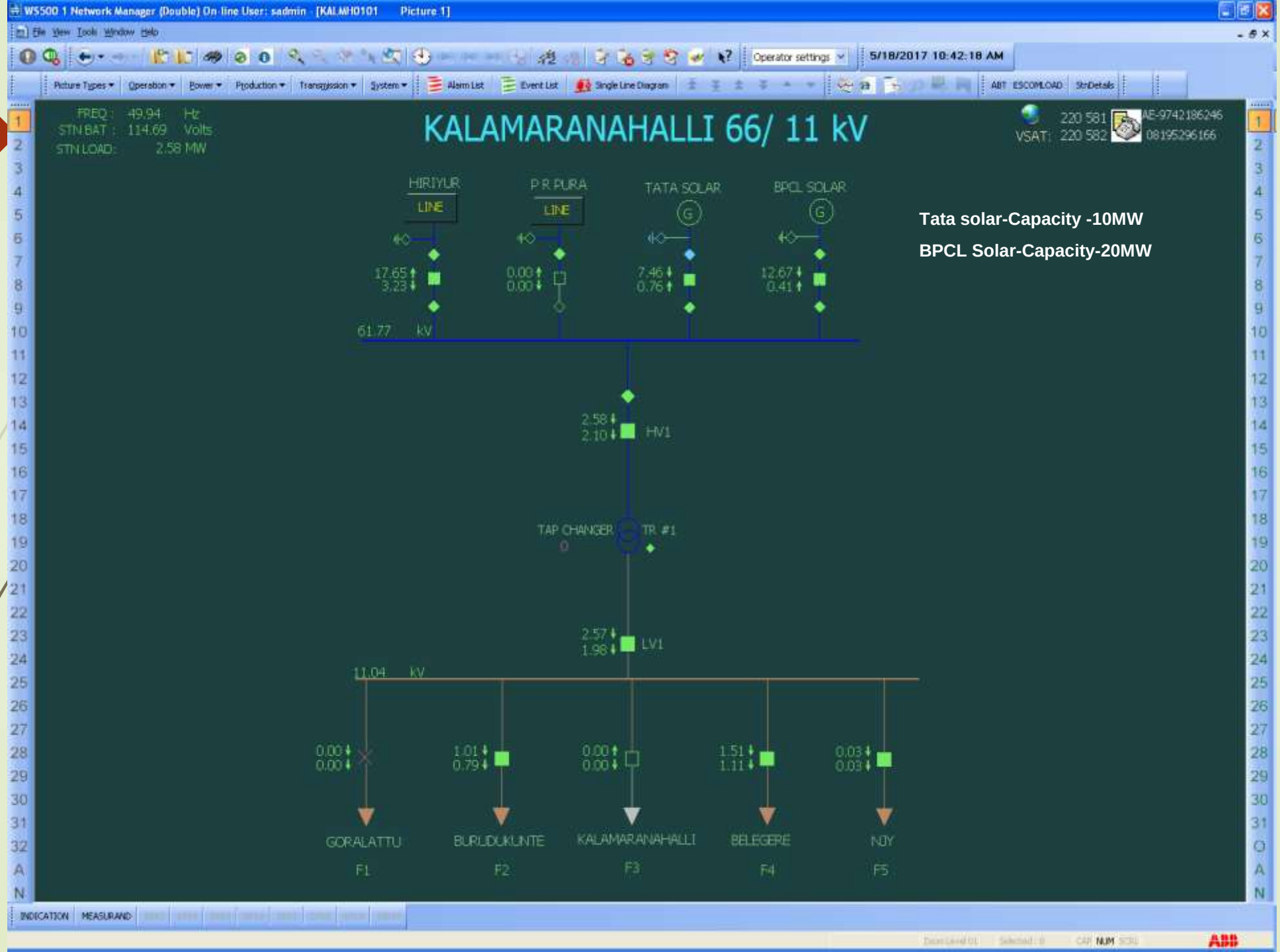
WIND VARIATION IN A DAY




TRANSM 66KV ZONE TOTAL_SOLAR
90
80
70
60
50
40
30
20
10
0
9AM
12PM
3PM
6PM
28 Wed Oct 2015

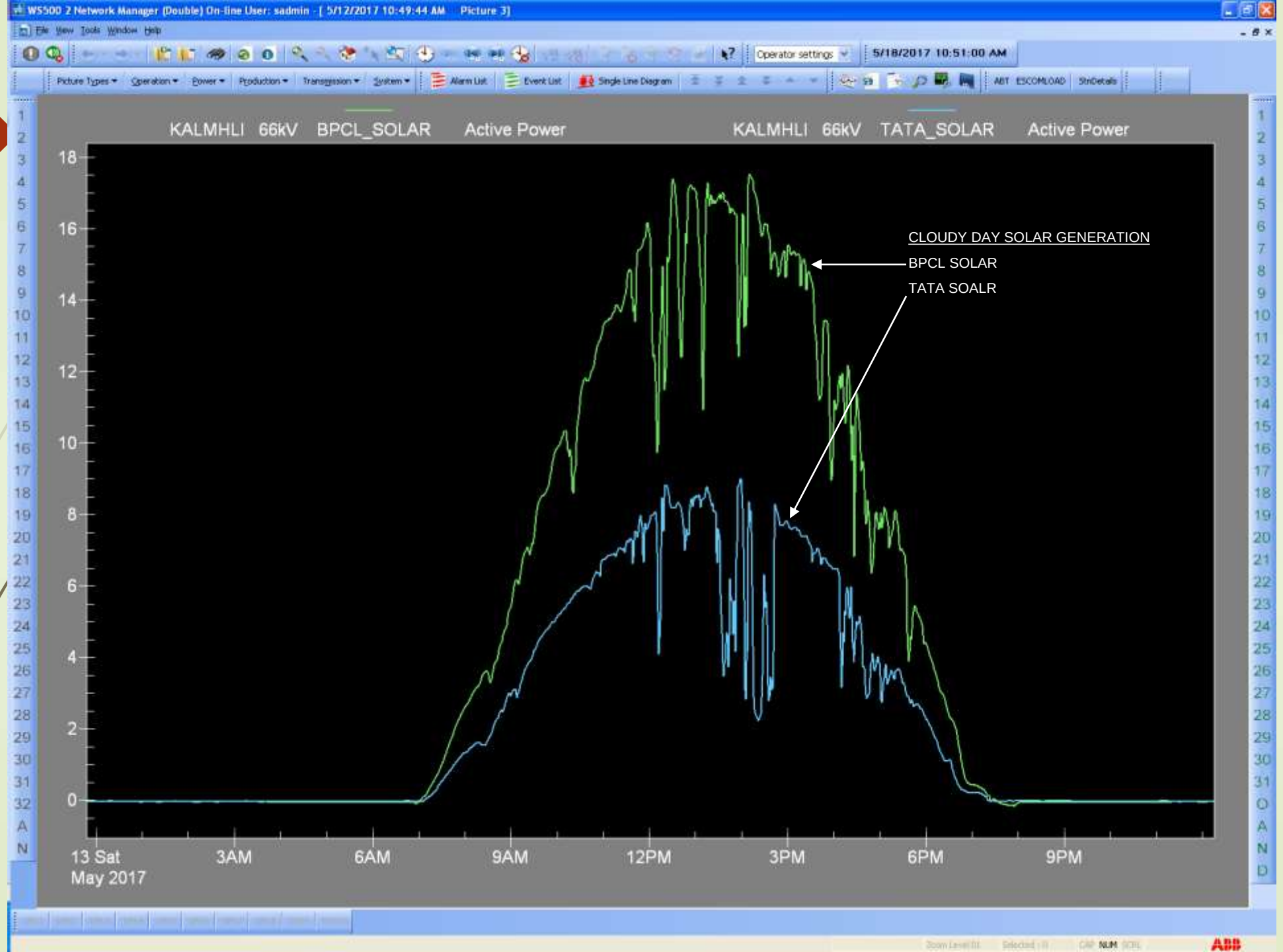

WS500 1 Network Manager (Double) On-line User: sadmin - [10/25/2015 6:19:58 AM Picture 2]
File View Tools Window Help
Operator settings
10/28/2015 6:23:52 PM
Picture Types
Operation
Power
Production
Transmission
System
Alarm List
Event List
Single Line Diagram
ABT ESCOMLOAD
StnDetails
TRANSM 66KV ZONE TOTAL_SOLAR
70
60
50
40
30
20
10
0
9AM
12PM
3PM
6PM
25 Sun Oct 2015

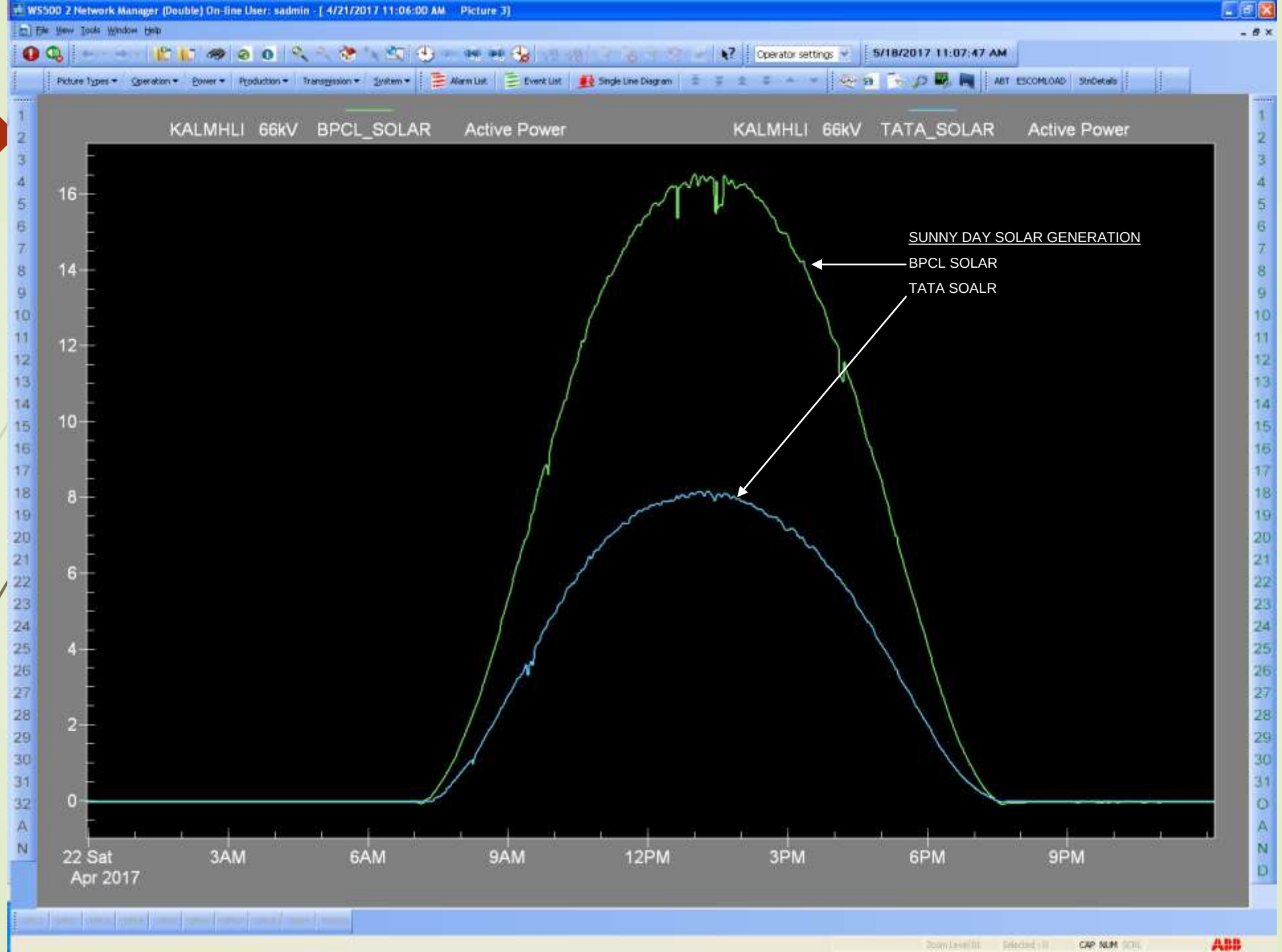

WS500 2 Network Manager (Double) On-line User: sadmin - [wind_solar Picture 2]
File View Tools Window Help
Operator settings
5/18/2017 10:47:55 AM
Picture Types
Operation
Power
Production
Transmission
System
Alarm List
Event List
Single Line Diagram
ABT ESCOMLOAD
StnDetails
REAL TIME SOLAR WIND
TRANSM 66KV ZONE TOTAL_SOLAR
TRANSM 66KV ZONE TOTAL_WIND
MW
400
200
0
MW
1000
500
17 Wed
May 2017
3AM
6AM
9AM
12PM
3PM
6PM
9PM
18 Thu



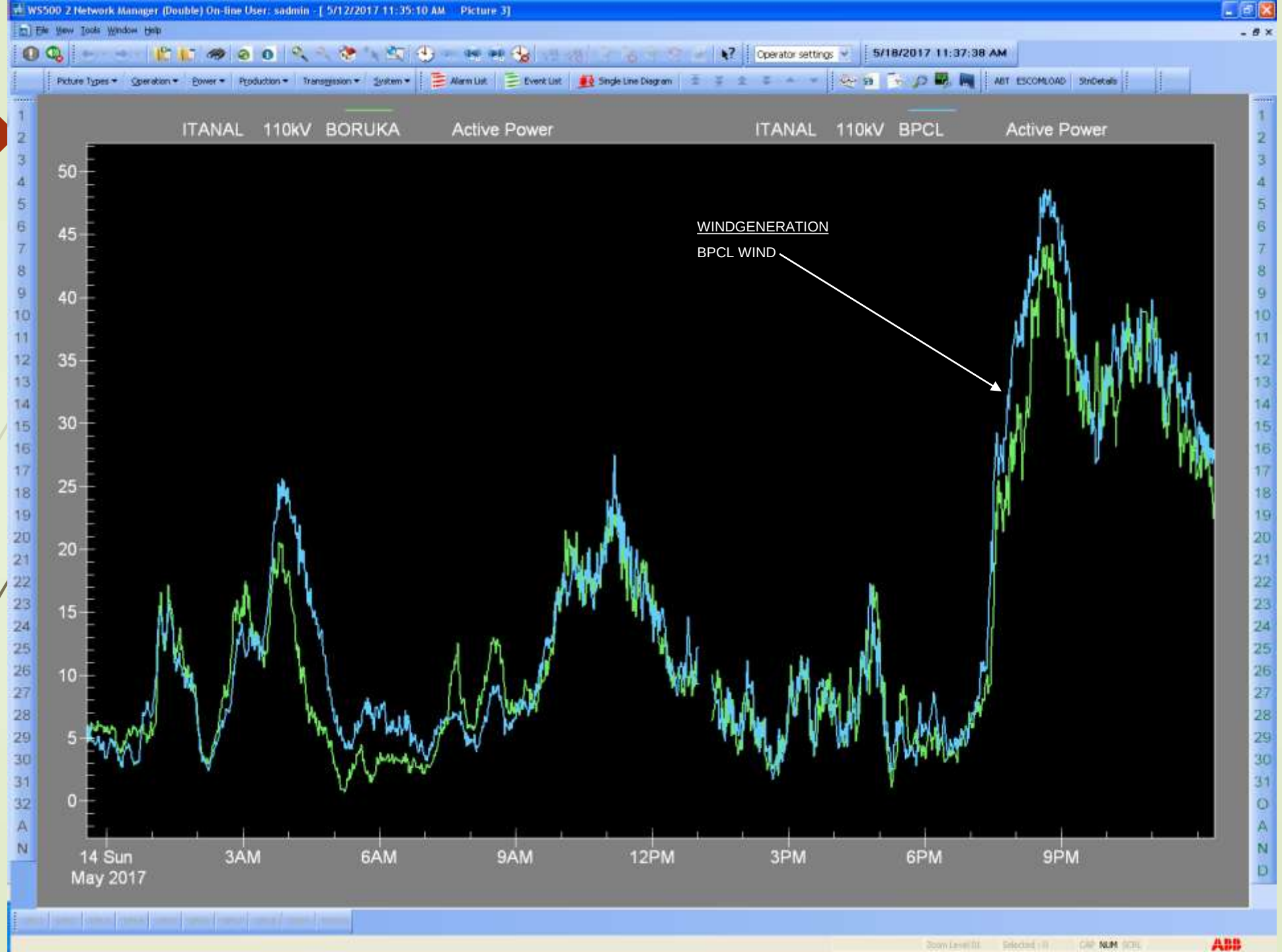
Tata solar-Capacity -10MW

BPCL Solar-Capacity-20MW


WS500 2 Network Manager (Double) On-line User: sadmin - [5/12/2017 10:49:44 AM Picture 3]
Operator settings
5/18/2017 10:51:00 AM
Picture Types
Operation
Power
Production
Transmission
System
Alarm List
Event List
Single Line Diagram
ABT
ESCOMLOAD
StnDetails
KALMHLI 66kV BPCL_SOLAR Active Power
KALMHLI 66kV TATA_SOLAR Active Power
CLOUDY DAY SOLAR GENERATION
BPCL SOLAR
TATA SOALR
18
16
14
12
10
8
6
4
2
0
13 Sat
May 2017
3AM
6AM
9AM
12PM
3PM
6PM
9PM

