



भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
नवीकरणीय ऊर्जा उद्भव विकास प्रभाग
Renewable Energy Source Development Division
*** ** ***

No. CEA/Plg/RES-30/2017

Dated: 14-07-2017

विषय: नवीकरणीय ऊर्जा स्रोतों के ग्रिड में एकीकरण को सुविधाजनक बनाने के लिए विभिन्न प्रकार के ऊर्जा स
Subject : **Minutes of the Fourth Meeting of the Technical Committee constituted by CEA for study of optimal location of the various types of balancing energy sources / energy storage devices to facilitate grid integration of Renewable Energy Sources and associated issues – reg.**

महोदय/Sir,

Minutes of the Fourth Meeting of the Technical Committee on the subject held on **13th June, 2017 at NRPC, New Delhi**, under the Chairmanship of **Member (Planning), CEA**, are enclosed herewith for your kind information and further necessary action.

Copies of the presentations made during the meeting are being sent on emails only.

एन आर पी सी, नई दिल्ली में 13 जून, 2017 को सदस्य (योजना), के. वि. प्रा. की अध्यक्षता में आयोजित उपरोक्त विषय पर तकनीकी समिति की चतुर्थ बैठक के मिनट्स (कार्यवृत्त) आपकी जानकारी और आवश्यक कार्रवाई हेतु संलग्न हैं।

बैठक के दौरान की गई प्रस्तुतियों की प्रतियां केवल ईमेल पर भेजी जा रही हैं .

कृपया पत्र की पावती दें/ Kindly acknowledge the receipt of the letter.

भवदीय/Yours faithfully

अशोक कुमार राजपूत/(Ashok Kumar Rajput)

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Convener and Member Secretary

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Copy for kind information to:

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- 5) SA to Chairperson, CEA,
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Minutes of the Fourth Meeting of the Technical Committee held on 13th June, 2017 under the chairmanship of Member (Planning), CEA for

study of optimal location of the various types of balancing energy sources / energy storage devices to facilitate grid integration of Renewable Energy Sources (RES) and associated issues

The **fourth meeting** of the Technical Committee constituted by CEA for study of optimal location of the various types of balancing energy sources / energy storage devices to facilitate grid integration of Renewable Energy Sources (RES) and associated issues was held under the Chairmanship of **Shri Pankaj Batra, Member (Planning), CEA**, on **13th June, 2017 (Tuesday)** at **NRPC, New Delhi**. The meeting was organized for deliberating specifically the issues concerning the **States of Northern Region**. List of participants is at **Annexure-1**.

Shri A K Rajput, Convener and Member Secretary of the Committee and Chief Engineer (RES), CEA welcomed **Member (Planning), CEA** and all the participants. He made a special mention about inviting **BBMB, SJVN and THDC India LTD (THDC)** for the meeting. He stated that these PSUs having Hydro Power Plants located in Northern Region (NR) have been invited to share their experiences that how these hydro resources, including the Pumped Storage Plant (PSP) could be optimally utilized for balancing power requirement in view of the increasing penetration of Renewable Energy Generation Sources (RES). Brief agenda for deliberations in the meeting was presented.

Member (Planning), CEA and Chairman of the Committee was requested to address and guide the participants.

Shri Pankaj Batra, Member (Planning), CEA stated that along with various issues of RE integration in the grid, the Committee is also deliberating on the issue of optimal use/location of the various types of balancing energy sources / energy storage devices so that variability of RE generation could be tackled in a smooth fashion. There could be various types of balancing sources including the Battery Energy Storage system (**BESS**). BESS of adequate capacity could be installed near the RES pooling station to relieve the transmission system. Depending upon the feasibility, balancing power could be sourced from storage / pondage type of hydro power plants, gas based power plants and also from thermal power plants (TPPs) depending upon response time.

Pumped storage power plants (PSPs) offer the unique advantage of acting as a load in the pump mode by raising the water to upper reservoir during times of surplus power and running in generating mode during times of deficit power situation in the grid, similar to BESS.

The Chair stated that a Policy Note on Gas has also been sent to MoP for use of the stranded gas based power plant capacity for “**balancing power**” needs. One start-stop cycle of the gas based plants affects its life by about 10 Equivalent Operating Hours (EOH), so instead of running all gas plants during peak time and shutting them down all during “off peak” hours, some plants could be used for balancing during the day i.e. in “load following mode,” providing various outputs.

