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ELECTRICITY MARKETS & REGULATION
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Experience of Pilot Project on Five-Minute Metering and Settlement in Indian Electricity Market

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Motivation

- A pilot project on five-minute metering, scheduling, accounting and settlement of selected hydro/thermal generators in the Indian interconnected power system are presented in this paper.
- The aim is to dispatching the power closer to real-time in pan-India to integrate 500 GW of renewable capacity by 2030.
- This pilot facilitated to gain the experience in ancillary services and also provided insights for implementation of other emerging resources like battery energy storage system, electric vehicles and demand response as ancillary services.

Method/Approach

- With the implementation of Reserve Regulation Ancillary Services as tertiary frequency control tool of thermal generators and pilot project for Fast Response Ancillary Services of hydro generators, it was envisaged that 'fast' and 'flexibility' features is not possible in fifteen-minute meters.
- Interface Energy Meters(IEM) having features of recording data at five-minute block basis at 0.01 Hz resolution of frequency were used for pilot project.
- Eight generators on Pan-India basis has selected for Pilot project.



Regulatory Framework

- The central regulator advised to purchase newly featured IEM .
- Technical Specification for IEMs, Automated Meter Reading System and Meter Data Processing for Inter State System was approved for Western part of India and same is used for pilot project.
- The new IEMs can record both active, reactive energy, voltage at five-minute block having auto time synchronization feature.

Technological advancements

- The additional features in new five-minute IEMs are as below:

Title	Feature
Device Language Message Specification (DLMS) compliant	The new five-minute meters are new generation IEMs which are also Device Language Message Specification (DLMS) compliant and hence, have additional registries to handle more instantaneous parameters & individual harmonic parameters.
Measurement of Frequency	In the existing fifteen-minute meters, frequency code is reflected and the same is converted to frequency (in Hz) through a formula. The new five-minute meters directly provide the frequency data in Hz eliminating the need for conversion.
Measurement of Reactive Energy	The new five-minute meter records average voltage and reactive energy exchanged for each five-minute time block. The existing fifteen-minute meters are capable to report only cumulative reactive energy exchanged in a day when average voltage was more than 103% or less than 97%.
Storage of Data	The new five-minute meters are capable of storing and exporting data upto 15 days vis-a-vis 10 days capability of fifteen-minute IEMs.
Field Configurability	The new generation five-minute meters have field configurability feature. A number of parameters can be configured in the five-minute IEMs through authenticated password protected mechanism.
Time synchronization	In the new five-minute meters, there is feature to synchronize the time with GPS signal and from PC using software.
Portability	Multiple communication ports such as optical port, RS-485 and Ethernet have been provided for fast and redundant data transfer capability in the new five-minute meters.

Case study of scheduling and settlement of Hydro Power Plant

- The actual response of the hydro station vis-à-vis the schedule is compared with five & fifteen minutes data

Date	15 minutes System			5 minutes System		
	Total Schedule In GWh	Total Actual In GWh	Deviation In GWh	Total Schedule In GWh	Total Actual In GWh	Deviation In GWh
30-11-2020	6.60	6.64	0.04	6.60	6.64	0.04
01-12-2020	6.60	6.62	0.02	6.60	6.61	0.01
02-12-2020	7.75	7.82	0.07	7.75	7.82	0.06
03-12-2020	8.65	8.75	0.10	8.65	8.75	0.10
04-12-2020	8.65	8.74	0.09	8.65	8.73	0.08
05-12-2020	8.65	8.72	0.07	8.65	8.72	0.07
06-12-2020	9.95	9.93	-0.02	9.95	9.92	-0.03
Total			0.366			0.315

Thermal Power Plant

- While comparing the schedule and actual of thermal generators, tendency towards under-delivery was observed during the ramp up of generating station.
- This under-delivery may lead to low frequency grid operation or need for additional despatch of ancillary services
- The change from following fifteen-minute to five-minute steps may help the power-plant to follow the schedule keeping grid security intact.

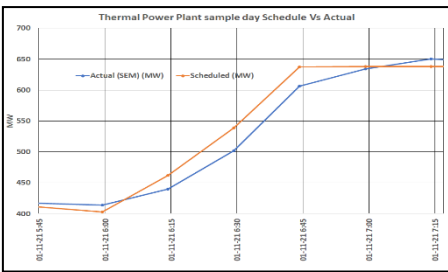
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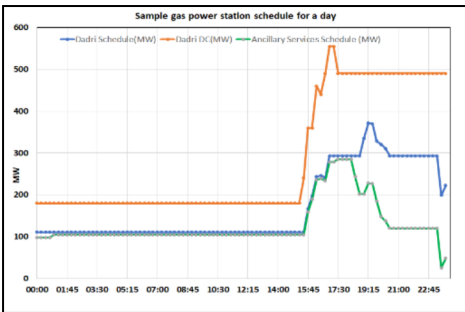
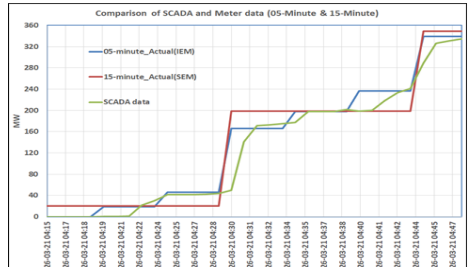


Discretization of Ramp and Schedule

- For hydro station, the block-wise actual net energy of five-minutes and fifteen-minutes was compared and was almost matching. It was observed that shifting to smaller granularity may help in better ramp management and utilization of hydro station.
- Hydro power station also have obligations other than power generation. The shifting to smaller five minute schedule time block would help the system operator to utilize the hydro ramping capability while fulfilling other constraints. Further they can also participate in ancillary services market with additional revenue stream.