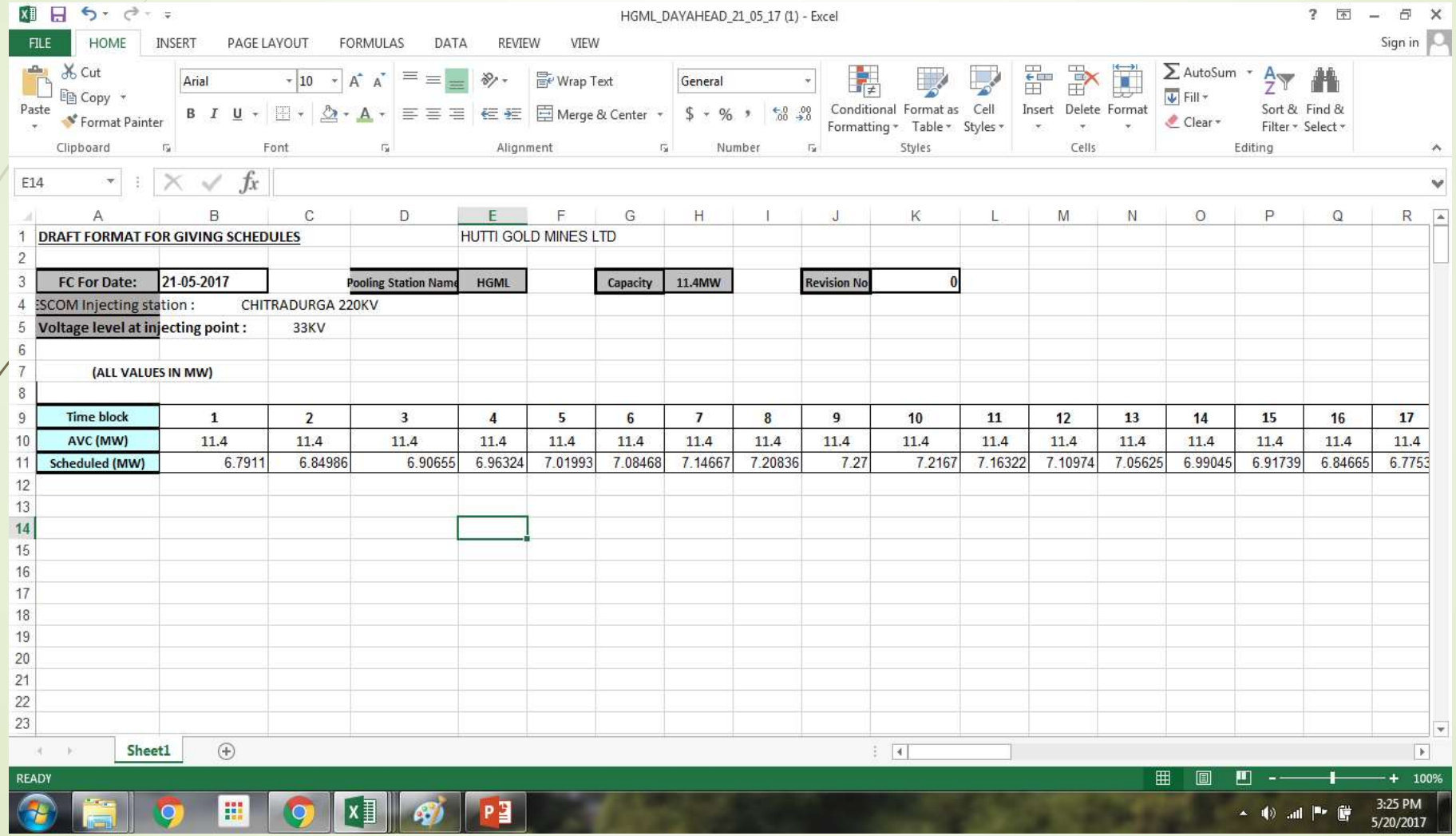

WS500 2 Network Manager (Double) On-line User: sadmin - [4/21/2017 11:06:00 AM Picture 3]
Operator settings
5/18/2017 11:07:47 AM
KALMHLI 66kV BPCL_SOLAR Active Power
KALMHLI 66kV TATA_SOLAR Active Power
SUNNY DAY SOLAR GENERATION
BPCL SOLAR
TATA SOALR
16
14
12
10
8
6
4
2
0
22 Sat
Apr 2017
3AM
6AM
9AM
12PM
3PM
6PM
9PM


WS500 1 Network Manager (Double) On-line User: sadmin - [ITANL0101 Picture 2]
Operator settings
5/18/2017 11:36:04 AM
Picture Types
Operation
Power
Production
Transmission
System
Alarm List
Event List
Single Line Diagram
ABT ESCOMLOAD
StnDetails
FREQ: 0.00 Hz
STN BAT: 0.00 V
STN LOAD: 5.64 MW
ITANAL 110/11kV
262051
VSAT: 262052
083xx-xxxxxx
9611739683
BPCL wind-Capacity-49.6MW
RAIBAG
RAIBAG-2
HIDIKAL-1
MLGPR
BPCL-1
BPCL-2
G
G
15.58
0.04
0.00
0.91
0.01
0.90
2.09
2.09
7.22
0.98
12.01
0.67
107.38 KV
2.52
1.95
HV1
3.12
2.43
HV2
Tap Changer
7
TR21
Tap Changer
7
TR22
2.58
1.85
LV1
3.17
2.29
LV2
11.04 KV
11.03 KV
F1-ITANAL
F2-IDLE
F3-IDLE
F4-IDLE
F5-SWAMIKUDI
F6-IDLE
CAP1
F7-IDLE
F8-IDLE
F9-IDLE
F10-DASRAKUDI
F11-LAXMIGUDI
F12-JAKWEL
CAP2
INDICATION
MEASURAND
CAP NUM


WS500 2 Network Manager (Double) On-line User: sadmin - [5/12/2017 11:35:10 AM Picture 3]
Operator settings
5/18/2017 11:37:38 AM
Picture Types
Operation
Power
Production
Transmission
System
Alarm List
Event List
Single Line Diagram
ABT ESCOMLOAD
StnDetails
ITANAL 110kV BORUKA Active Power
ITANAL 110kV BPCL Active Power
WINDGENERATION
BPCL WIND
50
45
40
35
30
25
20
15
10
5
0
14 Sun
May 2017
3AM
6AM
9AM
12PM
3PM
6PM
9PM


WS500 1 Network Manager (Double) On-line User: sadmin - [state_wind_solar_hydro_thermal 5/14/2017 10:47:34 AM Picture 2]
Operator settings
5/18/2017 11:16:48 AM
TRANSM 66KV GEN
KAR_GEN TOTAL M
TRANSM 66KV ZONE
TOTAL_WIND
TRANSM 66KV ZONE
TOTAL_SOLAR
TRANSM 66KV GEN
HYDRO TOT MW
TRANSM 66KV GEN
THERMAL TOT MW
8000
7000
6000
MW
STATE DEMAND
1000
500
MW
WIND
400
200
0
MW
SOLAR
800
600
400
200
MW
HYDRO
2000
1800
1600
MW
THERMAL
15 Mon
May 2017
3AM
6AM
9AM
12PM
3PM
6PM
9PM
16 Tue

Format in which schedules are received for Wind and solar



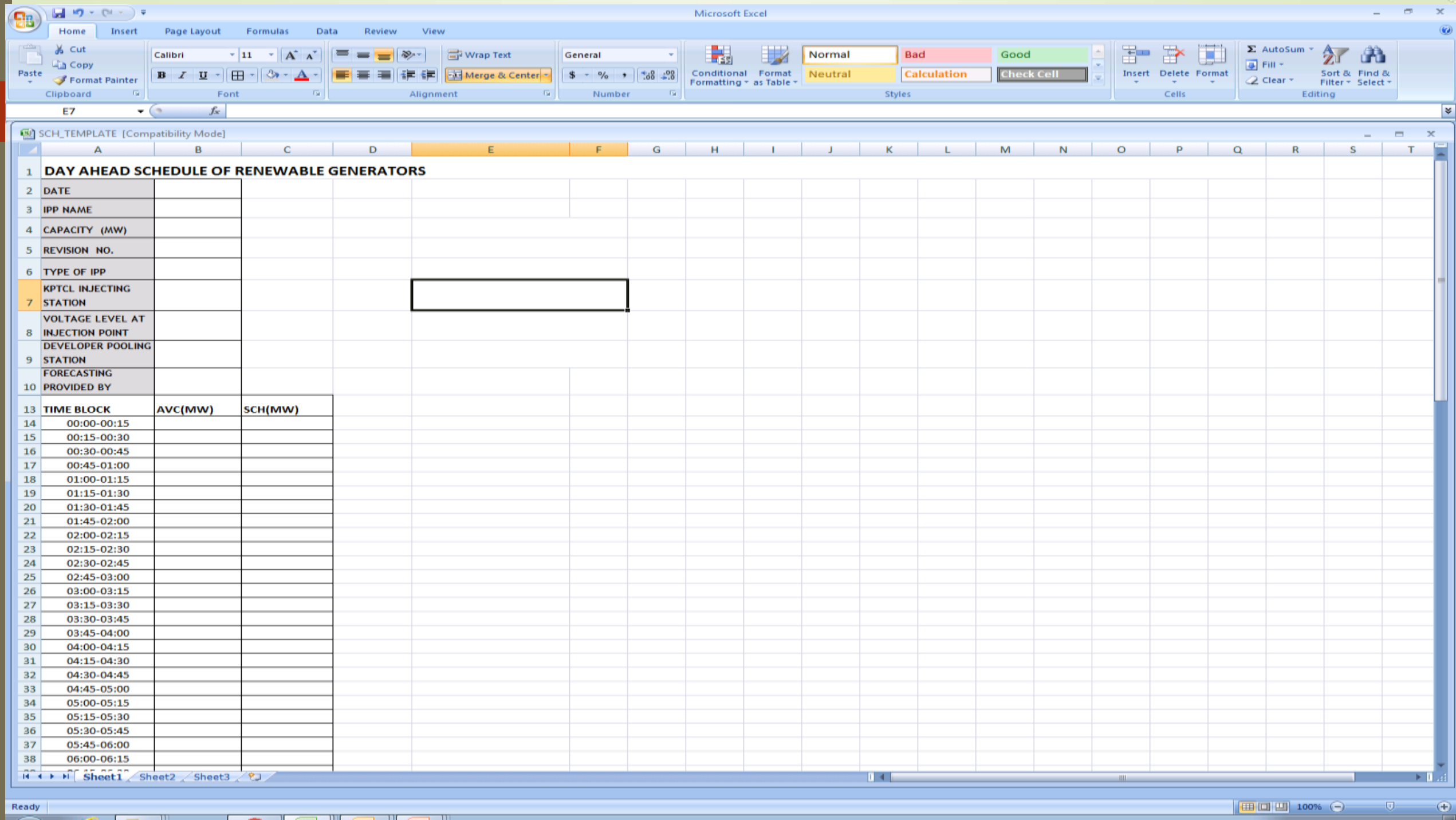
HGML_DAYAHEAD_21_05_17 (1) - Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	DRAFT FORMAT FOR GIVING SCHEDULES				HUTTI GOLD MINES LTD													
2																		
3	FC For Date:	21-05-2017		Pooling Station Name	HGML		Capacity	11.4MW		Revision No	0							
4	ESCOM Injecting station :	CHITRADURGA 220KV																
5	Voltage level at injecting point :	33KV																
6																		
7	(ALL VALUES IN MW)																	
8																		
9	Time block	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	AVC (MW)	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
11	Scheduled (MW)	6.7911	6.84986	6.90655	6.96324	7.01993	7.08468	7.14667	7.20836	7.27	7.2167	7.16322	7.10974	7.05625	6.99045	6.91739	6.84665	6.7753
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		
23																		