The Chair stated that the ramp rate for gas based plants could be about 10% per minute as compared to 1-1.5% per minute of rated capacity of thermal power generating units. This flexibility could be utilized for ramping requirements. If required, existing thermal power units can also be made to operate in flexible manner through appropriate retrofitting. The Committee

has to assess whether balancing requirements could be met within the State Level, or Regional Level or by utilizing the balancing resources of the entire country or also of neighboring Countries like Bhutan and Nepal, which have substantial hydro resources/reserves. There is a need to socialize the cost of balancing, otherwise RE rich States may be discouraged to put more RE capacity in the system, which is essential from clean energy point of view. Under the “Green Corridor Development (**GCD**)” plans transmission system strengthening has been planned and in some states, the work has started. **The Chair** stated that before actual implementation of the transmission system strengthening, a cost benefit analysis of strengthening of transmission system versus establishment of local storage device near RE generators pooling station should be carried out, to optimize the transmission system needs.

Member Secretary, NRPC shared his experience of Sardar Sarovar Hydro Project (SSHP). He mentioned that about 75% of energy used for pumping is recovered when required during generation. Formation of Joint Venture (JV) by different entities is also a good option for establishment of PSP, and balancing power requirement could be shared by the entities. He also stated that accuracy of forecasting and existence of scheduling for renewables is important in managing the variability of RES.

SE (REMC, Rajasthan) stated that for promoting RE generation and to attract investment in this field, the Rajasthan Govt. has announced Wind and Solar policies. He made a presentation, highlighting the composition of generating sources, poor availability of gas for gas based plants, generation availability from RE sources and operational aspects of RES in the state. He stated that Rajasthan is working out arrangements for improved availability of data from RES on a regular basis at the pooling station and transmission of their data to SLDC. Rajasthan has huge potential of Renewable Energy Sources in its western part, but the load center is in the eastern part. Rajasthan Renewable Energy Corporation Limited (RRECL) has set the targets for solar and wind projects in Rajasthan of about 27231 MW upto 2021-22. RVPN will develop transmission system for evacuation of 13000 MW RE power. PGCIL will develop Inter-state Transmission System (ISTS) for evacuation of balance 14000 MW RE power which would be exported. Work of establishment of Renewable Energy Management Centre (REMC), at the State Load Despatch Centre (SLDC) has been initiated. During periods of high wind power injections, the loading on some of the lines are observed on the higher side. Challenges faced by them during system operation are:

- a) RE is variable, uncertain and geographically concentrated in western part of the state, load centres are in the eastern parts.
- b) Availability of data from RES in real time mode is of vital importance for smooth operation of the grid.
- c) Forecasting and Scheduling regulations are not in place in the state.
- d) Balancing mechanism needs improvement.
- e) Sudden change in wind energy injection leads to under drawl (UD)/over drawl (OD) situation.

- f) Frequent ramping up/down of thermal units is resorted to, causing excess wear and tear.

In Rajasthan total installed capacity as on 30th April 2017 is 18710.69 MW of which 4121.20 MW is wind and 1229.70 MW is solar. Annual capacity utilization factor (CUF) of Wind power stations is 25%. He stated that in case of Rajasthan, for RE balancing, Hydro Power is not preferred as its generation is based on irrigation requirement. Gas also has issues if used as balancing source, because gas availability is a constraint. In Rajasthan Gas is arranged through monthly or yearly contracts .

Rajasthan stated that the Gestation period for Wind farms/Solar Parks is 3 to 4 months and Construction of the transmission system takes 2 to 4 years, till the planned transmission system is commissioned, evacuation constraint is envisaged. At the same time there are right of way (RoW) constraints also. Transmission network is sub-optimally utilized and also congestion is faced in transmission/distribution network. It was also stated that in order to control Over-drawl/Under-drawl, there is a need to enhance gas & hydro based generation.

Financial Aid should be facilitated by MOP for the balancing power needs. For compliance of deviation settlement Mechanism (DSM), he suggested for enhancement of OD/UD limit by CERC for the states rich in RE generation and the states having high demand, condition of change in direction (positive or negative) after 12 blocks be exempted or time period be increased..