Gas Power Plant

- The gas power station are normally peakers. They are flexible to operate under different fuel category of gas with same capacity.
- With the scheduling and accounting in five-minute time block basis, the peaking capability of the gas power plant can be utilized more efficiently and the total cost of despatch may be reduced.

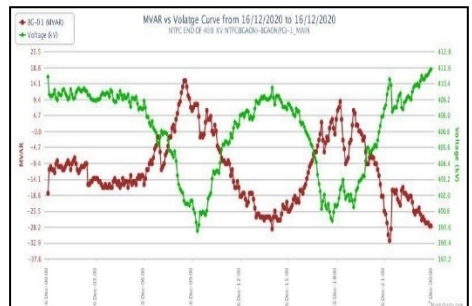
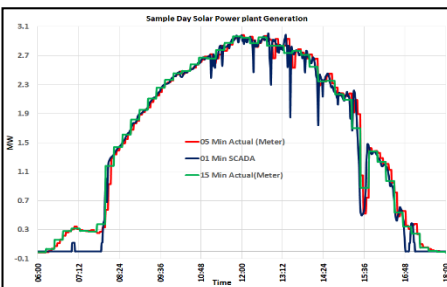


Voltage Measurement

- The five-minute meters has the feature to record reactive energy exchanged and the voltage in five-minute time block
- It would be a key step for measurement of the support provided during the requirement of reactive power supply/absorption by any generator.
- It would facilitate the introduction of Voltage Control Ancillary Services and new tool with system operator which can be triggered at the time of requirement.

Solar Power Plant

- The deviations charges are delinked with the frequency and linked to their Power Purchase Agreement (PPA).
- The solar power stations generation depends on the solar irradiation/ weather conditions. Smaller schedule time block would help them to follow the schedule and reduce the deviations.



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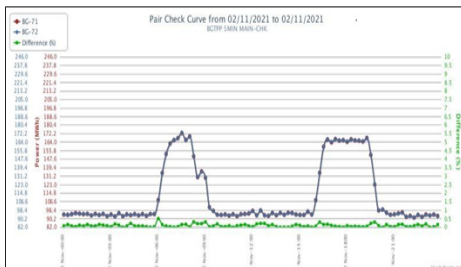
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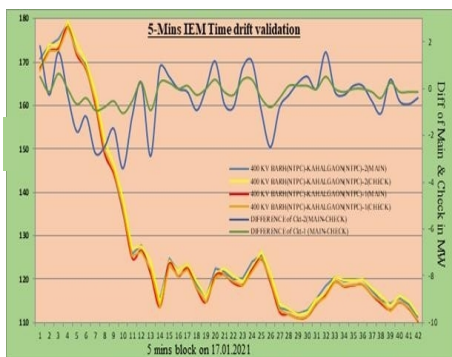
Meter data validation

- Pair check method is used to validate the meter data
- There is also provision of graphical pair check curve in Meter Data Processing (MDP) software for ease of end user



Need for Amendments in Transition

- To replace all the meters of 8500nos in Pan-India simultaneously is a great challenge. In order to facilitate smooth transition, it is needed that the new five-minute meter should have the capability to record/produce the data in fifteen-minute time block also so that parallel five-minute and fifteen-minute accounting continues till all the meters are replaced.
- In order to have the similar approach and to avoid any accounting related issued due to different format of converted file, the output file format has to be standardized before installation of the new meters.
- The time synchronization through Global Positioning System (GPS) facility is not available in the present fifteen-minute meters. the time drift correction can be done only for 1 minute in a week.



- It was learnt that significant time was required to collect the data manually from new meter compared to existing fifteen-minute meter. During pan-India roll out of new five-minute meters, it would not be possible to handle the data downloading manually and hence, AMR scheme would be a prerequisite.
- The control panels have limited space to install the meters. The new meter would have to be installed in place of the existing meter in same space. Therefore, the physical dimensions of the new five-minute meter need to be similar
- New meter would also report additional parameters such as reactive energy and voltage. In order to process the meter data, there is a need to upgrade the software at RLCs or develop new software solution to handle the increased volume of data with speed and robust features.
- The software upgradation at RPCs are also required to be handled for implementation of five-minute accounting & settlement pan-India
- Unique serial number may help in identification of the exact location, type and make of the meter. It would further help in fast replacement of faulty meter.

Conclusion and way forward

- Various existing Regulation of CERC and CEA needs to be amended
- It would take time to replace all the existing meters with associated scheduling to settlement systems. This transition would be a phased approach. It would be required to have both fifteen-minute and five-minute scheduling and settlement process in parallel until all the meters are replaced on pan-India basis.
- There is need to identify multiple vendors on competitive basis with requisite capability to manufacture and install the new five-minute meters in time bound manner.
- The priority list has to be prepared regarding the location and interface points
- In the frequency linked Deviation Settlement Mechanism (DSM) system presently in vogue in India, there is a need to have harmonization regarding DSM rates at the inter-state level.
- The capacity building and knowledge dissemination activities have to be undertaken for spreading awareness.
- There is need for suitable regulatory framework to facilitate the recovery of transition to five-minute metering costs taking into account the maintenance, periodic check, calibration and replacement