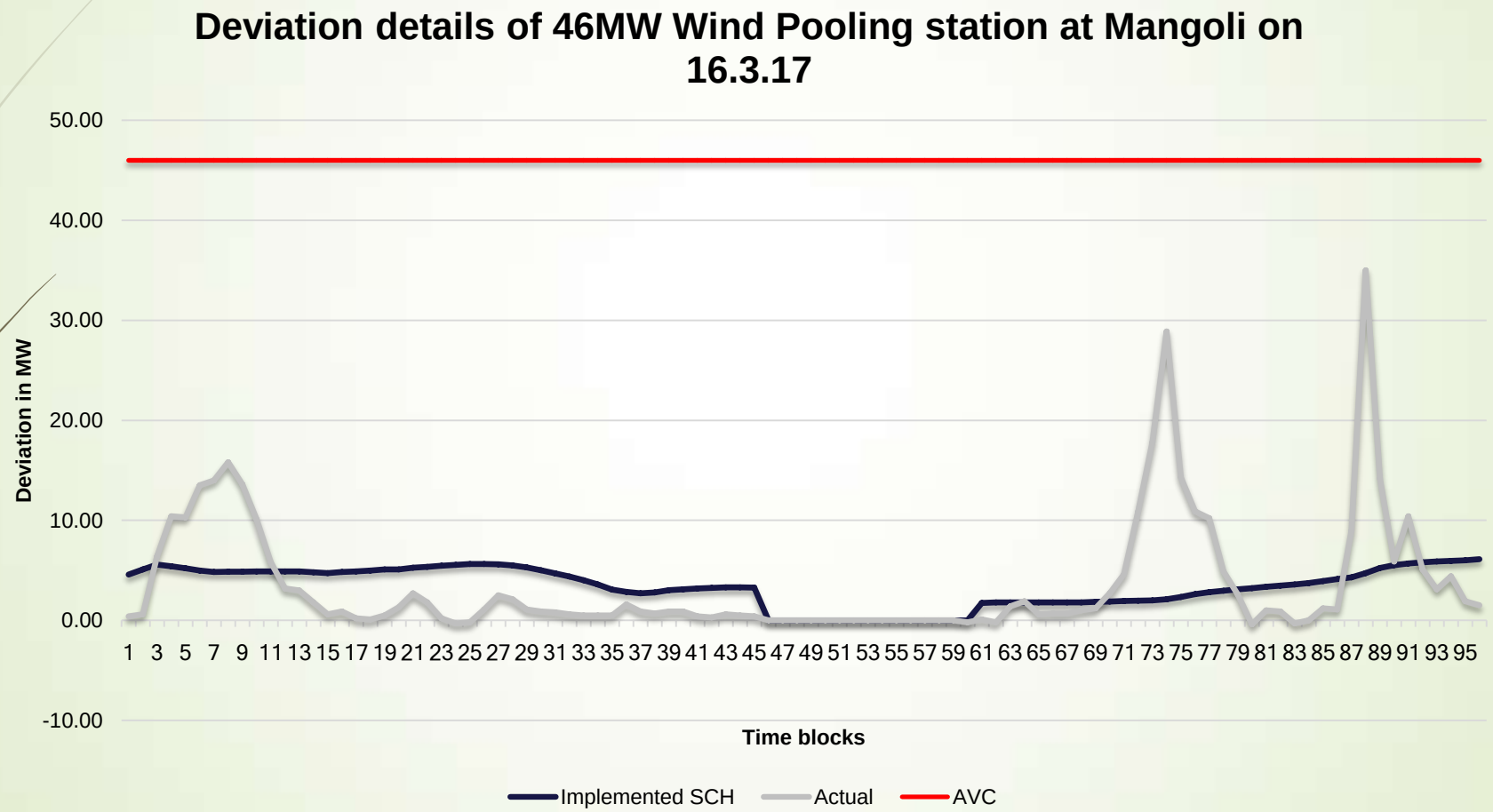
Sheet1

READY

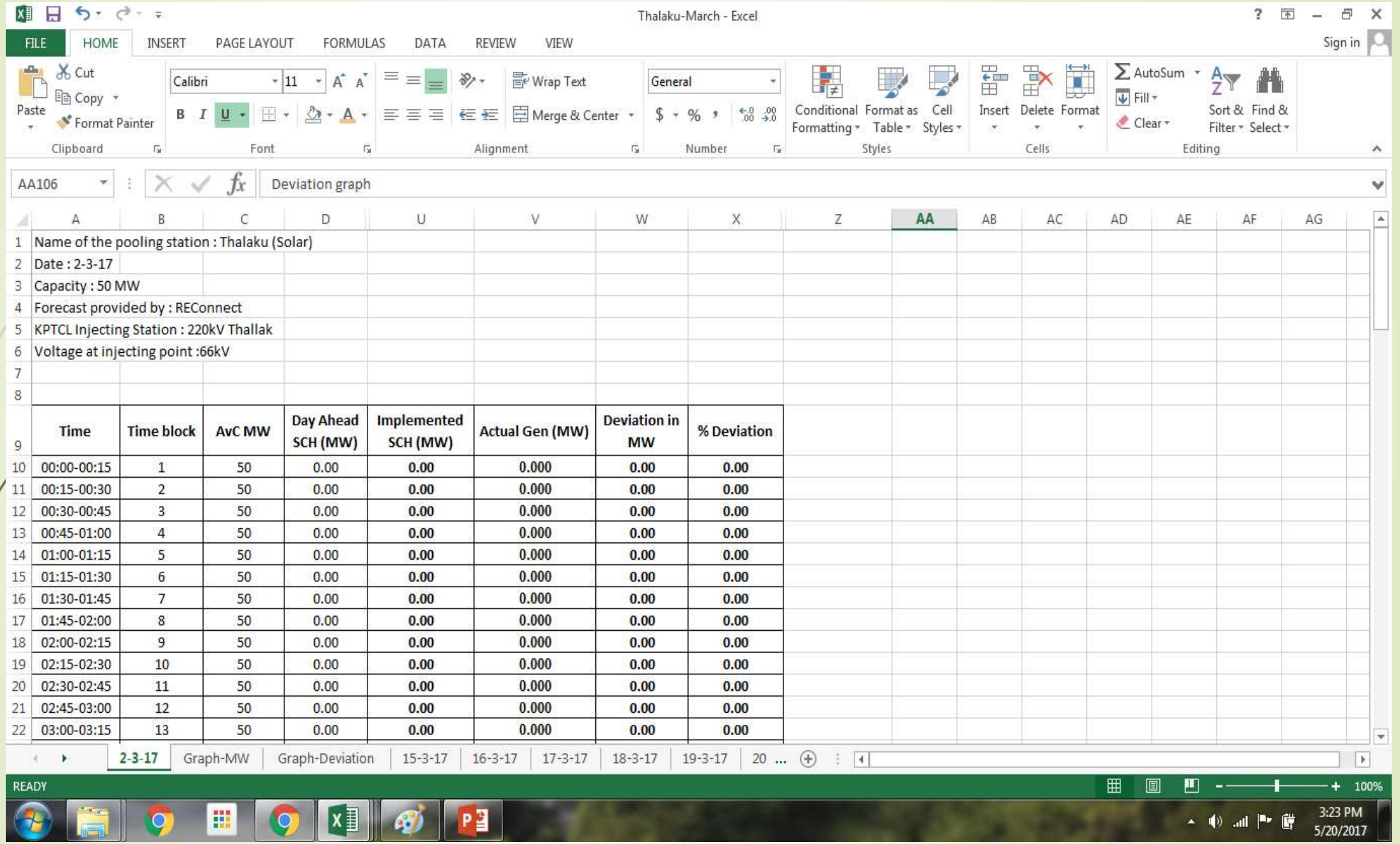
3:25 PM
5/20/2017


Microsoft Excel
Home
Insert
Page Layout
Formulas
Data
Review
View
Cut
Copy
Format Painter
Paste
Clipboard
Calibri
11
Font
Wrap Text
Merge & Center
Alignment
General
Number
Conditional Formatting
Format as Table
Normal
Bad
Good
Neutral
Calculation
Check Cell
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
E7
SCH_TEMPLATE [Compatibility Mode]
DAY AHEAD SCHEDULE OF RENEWABLE GENERATORS
DATE
IPP NAME
CAPACITY (MW)
REVISION NO.
TYPE OF IPP
KPTCL INJECTING STATION
VOLTAGE LEVEL AT INJECTION POINT
DEVELOPER POOLING STATION
FORECASTING PROVIDED BY
TIME BLOCK
AVC(MW)
SCH(MW)
00:00-00:15
00:15-00:30
00:30-00:45
00:45-01:00
01:00-01:15
01:15-01:30
01:30-01:45
01:45-02:00
02:00-02:15
02:15-02:30
02:30-02:45
02:45-03:00
03:00-03:15
03:15-03:30
03:30-03:45
03:45-04:00
04:00-04:15
04:15-04:30
04:30-04:45
04:45-05:00
05:00-05:15
05:15-05:30
05:30-05:45
05:45-06:00
06:00-06:15
Sheet1
Sheet2
Sheet3
Ready
100%

Deviation in wind generation



Sample Deviation settlement calculation for Solar Generation (2-3-2017)



Thalaku-March - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Sign in

Paste Cut Copy Format Painter | Calibri 11 | Wrap Text | General | Conditional Formatting | Format as Table | Cell Styles | Insert | Delete | Format | AutoSum | Fill | Clear | Sort & Filter | Find & Select

Clipboard Font Alignment Number Styles Cells Editing

AA106 Deviation graph

Name of the pooling station : Thalaku (Solar)
Date : 2-3-17
Capacity : 50 MW
Forecast provided by : REConnect
KPTCL Injecting Station : 220kV Thallak
Voltage at injecting point :66kV

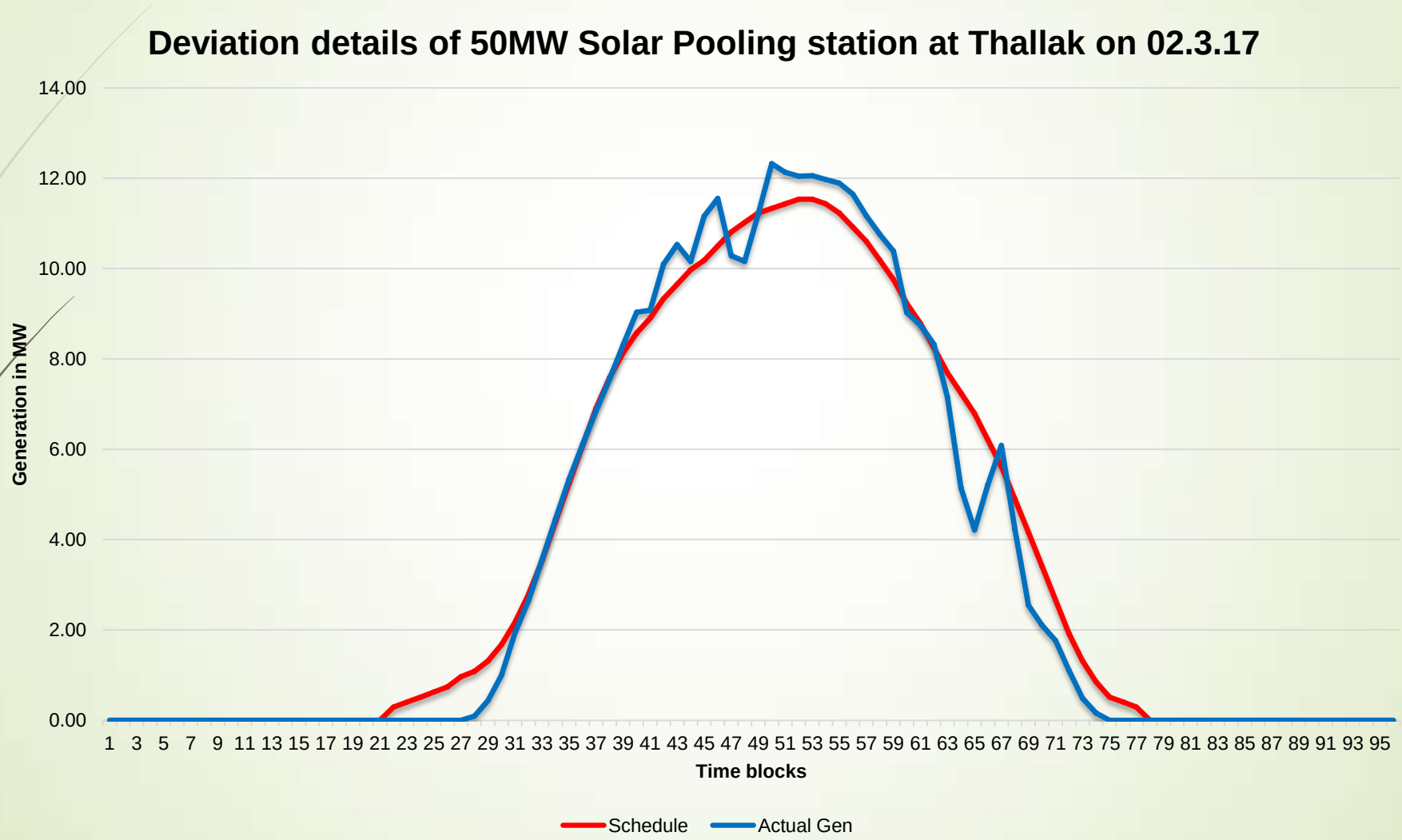
Time	Time block	AvC MW	Day Ahead SCH (MW)	Implemented SCH (MW)	Actual Gen (MW)	Deviation in MW	% Deviation
00:00-00:15	1	50	0.00	0.00	0.000	0.00	0.00
00:15-00:30	2	50	0.00	0.00	0.000	0.00	0.00
00:30-00:45	3	50	0.00	0.00	0.000	0.00	0.00
00:45-01:00	4	50	0.00	0.00	0.000	0.00	0.00
01:00-01:15	5	50	0.00	0.00	0.000	0.00	0.00
01:15-01:30	6	50	0.00	0.00	0.000	0.00	0.00
01:30-01:45	7	50	0.00	0.00	0.000	0.00	0.00
01:45-02:00	8	50	0.00	0.00	0.000	0.00	0.00
02:00-02:15	9	50	0.00	0.00	0.000	0.00	0.00
02:15-02:30	10	50	0.00	0.00	0.000	0.00	0.00
02:30-02:45	11	50	0.00	0.00	0.000	0.00	0.00
02:45-03:00	12	50	0.00	0.00	0.000	0.00	0.00
03:00-03:15	13	50	0.00	0.00	0.000	0.00	0.00

2-3-17 Graph-MW Graph-Deviation 15-3-17 16-3-17 17-3-17 18-3-17 19-3-17 20 ...

READY 100%

3:23 PM 5/20/2017

Deviation in Solar generation



PARTNERSHIP TO ADVANCE CLEAN ENERGY-DEPLOYMENT TECHNICAL ASSISTANCE PROGRAM

Development of Generic Renewable Purchase Obligation Compliance Web-tool

Presented to: Forum of Regulators – 12th Technical Committee Meeting

Date: May 30, 2017

Background of RPO compliance monitoring Webtool and related discussions during earlier meetings of Technical Committee

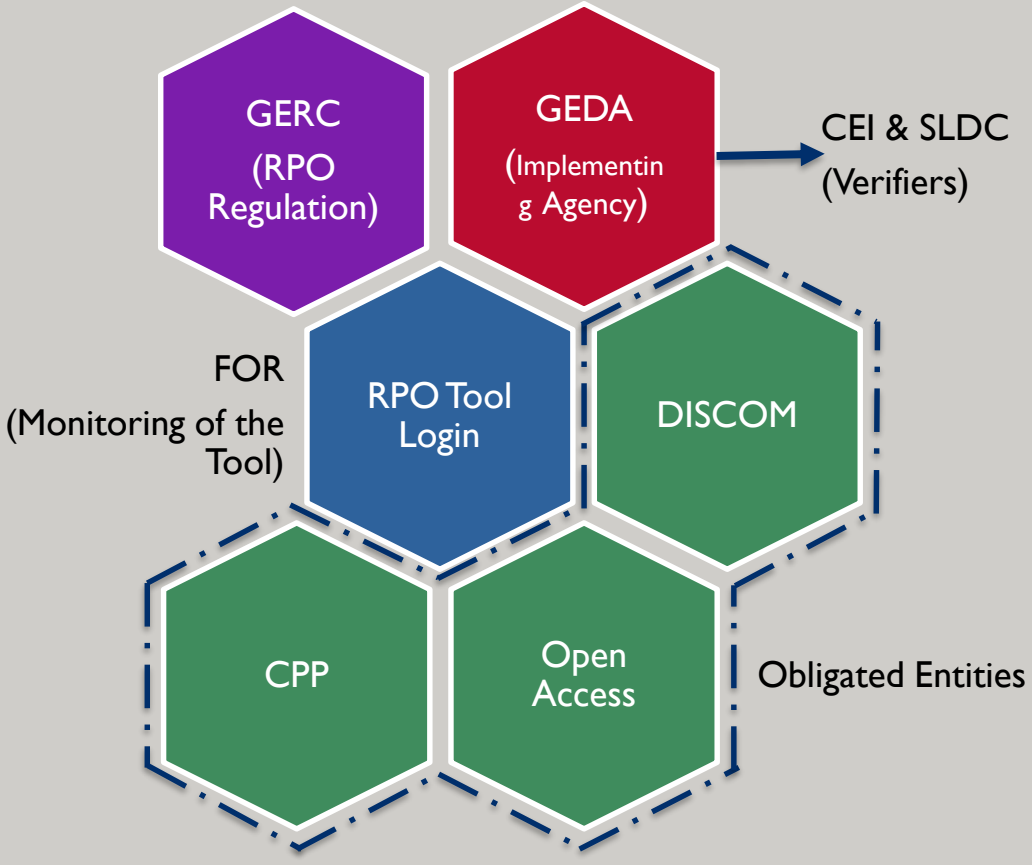
1. RPO compliance monitoring Web tool has been developed for Rajasthan, as an initiative under USAID PACE-D TA programme
2. FOR referred to Technical Committee to explore the possibilities for scaling up
3. The committee deliberated on need of generic web tool for RPO monitoring by states and agreed upon for necessity of framing Regulatory support for web tool implementation
4. During 10th meeting, presented the regulatory interventions required for rolling out the web tool for SERCs for monitoring compliance of RPO
5. Decided to develop Generic RPO Webtool to be ready for two states viz. (Rajasthan and Gujarat)
6. During 11th meeting, presented the details of Beta Version of Generic RPO tools with modalities

Progress on Generic RPO Webtool from 11th Technical Committee

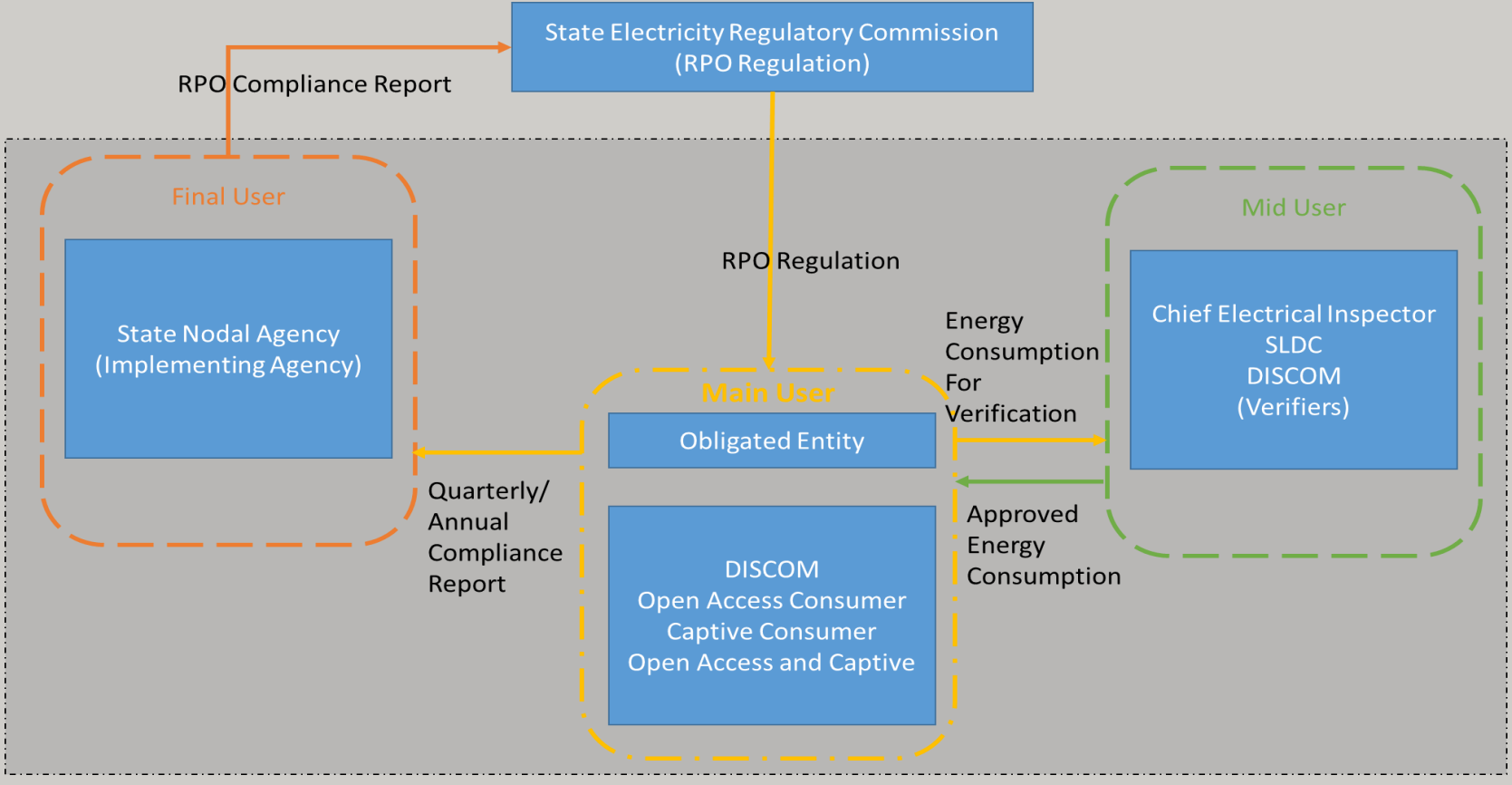
- Conducted a meeting with Officials of GEDA and GERC for discussion on Generic RPO Webtool.
- A follow up meeting with FOR secretariat was done to brief about the deliberations and points raised by GEDA and GERC team.
- Incorporated the changes in the RPO Webtool as suggested by the GEDA
- Presented a demo to FOR team on Generic RPO Webtool
- The constitution of working group/committee involving members from GERC, GEDA, GUVNL, SLDC, Electrical Inspectorate, Private Distribution Utilities and PACE-D TA Program is under process.