For Balancing of Renewable Generation, the following options were presented by Rajasthan:

- a) During High Wind power Injection and low demand period- Consideration of Incentive to agriculture and bulk consumers to use energy.
- b) To utilize variable range of thermal generation units, without adverse effect.
- c) For RE approvals/ connectivity - Strict compliance of regulation and adequate evacuation system.
- d) Availability of RE generators telemetry data especially at voltage level 33 kV and below.
- e) Rajasthan Electricity Regulatory Commission (RERC) has notified draft Regulation on Forecasting, Scheduling and Deviation settlement of Wind and Solar Generators, which should be finalized soon.
- f) Promote wind-solar hybrids for better utilization of grid infrastructure, grid stability and lowering of intermittency.

The presentation made by Rajasthan is at **Annex-A**.

Representative from **PGCIL** mentioned that voltage profile of transmission system in Rajasthan is a major issue and also the old wind turbine installations are not Low Voltage Ride Through (LVRT) compatible.

The Chair stated that Rajasthan should suggest location of Energy Storage Systems where congestion is maximum, so that a pilot project can be taken up. It was also suggested that action need to be taken by Rajasthan for availability of data at RE generating pooling stations and transmission of the same to SLDC.

Referring to establishment of communication network for data availability **CE(PCD)**, **CEA** informed that Government of India is setting up **National Optical Fiber Network (NOFN)** to provide connectivity to 2.50 lakh Gram Panchayats (GPs) spread over 6600 Blocks in 641 Districts across the Country. Minimum 100 Mbps bandwidth at each Gram Panchayat is proposed. The NOFN Scheme is being implemented through **BBNL (Bharat Broadband Network Limited)**, which has been set up as a Special Purpose Vehicle (**SPV**) by Government of India. The programme has been divided in two phases, with a target to cover 1.0 lakh Gram Panchayats in First phase and 1.5 lakh Gram Panchayats in Second phase. So far, work in Phase-I is almost complete. Phase-II of 1.5 lakh Gram Panchayats are targeted for completion by December, 2018. The implementation of Phase-II of **BharatNet** (erstwhile NOFN) is being envisaged through participation of States Governments. States would prepare Detailed Project report (DPR) and accordingly fund would be released to the State Govts. It was also clarified

that while laying optical fiber from a Block to Gram Panchayat (GP), in case substation is located in between, then the optical fiber can be routed through the substation. If, while laying underground optical fiber cable, right of way (ROW) is an issue then electric poles can also be used for stringing aerial fiber. He stated that Andhra Pradesh was planning to lay 61,000 kms of optical fiber underground cable in association with NOFN (National Optical Fiber Network) using **USOF** (Universal Service Obligation Fund). The estimated cost is Rs 4700 Cr (Rs 3800 Cr from Central + Rs 900 Cr from State).

CE(PCD), **CEA** suggested that the State Govt while connecting Block with GPs may consider integrating Discoms electrical network. Even in case, the Discoms' 11 kV or 33 kV or 66 kV substations do not fall in the route, the connectivity to such substations could be made from nearest fiber **POP** (Point of Presence), by laying incremental fiber. In this way, though the State Discoms may incur some additional cost, but it would benefit them to have fiber connectivity at most of the locations, which in turn could be connected to the nearest 132 kV level. As MOP is envisaging complete optical fiber connectivity at 132 kV and above voltage level, dovetailing of Discoms' electrical network with BharatNet fiber network would help the State Power System to have fiber connectivity up to distribution level.

The Chair stated that considering the importance and need of reliable communication, particularly when large numbers of renewable energy sources are being integrated into the grid, a separate meeting only on data communication aspects will be held.

CE (IRP), **CEA** gave a presentation highlighting the different aspects of RES penetration in the Indian grid in 2021-22 scenario. He suggested that, in order to develop a better understanding of the impact of RES in the state grid, the RE rich States of India should develop the following:

- i) The **Hourly Load Curve** for the entire year
- ii) The **Hourly Generation Profile** of wind and solar in the state for all the 8760 hours(24X365) of the year.