User Logins for RPO Generic Webtool

The tool is designed to facilitate all relevant stakeholders to provide reliable compliance reporting platform to share compliance information in transparent manner for all Obligated Entities, to ensure monitoring by State Agencies and to facilitate timely enforcement actions by the Regulators in case of shortfall or non-Compliance by Obligated Entities



Functioning of RPO Generic Webtool



Modifications in Generic RPO Tool

Based on interactions with GERC/GEDA and FOR, following changes have been incorporated in the generic RPO tool

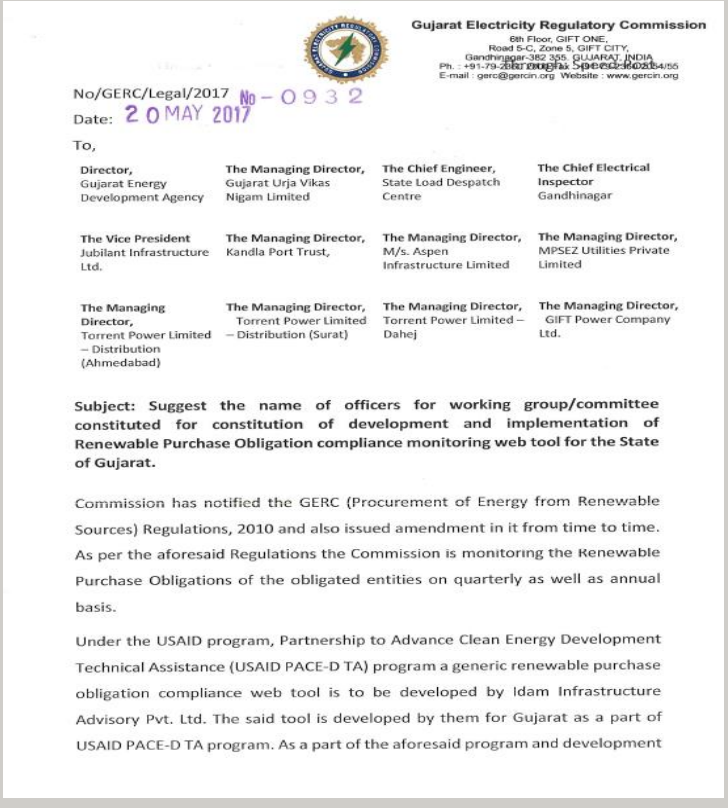
S. No.	Parameters	Addition / Modification	Description
1	Two step verification process	Addition	Feature to create a new login for data operator at Obligated entity level, one user will be admin user that will decide the role of other users.
2	Carry forward of the deficit RPO target to next year	Addition	Some states follow carry forwarding of RPO deficit to next year. The logic for the same is incorporated in the tool.
3	Inter-se adjustment of solar and non-solar RPO targets	Modification	If states want to monitor combined RPO met for certain class of obligated entities, instead of tracking separate compliance for solar and non-solar then, the provision for same has been incorporated.
4	Summary report for total obligated entities	Addition	A summary report has been prepared on the dashboard so as to provide snapshot of information covering following: • number of OEs registered • OEs updating the data • OEs not updating the data

Modifications in Generic RPO Tool

During the last meeting, various modifications were highlighted that are incorporated in the tool. Later to meeting with officials of Gujarat and FOR, following changes are incorporated in the generic RPO tool

S. No.	Parameters	Addition / Modification	Description
5	Summary report for status of RPO	Addition	A summary report is prepared on the dashboard that provided status of all OEs in numbers • Total RPO fulfilled by state • Total no. of OE (category wise) with RPO met and RPO deficit
6	Reports in PDF format	Addition	The reports can be downloadable in PDF format.
7	Reports in Excel format	Work under progress	The reports can be downloadable in excel format.

Constitution of Working Group for RPO webtool implementation at Gujarat



Gujarat Electricity Regulatory Commission
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Road 5-C, Zone 5, GIFT CITY,
Gandhinagar-382 355, GUJARAT, INDIA
Ph. : +91-79-2[illegible] Fax : +91-79-2[illegible]/55
E-mail : gerc@gercin.org Website : www.gercin.org

No/GERC/Legal/2017 No – 0932
Date: 20 MAY 2017

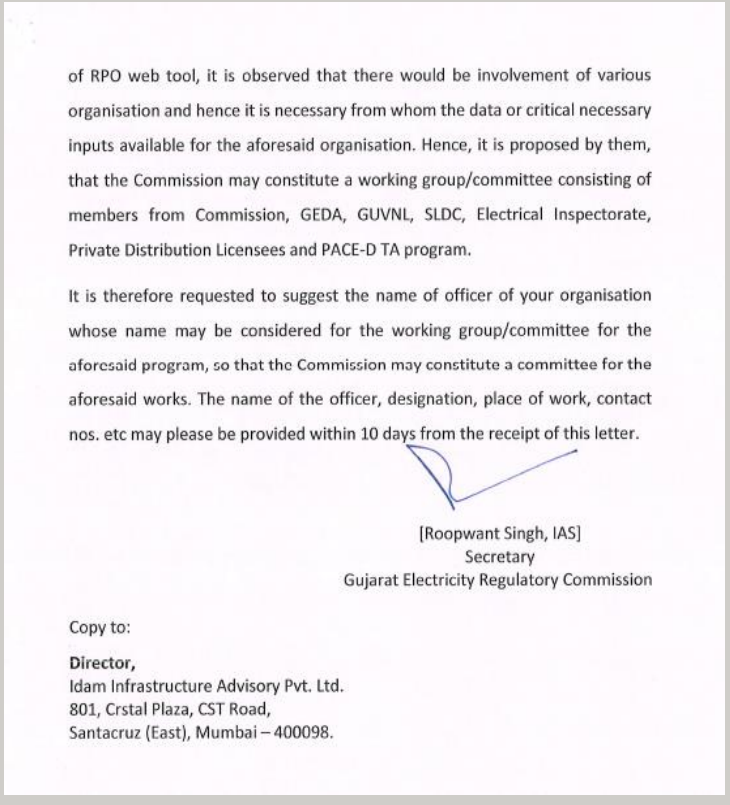
To,

Director, Gujarat Energy Development Agency	**The Managing Director,** Gujarat Urja Vikas Nigam Limited	**The Chief Engineer,** State Load Despatch Centre	**The Chief Electrical Inspector** Gandhinagar
The Vice President Jubilant Infrastructure Ltd.	**The Managing Director,** Kandla Port Trust,	**The Managing Director,** M/s. Aspen Infrastructure Limited	**The Managing Director,** MPSEZ Utilities Private Limited
The Managing Director, Torrent Power Limited – Distribution (Ahmedabad)	**The Managing Director,** Torrent Power Limited – Distribution (Surat)	**The Managing Director,** Torrent Power Limited – Dahej	**The Managing Director,** GIFT Power Company Ltd.

Subject: Suggest the name of officers for working group/committee constituted for constitution of development and implementation of Renewable Purchase Obligation compliance monitoring web tool for the State of Gujarat.

Commission has notified the GERC (Procurement of Energy from Renewable Sources) Regulations, 2010 and also issued amendment in it from time to time. As per the aforesaid Regulations the Commission is monitoring the Renewable Purchase Obligations of the obligated entities on quarterly as well as annual basis.

Under the USAID program, Partnership to Advance Clean Energy Development Technical Assistance (USAID PACE-D TA) program a generic renewable purchase obligation compliance web tool is to be developed by Idam Infrastructure Advisory Pvt. Ltd. The said tool is developed by them for Gujarat as a part of USAID PACE-D TA program. As a part of the aforesaid program and development



of RPO web tool, it is observed that there would be involvement of various organisation and hence it is necessary from whom the data or critical necessary inputs available for the aforesaid organisation. Hence, it is proposed by them, that the Commission may constitute a working group/committee consisting of members from Commission, GEDA, GUVNL, SLDC, Electrical Inspectorate, Private Distribution Licensees and PACE-D TA program.

It is therefore requested to suggest the name of officer of your organisation whose name may be considered for the working group/committee for the aforesaid program, so that the Commission may constitute a committee for the aforesaid works. The name of the officer, designation, place of work, contact nos. etc may please be provided within 10 days from the receipt of this letter.

[Roopwant Singh, IAS]
Secretary
Gujarat Electricity Regulatory Commission

Copy to:

Director,
Idam Infrastructure Advisory Pvt. Ltd.
801, Crstal Plaza, CST Road,
Santacruz (East), Mumbai – 400098.

The Commission has issued notice for constitution of Working Group for RPO Webtool implementation in Gujarat. Two Licensees have nominated officials for Working Group.

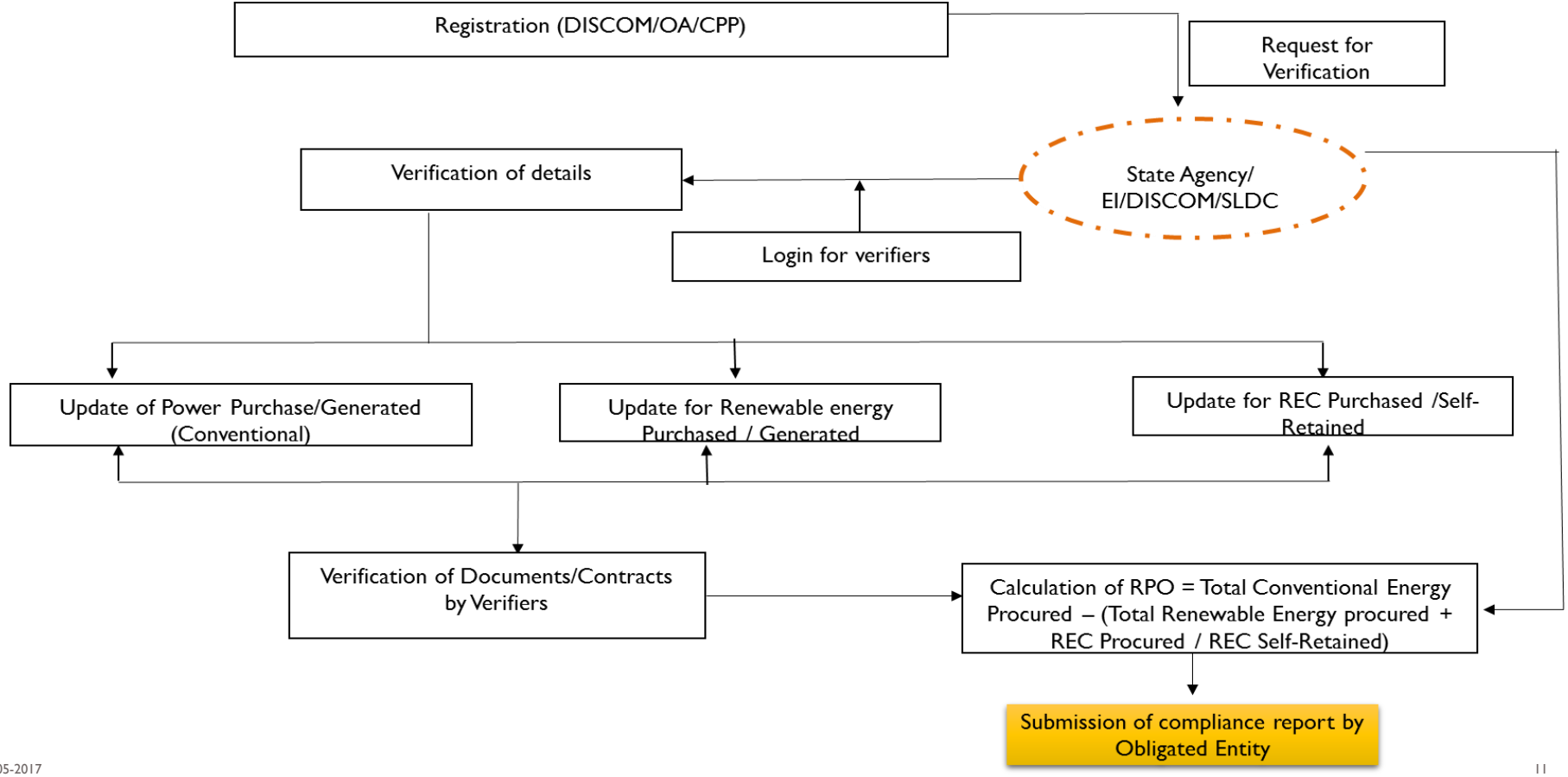
Next steps for Generic RPO Tool

- Sharing Source Code with GEDA for Security Audit
- Web-tool Migration on website on the server of Govt. of Gujarat
- Testing of tool on website of Gujarat with actual data
- Submission of technical documents; URS document, and training manual to GEDA
- Training of Obligated Entities

Visuals of Generic RPO Web-tool

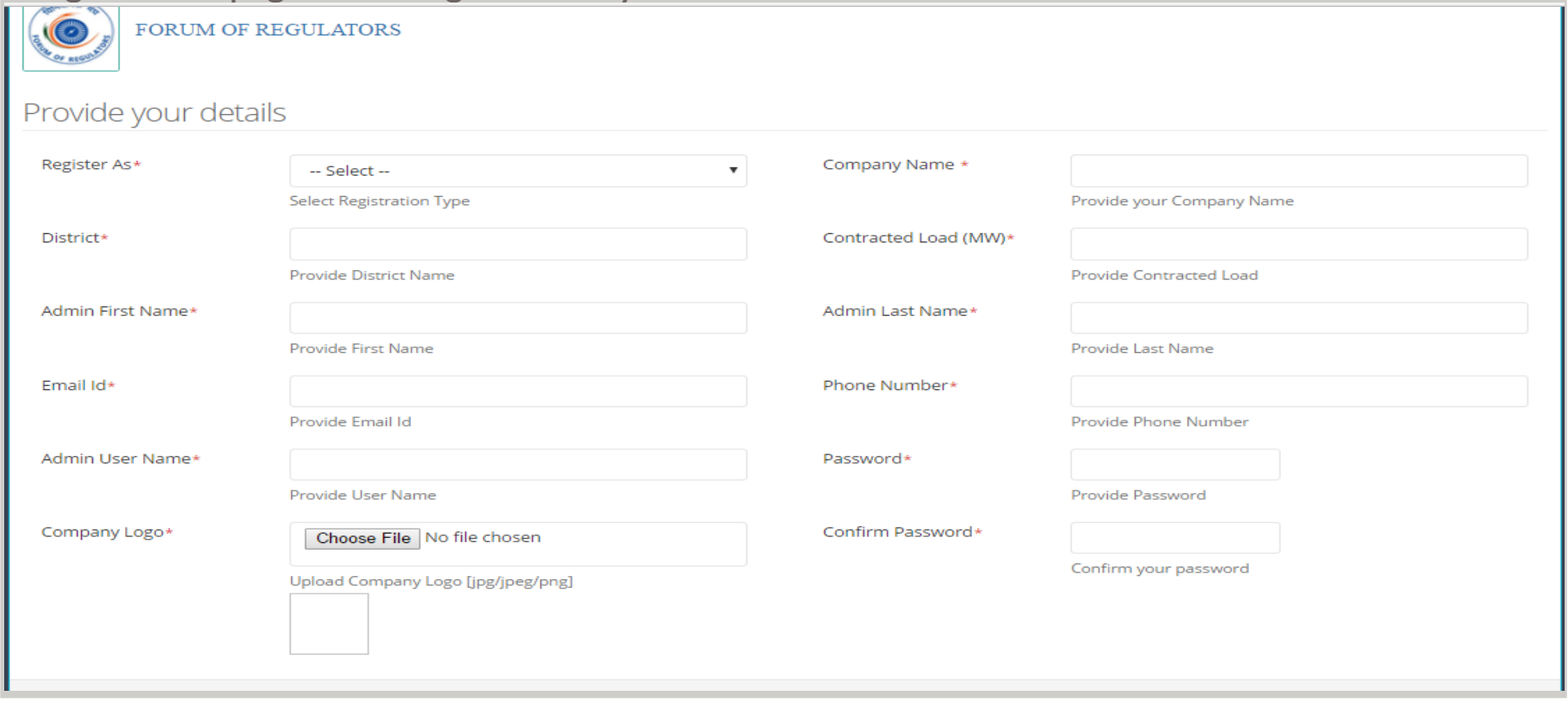
(Beta version)

Process flow chart for Obligated Entity



Generic RPO Web-tool for Obligated Entity: Beta Version

Registration page for Obligated Entity



Dashboard for Obligated Entity

Dashboard Summary of an obligated entity

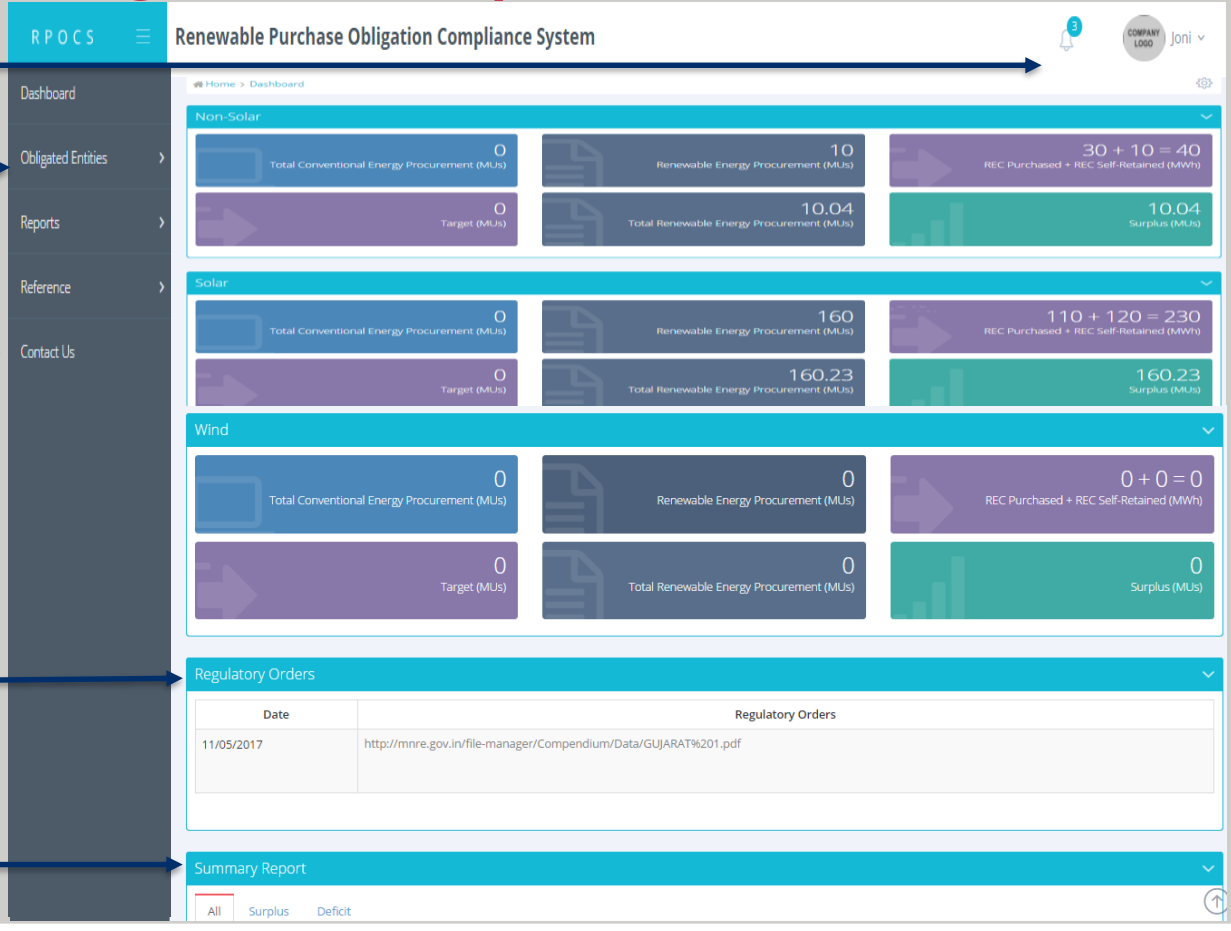
Vendor Requests, Contracts & Periodical Consumptions

All RPO related Regulatory Documents for Help

SNA Contact Details

List of Pending Verifications: Contracts & Periodical Consumptions

Compliance Report Summary of all obligated entities

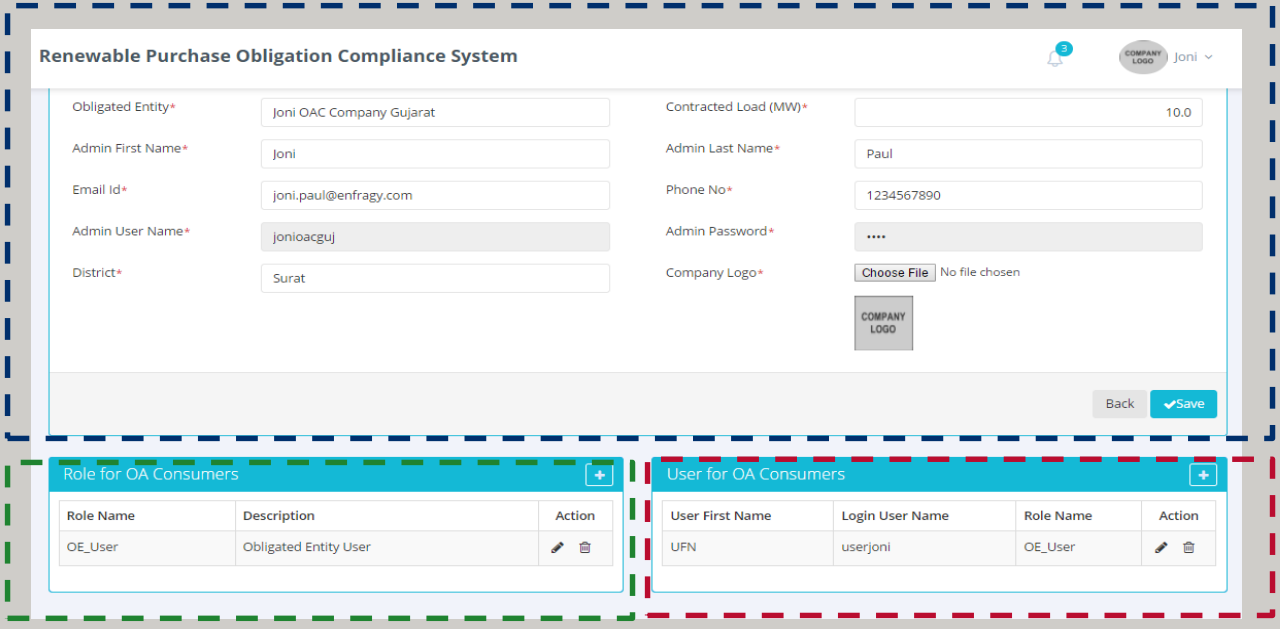


Maker and Checker for Obligated Entity

- Two-step verification login for Obligated Entity have been incorporated. Here, the obligated entity will design a new maker login and assign roles to it.

Obligated Entity information page (The information provided at the time of registration can be edited by OE if needed)

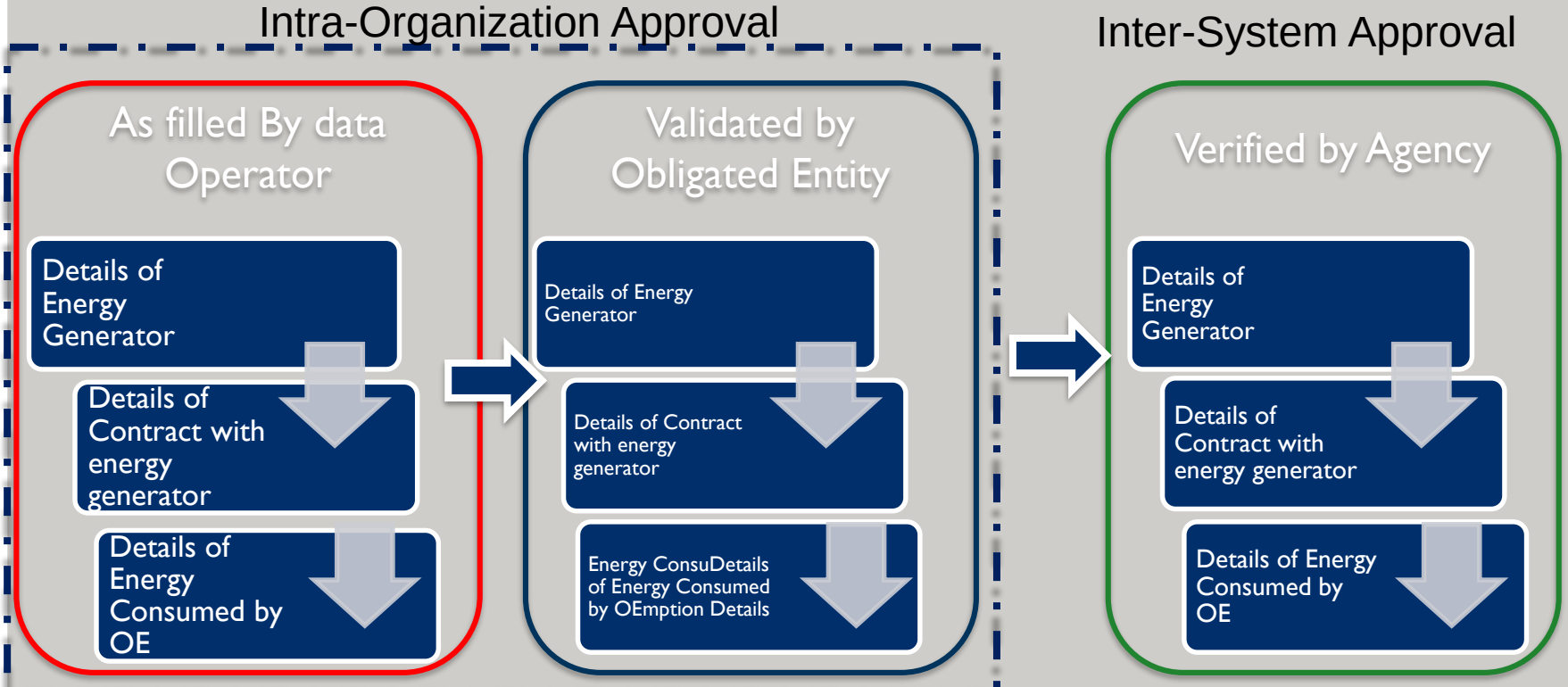
OE can define the role of Data Operator



OE defining Login Credentials for Data Operator

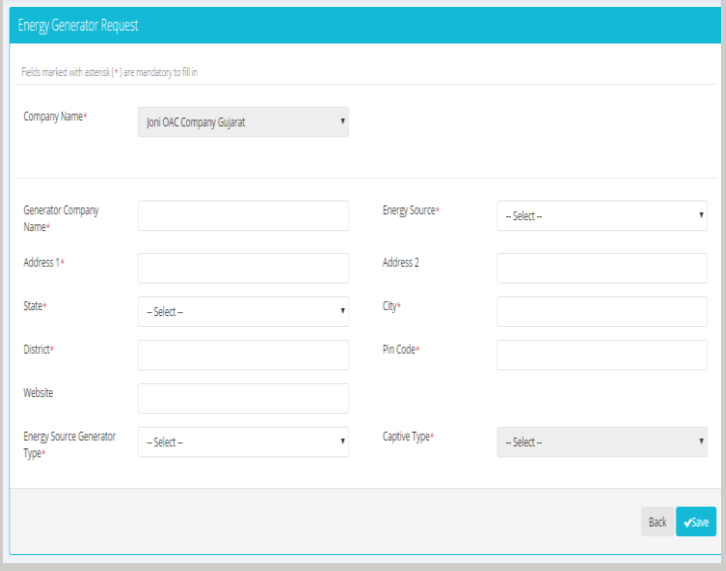
Energy Consumption Data - Validation & Verification Process

The Energy consumption data process is a three step process. Initiated by data operator and approved by OE. Subsequently, the data is forwarded to verifiers (CEI, SLDC and DISCOM).

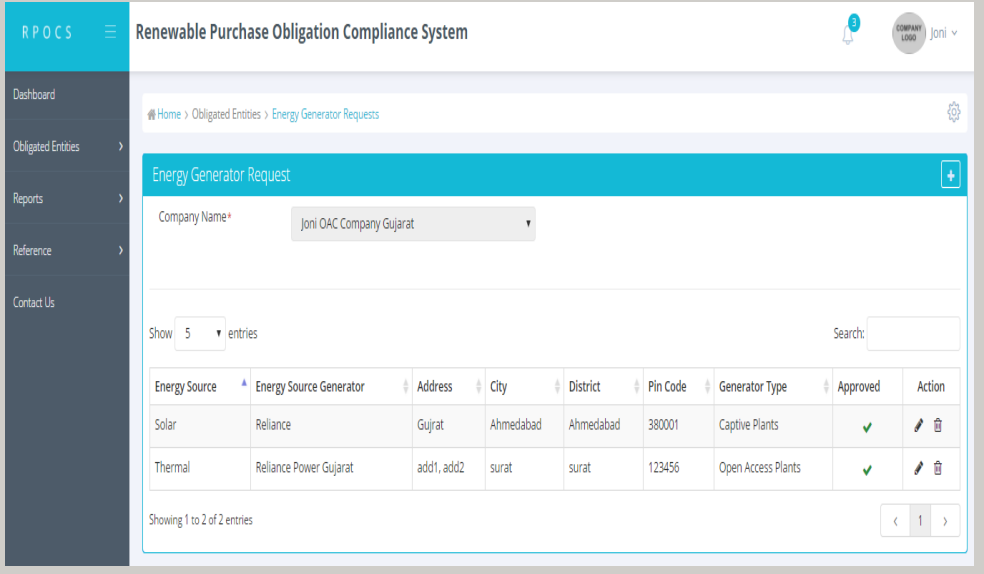


Details of Energy Generator contracted by Obligated Entity

Details of energy generator can be filled in a single form. The filled details are forwarded to the verifiers.

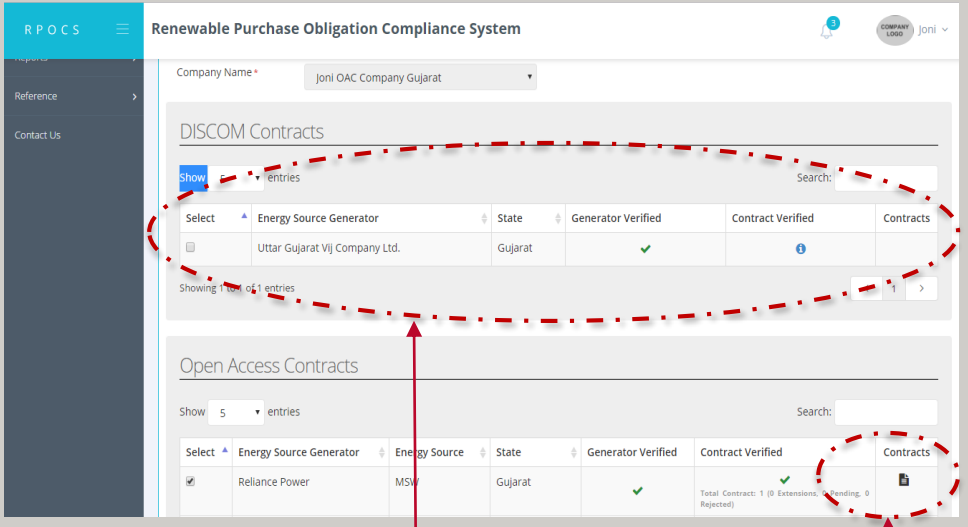


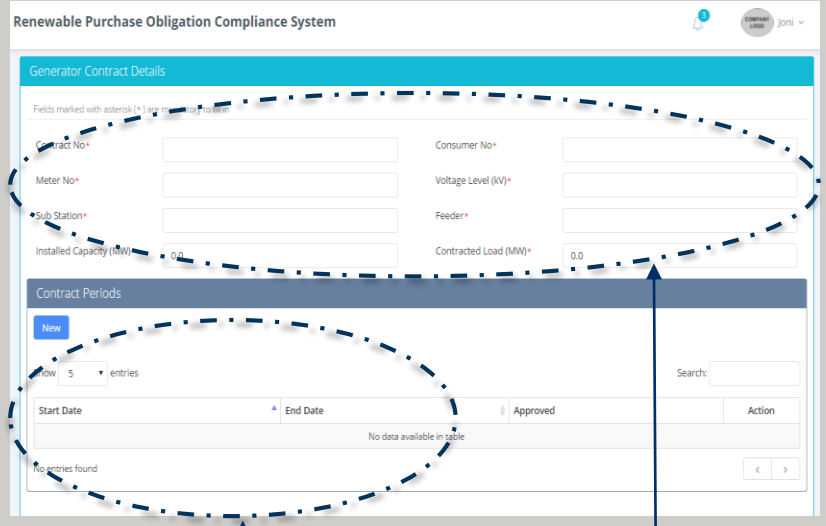
Energy generator request page for Obligated Entity



List of Energy Generators and their approval status by verifiers

Details of Contracts with Energy Generator





Approved List of Energy Generators (DISCOM, OA and CPP generators).

Select generator to fill-in the contract details.