- iii) The **Net Load Curve** and **Duck Curve** for each day of the year.
- iv) The **ratio of minimum load and maximum load** of the net load curve for each day of the year and thereafter, identifying the **critical period in the year** when the backing down requirement would be maximum.
- v) The **expected daily and yearly contribution of energy** by the different categories of RES.
- vi) **Hourly/sub-hourly Ramping Duration Curve** for the whole year.
- vii) A separate **Generation Duration Curve** for both solar and wind for the year.
- viii) **Distribution Curve for Daily Peak Generation** for Solar and Wind
- ix) The **Combined Solar and Wind Generation Distribution Curve** for the whole year.
- x) **Segregation of the entire year suitably into different seasons** and finding out the **critical days in each season** and during generation planning for the critical period.

He suggested that, by analyzing the above curves, the State will be having a better visibility regarding the roles and impact of RES at different times of the year. This would also help in doing advance planning by the states.

The Representative from **NRLDC** apprised the group about the weather forecasting system and portal developed with the help of India Meteorological Department (IMD). MOU to this effect was signed on 18th May, 2015 between India Meteorological Department (IMD) and Power System Operation Corporation (POSOCO) with the objective that "Weather information provided by IMD shall be used by the Power System Operators across India for better management of Indian Power System." Weather Portal for Power Sector has been developed using readily available products of IMD for all 5 regions of the Country. Meteogram is used for forecast of rainfall, humidity, temperature, cloud cover, wind, wind direction, thunderstorm etc. in graphical representation (10 days in advance). It is 3 hourly forecast for 10 days. Each Meteogram provides information for 10 km radius and is updated at 00:00 Hrs and 12:00 Hrs universal time coordinated (**UTC**). **To obtain local time (IST)** in India, we need to add 5 hours and 30 minutes to the Coordinated Universal Time. There is a need to customize the portal for indicating Indian Standard Time (**IST**).

RADAR: Radio Detection and Ranging system is also being used for prediction of weather conditions. The Doppler Weather Radar generates different displays and derived products of practical utility based on standard algorithms. These displays are updated @ every 10 minutes.

The Ultimate aim is to provide weather layer superimposed on regional/national GIS displays with power system network, for forecast as well as real time weather information

The presentation made by NRLDC is at **Annex-B**.

THDC made a presentation on "*Need of Hydro Power Revival and its Role as Balancing Energy Source*." They highlighted that in view of intermittency of RE, balancing power needs are inevitable. It was stated that the bulk grid

supports and is supported by conventional rotating generators (Coal, gas, hydro, nuclear) which provide "Essential Reliability Services" (ERSs). As the penetration level of asynchronous generation increases, this will either increase cost, limit operational flexibility, degrade reliability or most likely result in a combination of all three factors. Hydropower is mature and cost competitive renewable energy source. Development of Hydro projects is important to meet the objectives on sustainable development and for energy security.

THDC presented the Role of Tehri Power Complex in Northern Grid with following highlights:

- Tehri Power Complex consists Tehri HPP(4X250MW), Koteshwar HEP(4X100MW) and Tehri PSP(4X250MW). Tehri HPP & Koteshwar HEP Tehri are in operation and PSP scheduled for commissioning by FY 2019-20.
- The live storage capability of Tehri Hydropower Plant facilitates the Grid to optimize use of variable RES over both shorter and longer periods.
- Upcoming Tehri PSP having variable speed Asynchronous machines will enhance energy storage capacity of Northern grid.
- Given large inertia, Tehri Power Plant strengthens the transient stability of grid.
- Tehri Plants are operating with least forced outage, which shows high reliability. In last five years, they successfully limited the forced outages within 0.4% by adopting best O&M practices.

THDC also presented the salient features of two of its Wind power installations located in Gujarat.

To revive Hydro Power sector, the following suggestions were made by **THDC**:

- a. Need to achieve adequate Hydro-thermal mix
- b. Preferential Treatment should be ensured for development of Hydro Projects
- c. Declaring all Hydro Power as renewable energy shall definitely act as a catalyst in revamping Hydro Sector
- d. Providing Hydro power purchase obligation within currently mandated Non Solar RPOs to qualify for dispatch priority
- e. Providing interest subvention during construction and post COD to all Hydropower projects
- f. Excluding cost of enabling infrastructure from Project cost
- g. Create a hydro power development fund.
- h. Softening lending terms and conditions for Hydro projects by engaging bankers and financial institutions.