Tab to update Energy Consumption Contract

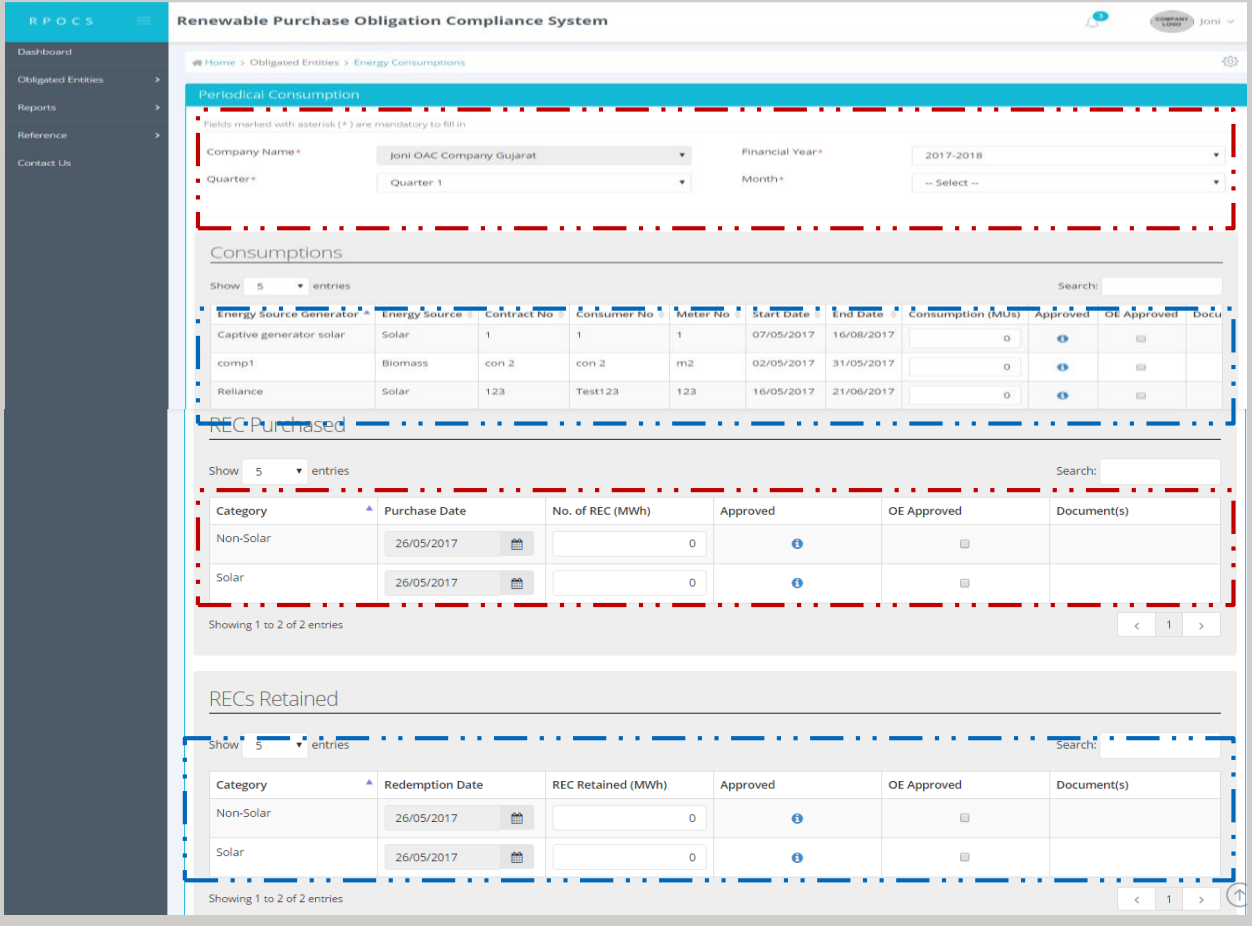
Energy Consumption Contract Period

Energy Consumption Contract Details

Details of Energy consumed as per the contract with Energy generator

1

Select financial Year, Quarter and month to update the Energy Consumption details



2

Fill-in the conventional and non conventional energy procured

3

Fill-in Number of RECs procured by Obligated Entity

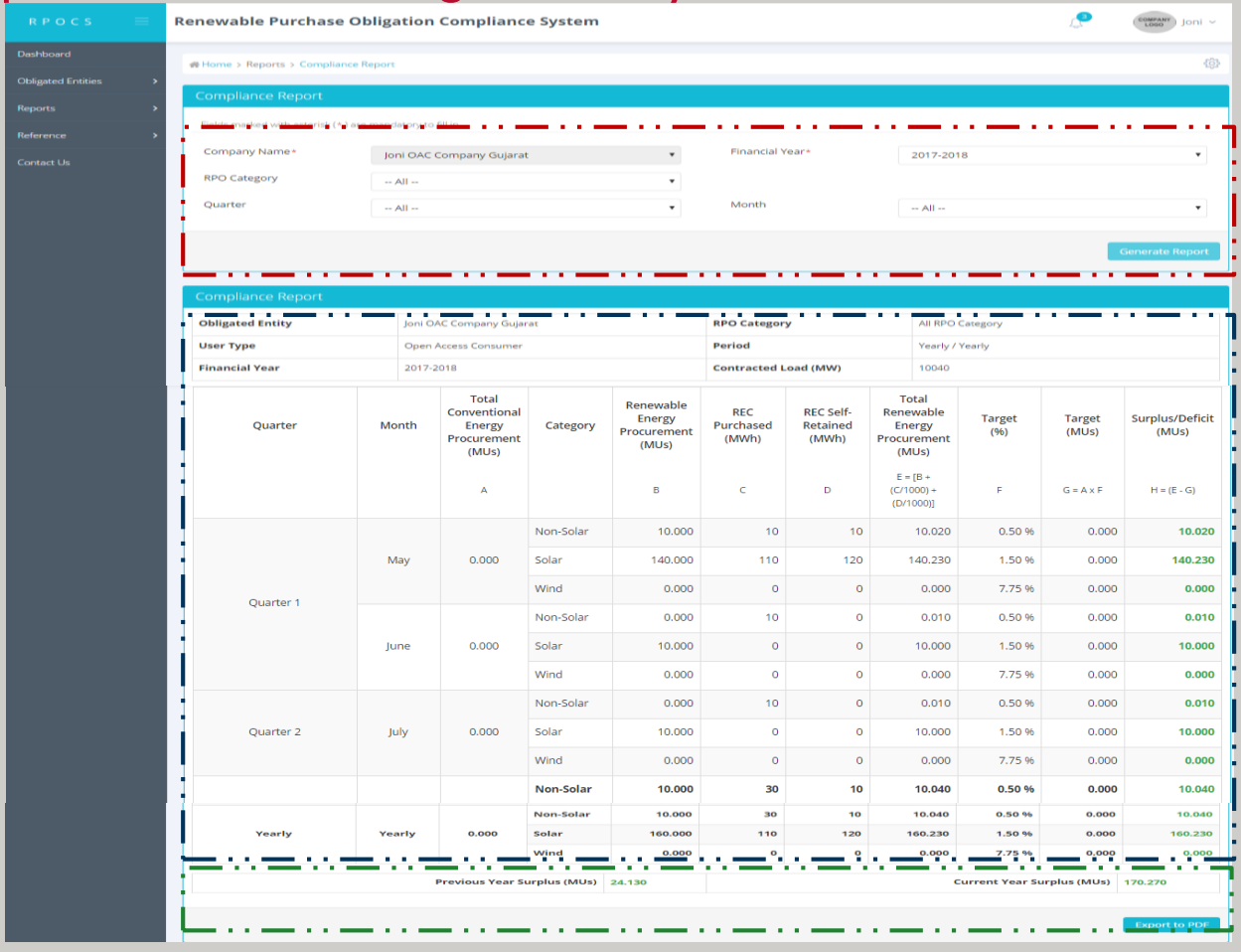
4

Fill-in Number of RECs self-retained by Obligated Entity

Compliance report format for Obligated Entity

Select financial Year, Quarter and month to generate Compliance Report

RPO Compliance Report also covers the previous year deficit, and carry forward that deficit to current year's deficit/ surplus to determine the final status of RPO Compliance.



Quarter	Month	Total Conventional Energy Procurement (MUs) A	Category	Renewable Energy Procurement (MUs) B	REC Purchased (MWh) C	REC Self-Retained (MWh) D	Total Renewable Energy Procurement (MUs) E = [B + (C/1000) + (D/1000)]	Target (%) F	Target (MUs) G = A x F	Surplus/Deficit (MUs) H = (E - G)
Quarter 1	May	0.000	Non-Solar	10.000	10	10	10.020	0.50 %	0.000	10.020
			Solar	140.000	110	120	140.230	1.50 %	0.000	140.230
			Wind	0.000	0	0	0.000	7.75 %	0.000	0.000
	June	0.000	Non-Solar	0.000	10	0	0.010	0.50 %	0.000	0.010
			Solar	10.000	0	0	10.000	1.50 %	0.000	10.000
			Wind	0.000	0	0	0.000	7.75 %	0.000	0.000
Quarter 2	July	0.000	Non-Solar	0.000	10	0	0.010	0.50 %	0.000	0.010
			Solar	10.000	0	0	10.000	1.50 %	0.000	10.000
			Wind	0.000	0	0	0.000	7.75 %	0.000	0.000
			Non-Solar	**10.000**	**30**	**10**	**10.040**	**0.50 %**	**0.000**	**10.040**
Yearly	**Yearly**	**0.000**	Non-Solar	10.000	30	10	10.040	0.50 %	0.000	10.040
			Solar	160.000	110	120	160.230	1.50 %	0.000	160.230
			Wind	0.000	0	0	0.000	7.75 %	0.000	0.000

Previous Year Surplus (MUs)	24.130	Current Year Surplus (MUs)	170.270

RPO compliance is determined by applying the RPO% specified by SERC on Conventional energy consumed by OE.

Dashboard GEDA and FOR

System Settings page to setup mails and other settings

State Agency page to define financial year-wise RPO %

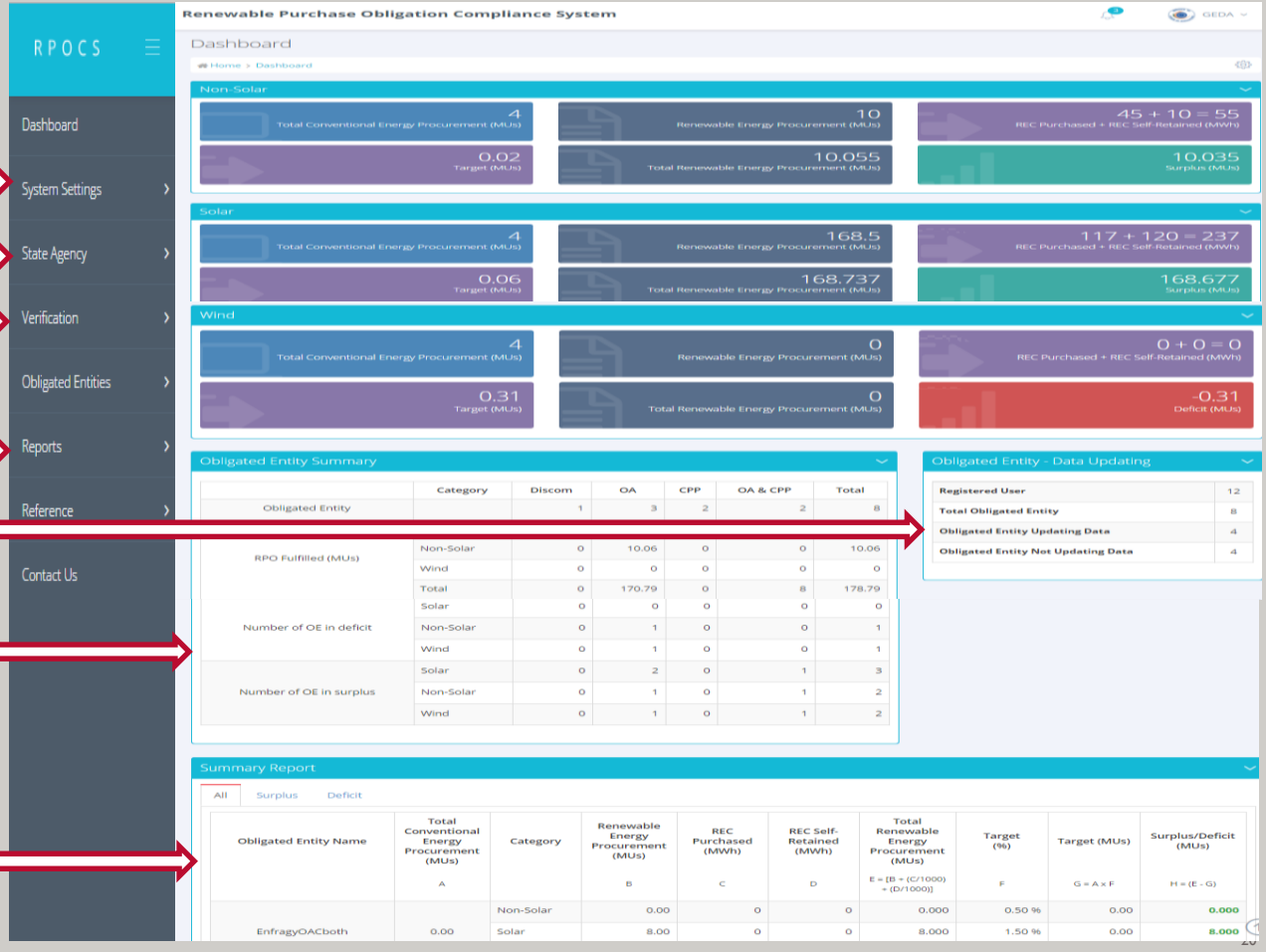
Verification of energy generator requests, Contracts with energy generator and Periodical consumption.

Compliance report and other report formats

List of Obligated Entitles updating data

Obligated entity summary

Compliance Report Summary of all obligated entities



Obligated Entity Summary	Category	Discom	OA	CPP	OA & CPP	Total
Obligated Entity		1	3	2	2	8
RPO Fulfilled (MUs)	Non-Solar	0	10.06	0	0	10.06
	Wind	0	0	0	0	0
	Total	0	170.79	0	8	178.79
Number of OE in deficit	Solar	0	0	0	0	0
	Non-Solar	0	1	0	0	1
	Wind	0	1	0	0	1
Number of OE in surplus	Solar	0	2	0	1	3
	Non-Solar	0	1	0	1	2
	Wind	0	1	0	1	2

Obligated Entity Name	Total Conventional Energy Procurement (MUs) A	Category	Renewable Energy Procurement (MUs) B	REC Purchased (MWh) C	REC Self-Retained (MWh) D	Total Renewable Energy Procurement (MUs) E = [B + (C/1000) + (D/1000)]	Target (%) F	Target (MUs) G = A x F	Surplus/Deficit (MUs) H = (E - G)
		Non-Solar	0.00	0	0	0.000	0.50 %	0.00	0.000
EnfragyOACboth	0.00	Solar	8.00	0	0	8.000	1.50 %	0.00	8.000

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Senior Clean Energy Specialist
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Regional co-operation for Optimum Utilization of Generation Resources

SRPC SECRETARIAT
BANGALORE

- This Sub-Group shall inter-alia examine the feasibility and modality of **co-operation among States in the respective region**[1] for ensuring **optimum utilization of generation**[2] resources with **least cost options** for **balancing across the region**[3].

Issue	Constraint	Remarks
Co-operation Among States In The Respective Region	Existing practice is Scheduling for Each Control Area. Co-operation Among the states in the respective region can only be under the ambit of existing scheduling process of IEGC.	Any Co-operation Is Possible Only Through Schedule Transition • It Would Require Minimum Time For Implementation. • Transmission Charges And Losses Applicability. • Cost Of Such Transaction. • Willingness of other states to purchase such power at that time with quantum and agreed cost .

- A Regional level Co-operation May Lead To Distortion Of Merit Order Dispatch.
- This May Lead To Audit Objection For Both Buyer And Seller.
- There Is Merit Order Monitoring At MoP/CEA Level

Issue	Constraint	Remarks
Optimum Utilization Of Generation	Existing Practice Is Merit Order Based For Each Control Area. The Generator Scheduling Is Based On PPA With States. Optimum Utilization Is Restricted To PPA With States.	Reserve Shut Down Of Units, Purchase Of Power By Another State Is Restricted Due To PPAs.

This May Require Regional Level Stack Of All The Generators

Issue	Constraint	Remarks
Balancing Across The Region	Existing Practice Is Balancing Across Each Control Area.	The Present Practice Of Real Time Monitoring Is Control Area Wise. In Case A Control Area Requires Balancing Power Through Regional System It Has To Be As A Schedule Transaction.

With The Concept Of Control Area Wise Scheduling And Deviation Concept Of Regional Level Balancing With Control Area Cannot Co-Exist

Solution……

- As The Intend Is To Give The RE Rich State A Comfort Of Insulation From Deviation From The Forecast By RE Source, It Would Be Prudent To Forecast, Schedule, Meter And Account As Regional Entity Than As State Entity.
- The Power Would Be Scheduled As Per PPA (Based On Forecast) To The State.
- Deviation Of The RE Source Would Be Settled As Per SERC/CERC Regulation.

Advantage

- The Deviation Of RE Source Would Not Affect RE State Unless The Schedule Is Revised Based On Forecast Or Outages.
- All The RE Source In One Bid Area Can Be Clubbed To Reduce The Deviation And To Ensure That ATC Is Not Violated.
- Ancillary Services, AGC, Spinning Reserve At Regional Level Can Help In Absorbing The RE Deviation.
- The Responsibility To Absorb The Scheduled RE Power Would Be With State As It Is Must Run.

Requirement

- Infrastructure for Scheduling, Metering and Monitoring of RE Source. (The Same should be in Place as per Existing Regulations)

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

Agenda Note

1.0 In the 11th Meeting of the "Technical Committee for Implementation of Framework on Renewables at the State Level" held at Chennai on 28th March 2017, it was decided to form a Sub-Group to examine the various aspects of migrating from 15-minute to 5-minute scheduling, metering, accounting and settlement at the inter-state level to facilitate large scale integration of renewables.