They informed that PSP is to be commissioned by 2020, which can be used for balancing of RES. He said that hydro can play a critical role in balancing as it can ramp up quickly and is also environmentally sustainable. He said that Tehri is a storage type hydro plant. In the rainy season, it overflows and

Koteshwar is a downstream dam used as pondage. He also informed that capital cost of Tehri PSP is as low as Rs.1.9 crore/MW. FRL- for dam is 830 m and MDDL is 740 m. This helps the plant to store energy during off-peak hour and generate when required. The machine can have finer control of frequency and high inertia helps to provide transient stability to the grid. The presentation made by THDC is at **Annex-C**.

The Chair informed that Hydro, as balancing source, will be used during summer and winter since in the monsoon season it may be overflowing. He requested THDC to do a study on the coordinated operation of reserves for the Tehri Complex.

Representative from **BBMB** informed that there are downstream constraints to supply water to Anandpur Sahib canal. They have 155 MW installed generating capacity on canal which is must run. The views of BBMB is at **Annex-D**.

The Chair made a remark that the CERC Regulations states that in the case of a pumped storage plant, energy had to be supplied by the beneficiary for pumping to the extent of its share, 75% of which could be retrieved by the beneficiary, during a period of its choice. However, it was not clear for how much time the pumped water could be stored. He also mentioned that the evaporation and transportation losses need to be considered. He suggested a **specific meeting to discuss the issues of operationalization of PSPs be scheduled separately**. He also suggested that in order to compensate for spinning reserve, in ancillary services Regulations, some incentives need to be given to the generators who are participating in balancing services.

Formation of a Committee under **Member Secretary NRPC, CEA** alongwith concerned hydro plants for **integrated operation of reservoir was suggested**. The Representative from **NTPC** made a presentation on study of thermal plant flexible operation. He mentioned that 25-30 parameters need to be considered and their weighted average can give an idea about the suitability of the plant to be used for balancing. He stated that old plants can be used for flexible operation after retrofitting. Boiler will need more changes as compared to turbine. Thicker water tubes mean more stresses therefore thinner tubes are required. The minimum load for which a subcritical plant can be used for flexible operation will depend on the quality of coal being used. For thermal power units, minimum cycling cost is incurred for "load following" and maximum cost for "cold start." This analysis is based on a study carried out in Germany on German machines. He also requested for details of simulator available with various stakeholders, so that specific changes can be made to incorporate balancing features for training of operators, under the capacity building programme.

NTPC stated that there is Cost of cycling to Generating Companies and proper mechanism to recover these costs is necessary to maintain the financial sustainability of the Generating Companies. The presentation made by NTPC is at **Annex-E**.

Making a presentation on the pilot project in Puducherry, **PGCIL** representative brought out a comparative study of **Li-Ion battery, Flow battery and Advanced Lead Acid battery** on various parameters. The presentation made by PGCIL is at **Annex-F**.

The Representative from CERC wanted the following to be addressed:

- A detailed calculation of balancing requirement for all over India and possible options to meet the same.
- Whether existing thermal plants will be able to flex and provide the flexibility or additional resources need to be installed.
- An assessment of existing and planned pumped hydro stations may be done. The costing for same may also be considered.
- A calculation on storage requirement may be carried out.
- International experience may be assessed
- Whether plants proposed to be retired can be used for balancing requirement

PSERC representative put forward his concern about higher cost of power for some states. He stated that states which are contributing more in Hydro power need to be compensated. The penalties faced by states for short lifting of coal also need to be considered.

Representative from **MP SLDC** suggested that new plants to be constructed in the same place replacing the old ones.

Summing up the discussions, **Member (Planning), CEA** stated that the concerns of all the states will be taken care of, but they should also try to look at the bigger picture since a comprehensive approach is required. In the long run, RES is the best solution for our energy mix. The best part is that the demand is growing in our country, so with economies of scale and increasing competition, between different energy sources, the cost of RES generation would drop, while that of coal and associated labour will continue to increase. He stated that **Demand response** is one of the best methods for balancing renewable generation. As an example he stated that Mumbai uses demand response in a pilot project. For automated demand response use of smart meters would be required.

The Meeting ended with the vote of thanks to the chair.

Annex-I

List of Participants- Fourth Meeting of the Technical Committee held on **13th June, 2017** under the chairmanship of Member (Planning), CEA for study of optimal location of the various types of balancing energy sources / energy storage devices to facilitate grid integration of Renewable Energy Sources and associated issues

4th Meeting of the Technical Committed on Optimal Location of Balancing Sources Participant List						
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