2.0 Accordingly, the Sub-Group has been constituted comprising of the following members:-

(a) Shri S.K. Soonee, Advisor, POSOCO
(b) Representative of all RPCs and NPC
(c) Representative of CEA
(d) Representative of POSOCO
(e) Representative of CTU
(f) Representative from one RE rich state each in NR, WR and SR

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

a) Look at all pros and cons of moving to 5-Minute Scheduling, Metering, Accounting and Settlement
b) Identify all activities to move from 15-minute to 5-minute scheduling, metering, accounting and settlement
c) Identify changes required in various Regulations including Grid Code and suggest the required amendments
d) Suggest amendments required to the CEA Metering Regulations and assess the metering infrastructure required
e) Suggest any specific requirements in this context for cross border transactions
f) Infrastructure requirements in terms of hardware & software upgradation needed for scheduling, metering, accounting and settlement by the NLDC, RLDCs, SLDCs and RPCs/NPC
g) Detailed action plan for migration including phasing of activities if required
h) Time-frames for the implementation of identified activities and target date for migration to 5-minute scheduling, metering accounting and settlement
i) Information dissemination requirements to be identified
j) Capacity building measures required for all stakeholders
k) Any other suggestions related to above

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

5.0 The introduction of ABT was recommended by Government of India (GoI) appointed ECC (Energy Conservation and Commercialisation) Inc. Consultant in its comprehensive report on Bulk Power Generation and Transmission Tariff in February - 1994. It was also supported by NTF (National Task Force) & RTF (Regional Task Force) recommendations from 1995-98. In line with these recommendations, CERC introduced multi-part tariff through implementation of ABT Mechanism w.e.f 04th January, 2000 at inter-State level.

6.0 The ABT Mechanism comprising of 15-minute scheduling, despatch, metering, accounting and settlement along with deviation accounts at the ISTS level was implemented in different regions in a phased manner from 2002-2003. Under the ABT mechanism, a coordinated multi-lateral scheduling model has been adopted. Electricity Act, 2003 mandated open access in inter-state transmission which was introduced in May, 2004 and a beginning was made with Bilateral transactions with 15-minute trading in power and settlement. Subsequently, in 2008, Collective transactions through the Power Exchanges were also introduced with hourly bidding, clearing and settlement of trades (energy only). Subsequently w.e.f. 1st April 2012, the Power Exchanges also moved to a 15-minute price discovery in the Day Ahead Market (DAM). This shift aligned the Power Exchange markets with scheduling, despatch & settlement practice in India.

7.0 In recent developments, Ancillary Services were launched in April, 2016 to address the need for 'fast' / 'quick' response from generators (16 – 30 minutes). The amendments in Indian Electricity Grid Code(IEGC) in April, 2017 mandated primary response (within seconds). CERC has also laid down roadmap for Automatic Generation Control (AGC) (seconds to few minutes) for enabling Secondary Reserves on a regional basis in October, 2015. An AGC pilot project is being implemented in northern region (NTPC Dadri - II TPS) and is expected to be operational in the next 3 months.

8.0 Imperatives for moving to 'Fast Markets'

a. Learning from implementation of Ancillary Services in India

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

b. Re-scheduling of resources

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

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

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

c. Increasing RE penetration

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

d. Lowering of Overall System Operating Costs

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

e. Ramping requirements

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

f. Recognizing flexibility as a requirement

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

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

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

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

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

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

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

"Scheduling and Dispatch: Through both practice and theory, it has become evident that grids that are operated in a manner where scheduling and dispatch are implemented over short time durations (e.g., as low as five minutes) have significantly lower overall costs to consumers as the need for ancillary resources decreases.

Currently, in India, scheduling occurs on a day-ahead basis while dispatch occurs on a 15-minute basis. System operations technologies and protocols need to be updated to enable five-minute scheduling and dispatch of all resources connected to the grid and automated incorporation of RE forecasts. It should be noted that accuracy of RE forecasts is significantly higher the closer they get to dispatch. Consequently, the ancillary service requirements will also be lower"

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

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

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

"5.6……The States who are about to implement the intrastate accounting and settlement system could leapfrog and go for scheduling and settlement at 5-min interval. The scheduling software and the energy meters specifications could in line with the above. All

the other States and the Regional Pools shall also endeavor to have systems and logistics for 5-min scheduling and settlement system…"

"Apendix -6: …….One static type composite meter shall be installed for each EHV circuit, as a self-contained device for measurement of active energy (MWh) transmittals in each successive 5 minute block and certain other functions, as described in the following paragraphs……"

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

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

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

11.0 Issues to be discussed and actions needed for implementation of Fast Markets in India are as follows:

a. Forecasting (Both Load and Renewables)
b. Scheduling & Despatch
c. Markets
    i. 5-minute OTC (bilateral) markets;
    ii. Power Exchanges – 5 minute price discovery

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

12.0 References

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b. The Future of Wholesale Electricity Market Design, Brattle Group, http://www.brattle.com/system/publications/pdfs/000/005/359/original/The_Future_of_Wholesale_Electricity_Market_Design.pdf?1475081019
c. Melbourne Energy Institute Submission to the AEMC Five Minute Settlement consultation paper, June 2016 http://www.aemc.gov.au/getattachment/1d460acc-dbe2-45ea-bb4e-1903161d90f1/Melbourne-Energy-Institute.aspx
d. IEA Report on Re-powering Markets: Market design and regulation during the transition to low-carbon power systems https://www.iea.org/publications/freepublications/publication/REPOWERINGMARKETS.PDF
e. Grid Flexibility: Methods for Modernizing the Power Grid, Sonia Aggarwal and Robbie Orvis, March 2016 http://energyinnovation.org/wp-content/uploads/2016/05/Grid-Flexibility-report.pdf
f. Big, Fast, and Flexible: Grid Operations for Efficient Variable Renewable Integration, Michael Milligan, NREL https://cleanenergysolutions.org/sites/default/files/documents/big-fast-flexible-webinar-final-10oct2016.pdf
g. CE Delft and Microeconomix (2016): Refining Short-Term Electricity Markets to Enhance Flexibility. Study on behalf of Agora Energiewende. https://www.agora-energiewende.de/fileadmin/Projekte/2015/Penta_EOM/Agora_Penta_Refined_ST_Markets_and_Flexibility.pdf
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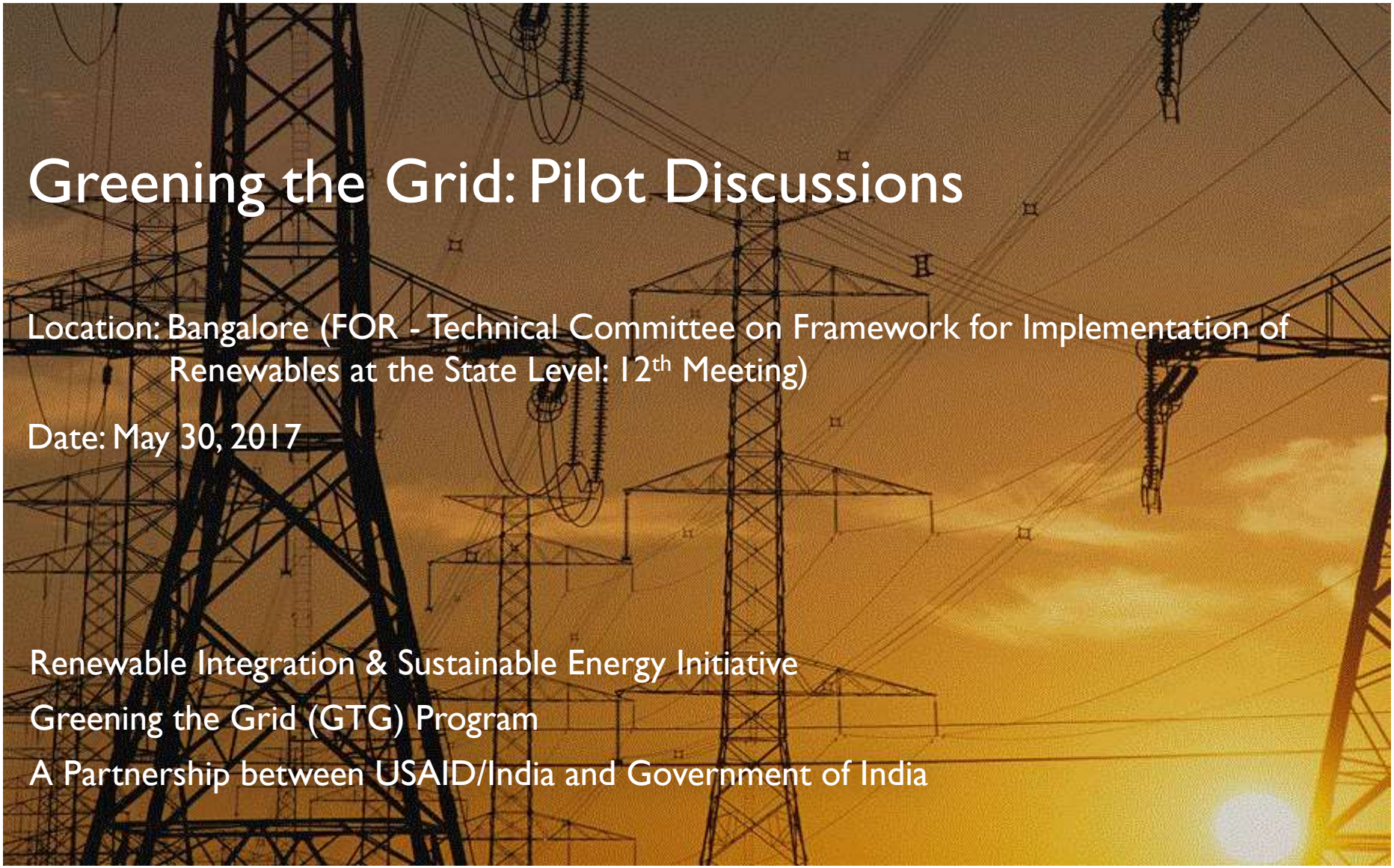


Greening the Grid: Pilot Discussions

Location: Bangalore (FOR - Technical Committee on Framework for Implementation of Renewables at the State Level: 12th Meeting)

Date: May 30, 2017

Renewable Integration & Sustainable Energy Initiative

Greening the Grid (GTG) Program

A Partnership between USAID/India and Government of India

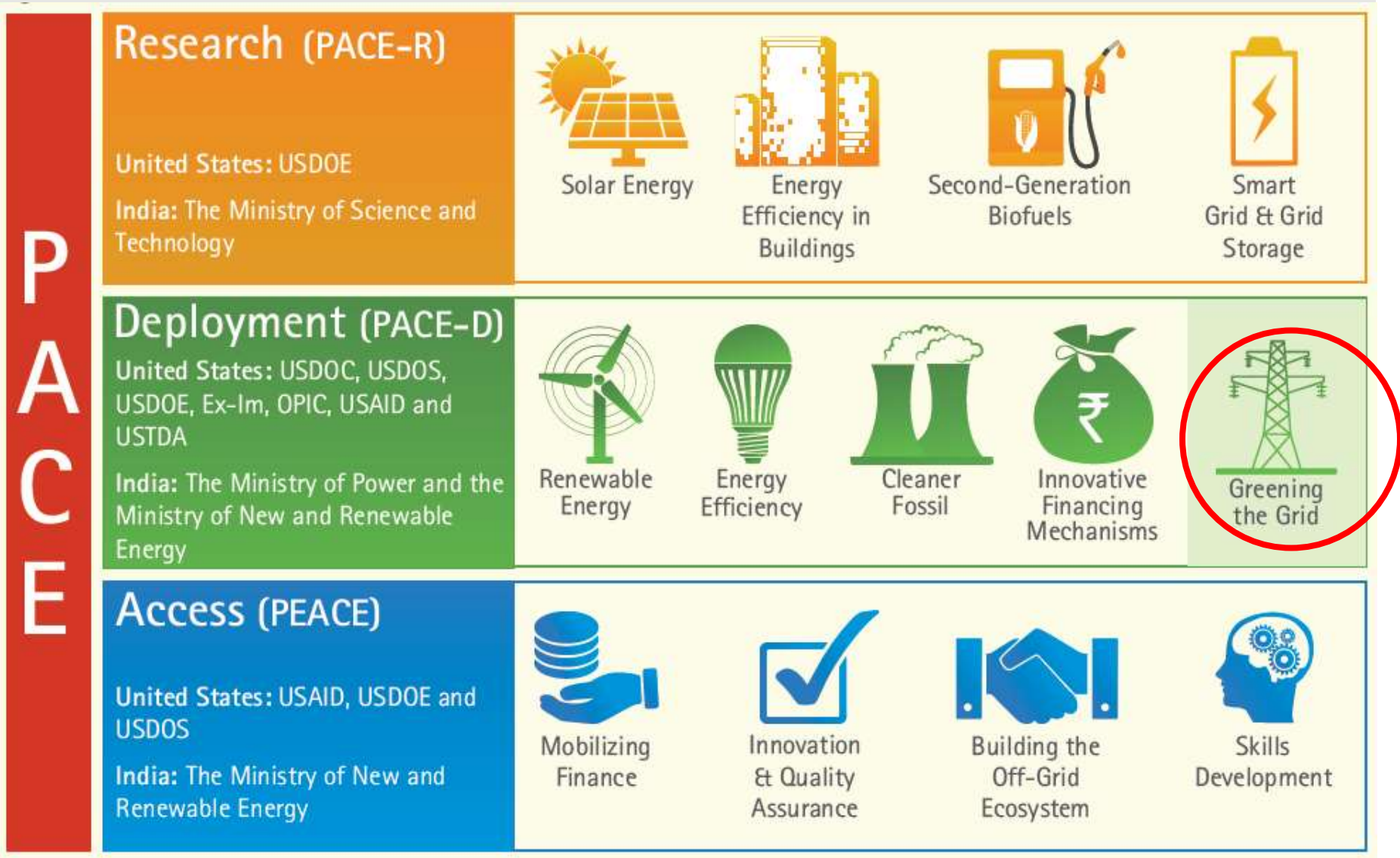
Contents

1. Introduction to Greening the Grid (GTG)

2. Pilot Discussion

   - Grid Connected Storage Systems
   - Dynamic Compensation for Large RE Integration
   - Coal Based Flexible Generation - GSECL (Partnering NTPC?)
   - Automatic Generation Control for Secondary Response (South – Karnataka; hydel, wind and solar)
   - Real-time monitoring of DERs and enhancing net load forecasting ability of Discoms (BESCOM / TPDDL)
   - Regional platform for day-ahead and intra-day coordination in dispatch (Western or Southern)

Greening the Grid - A New Component



Greening the Grid - U.S.-India Joint Partnership

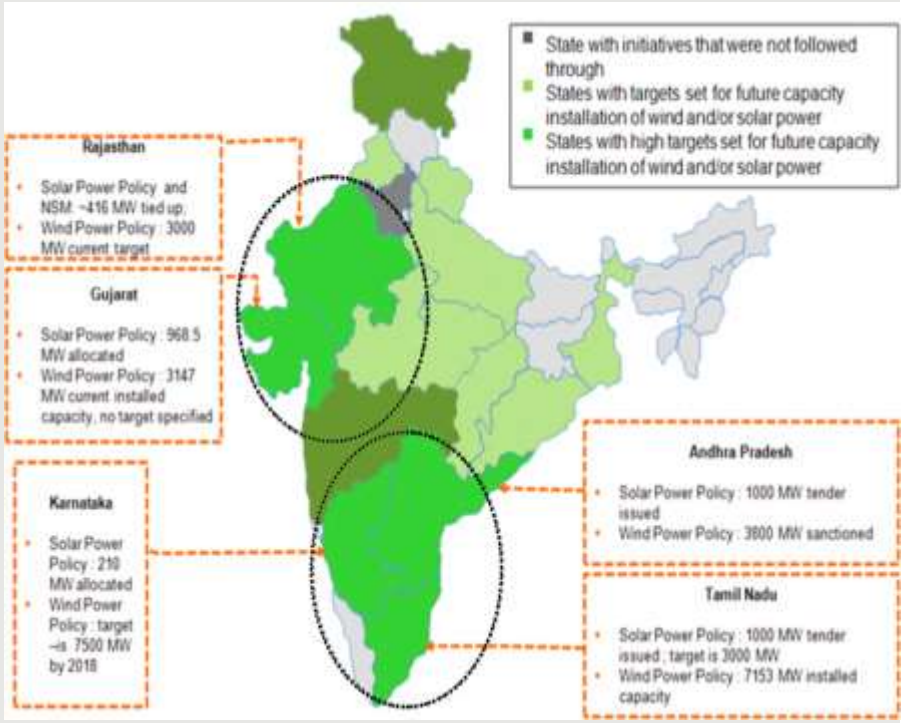
Expand the successful PACE-D Partnership...

"Greening the Grid"

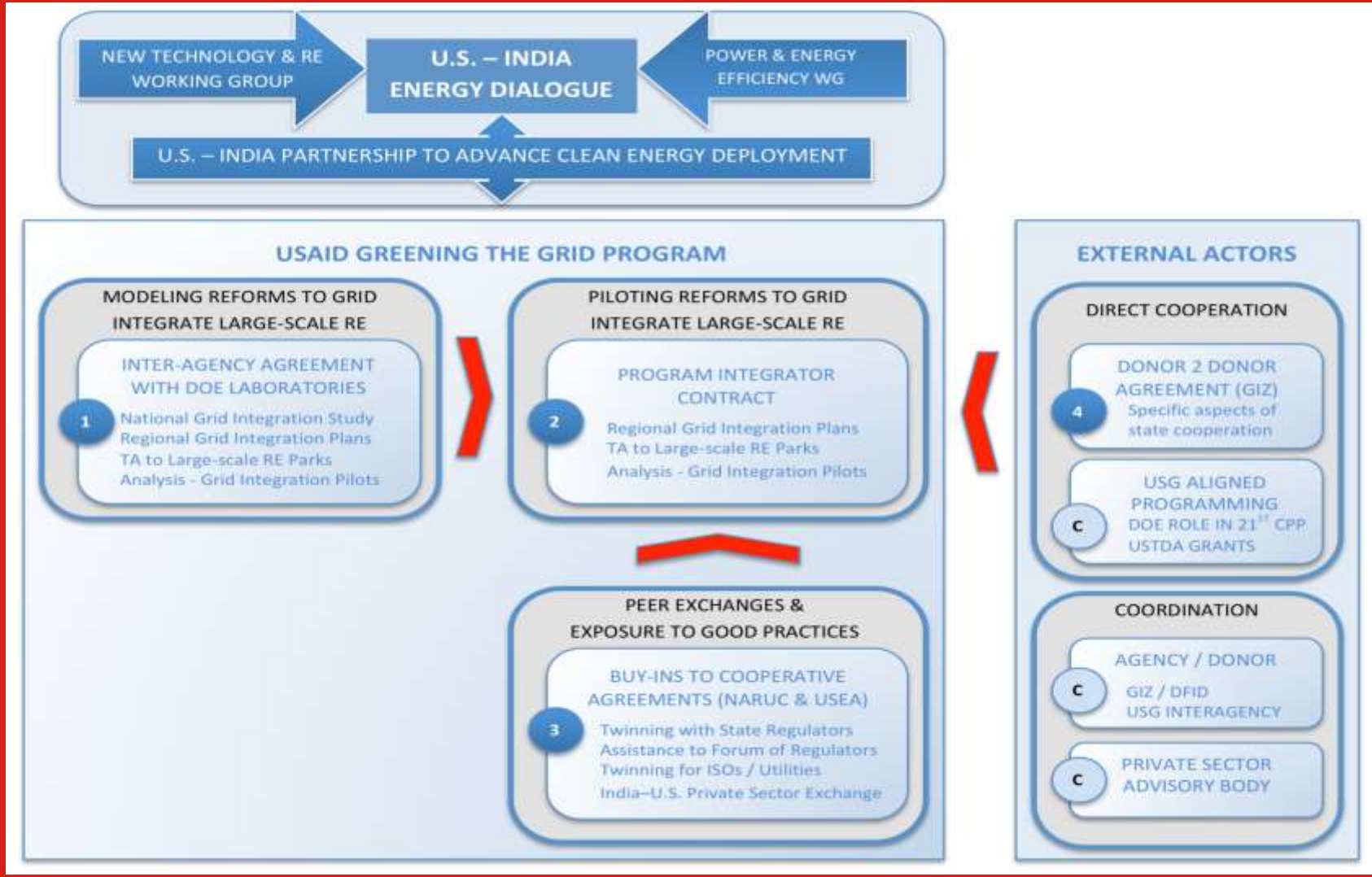
Partnering to scale up renewable energy integration into India's power grid

Goal: Enhance efforts to manage large-scale RE grid integration

- Robust analysis of challenges and solutions
- Integration pilots to validate scalable reforms
- Sharing of knowledge and best practices



Greening the Grid - Project Components



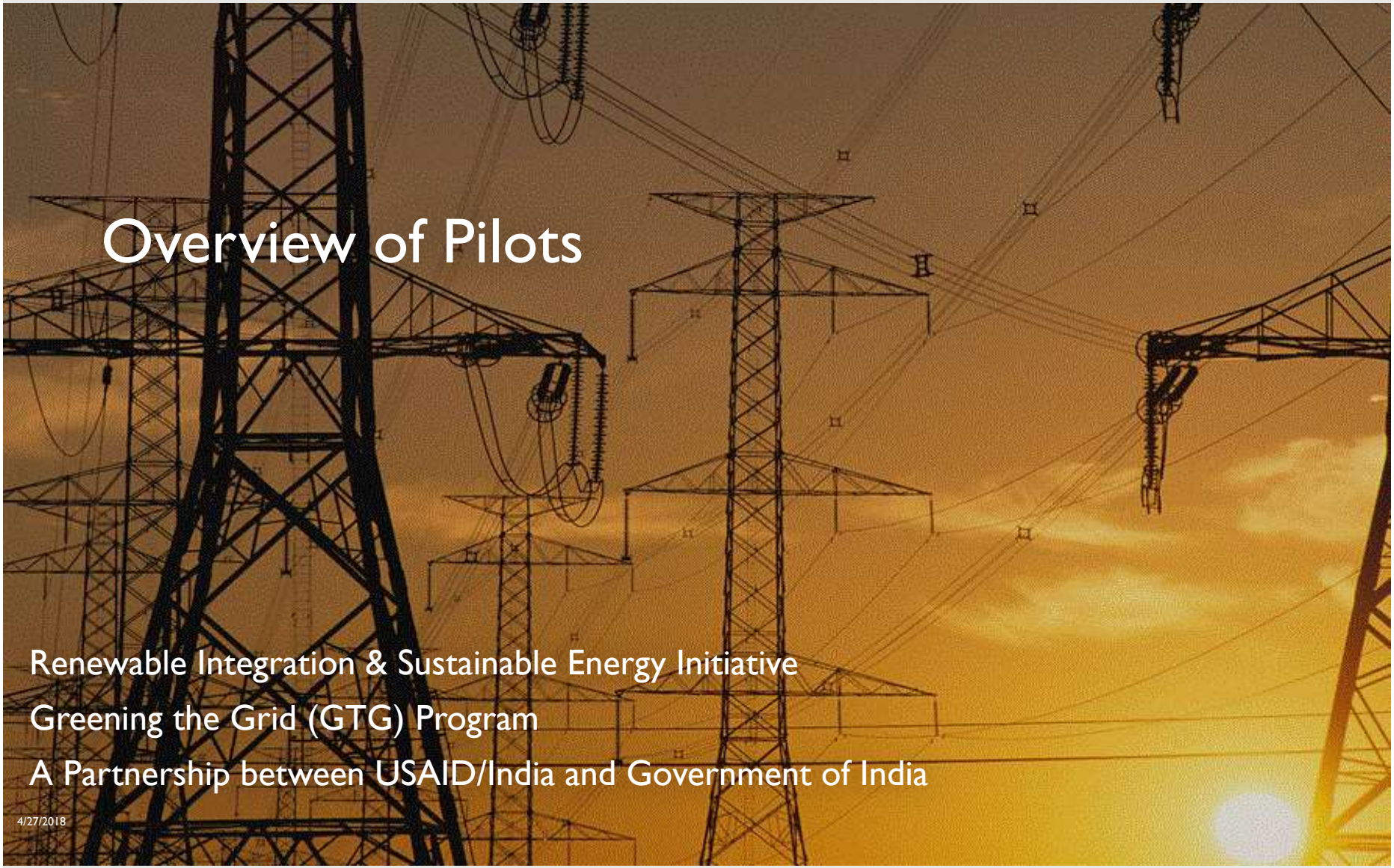
Greening the Grid - Progress to date

- National Grid Integration study to be released in June
- Regional Grid Integration study close to completion
- Analysis for Solar park and Automated Demand Side Management pilot

- MOU between FOR and NARUC approved by Cabinet
- Regulatory primer prepared
- A Regulatory Exchange and 2 boot camps (RE forecasting and AS) organized
- Three peer exchanges organized (regulators and System Operators)

- RISE Awarded to Deloitte LLP
- Mandated to do 6 grid integration pilots and provide TA for scale up
- Identified potential list of pilots based on discussions with stakeholders

- D2D agreement for state level cooperation
- D2MDB – align grants & assistance with debt



Overview of Pilots

Renewable Integration & Sustainable Energy Initiative

Greening the Grid (GTG) Program

A Partnership between USAID/India and Government of India

4/27/2018

Grid Connected Storage System

Introduction

- Storage is expected to play a significant role in the successful integration of RE generation into the electric grid of the future.
- Amongst the challenges that storage can address include (a) accommodating RE generation's output variability at the local and aggregate levels, (b) temporal mismatch between generation and demand, (c) power quality issues caused by RE.
- A pilot for evaluating storage technologies and its commercial and business applications is being proposed under RISE
- As a first step in the pilot, a partnership is proposed with PGCIL to implement and test techno-economic use cases in PGCIL's BESS facility under development at Puducherry with the following design parameters.

Battery Type	BESS Design for
Advanced Lead Acid	500kW/30min (250kWh)
Lithium Ion	500kW/30min (250kWh)
Flow	250kW/4 hours (1 MWh)

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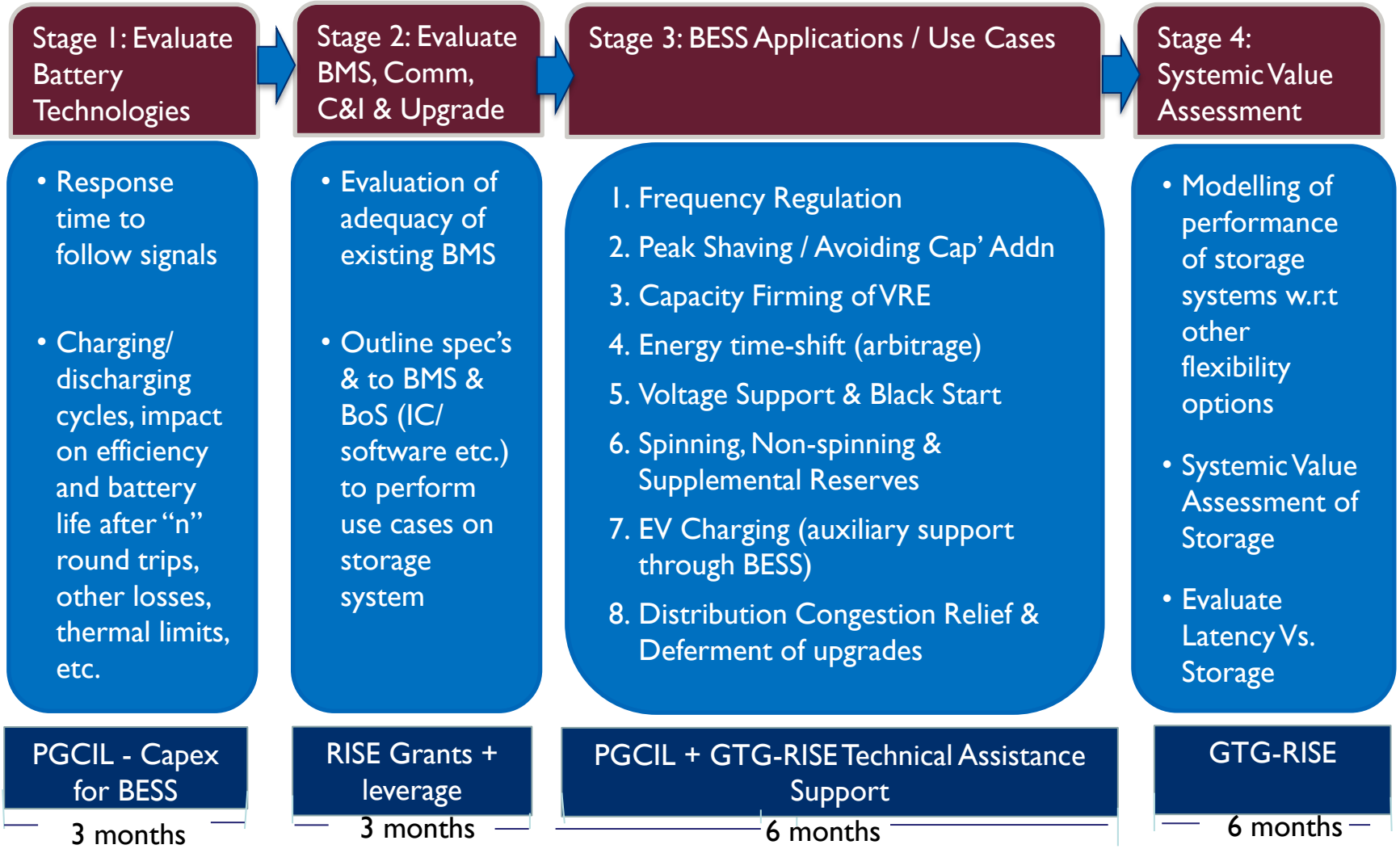
Grid Connected Storage System Evaluation



Dynamic Compensation for Large RE Integration

Introduction

- Rajasthan is developing the Bhadla Ultra Mega Solar Park in phases & corresponding lines & s/s are being planned/executed by both State Transco and CTU.

Bhadla Solar Park	Capacity (MW)	Status
Phase I	420 MW	Bid out
Phase II	680 MW	DPR submitted, Infrastructure development activities under progress.
Phase III	1000 MW	

- Significant progress has been made in the country on resource adequacy, production cost modelling and load flow studies at the State and National level. However, stability studies focused on all the various stability aspects are required for ensuring a secure and reliable system operation.
- The proposed pilot envisages load flow study (detailed State level network modelling with reginal interconnections), stability study and other technical studies to evaluate impact of grid integration of large solar park.
- Strategies for dynamic compensation shall be evaluated in Bhadla as part of this Pilot, including changes to inverter specifications and deployment of STATCOMS.

Coal Based Flexible Generation for GSECL

Global Experience in Coal Based Flexible Generation

- CEA prescribes a 3%/min ramp rate but actual achieved by stations in India is much lower. OEMs have suggested much higher values of ramping:
  - For e.g. Mitsubishi Hitachi Power Systems gives a rate of 7%/min from 40% to 100% output for steam generators of new hard coal or lignite fired plants.
  - Babcock Power has also reported 7%/min for a USC in load range of 50%-90% in 550 MW units in Germany
- Experience shows that flexibility can be increased by a combination of:
  - making changes to the firing system (changes in mill operations, indirect firing systems, flame monitoring etc.)
  - making changes to pressure parts (designing thinner metal, modifications in evaporator and economizer design)
  - changes to the plant configuration related to the boiler area (using more than one boiler for a STG), and
  - improving control systems and instrumentation.

Automatic Generation Control

Automatic Generation Control

- POSOCO is conducting a pilot study on secondary response through automatic generation control in northern India.

- A pilot on evaluating AGC in providing secondary response in southern India would supplement adoption of AGC for ancillary market. The scope of the pilot includes the following

  - Participation of select Generation units (hydro, wind, solar) in an AGC pilot
  - Draw inferences from international experiences on pricing and compensation for generators in operating on an AGC mode
  - Work with OEMs and Generators to devise a suitable compensation mechanism for AGC
  - Assist CERC in specifying regulations for phased implementation of AGC with accompanying compensation mechanisms

Real-time monitoring of DERs and enhancing net load forecasting ability of Discoms

Real-time monitoring of grid-connected DERs & enhancing net-load forecasting ability of Discoms

- **Pilot Activity:** Enablement of real-time monitoring of DERs on a pilot basis and improving net load forecasting ability of Discoms
  - Undertake a real-time monitoring pilot through deployment of smart meters
  - Work out the synergies of UDAY's smart meters mandate with net-metering systems – can provide a pathway for enablement of real-time monitoring of DERs
  - Assist a state-owned Discom with procurement and implementation of net-load (i.e. net of DER generation) forecasting systems in coordination with REMC/SLDC
  - Provide inputs to CEA / FOR towards harmonizing net-metering for DERs/prosumers with smart meters for consumers

Regional platform for day-ahead and intra-day coordination in dispatch (Western or Southern)

Regional platform for day-ahead and intra-day coordination in dispatch (2 or more States)

Pilot Activity: Design a mechanism & implement a platform for coordination on day ahead basis with joint dispatch (or similar least cost dispatch mechanism) in intra day timescales. Currently the imbalance on intra-day basis is being largely managed within state control areas resulting in reduced flexibility to accommodate VRE.

Progress so far under USAID – Greening the Grid:

- NREL's Grid Integration studies established the overall benefits of regional / larger balancing areas in reducing curtailments of VRE
- NARUC's primer on regulatory mechanisms for forecasting, scheduling and balancing outlined the Western US experience of coordination between a large number of disparate control areas
  - Useful parallels for India in operationalizing Joint Dispatch or EIM

Regional platform for day-ahead and intra-day coordination in dispatch (2 or more States)

Key Activities:

Activities	Timeline
Simulations (in PLEXOS?) for establishing business case for 2 or more volunteering States	To + 2 months
Outline coordination mechanisms / options and changes to regulations necessary to implement the same (e.g., transmission pricing for short-term trades, DSM considerations, etc.)	To + 4 months
Develop or utilize an existing platform (PX or RLDC FTP) for joint dispatch	To + 6 months
Regulatory approvals (SERCs/CERC) (will need permissions / accounting changes under DSM & REA)	To + 6 months
Support in shadow mode operation and Go-Live	To + 6 to To + 9 months

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DISCUSSIONS

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