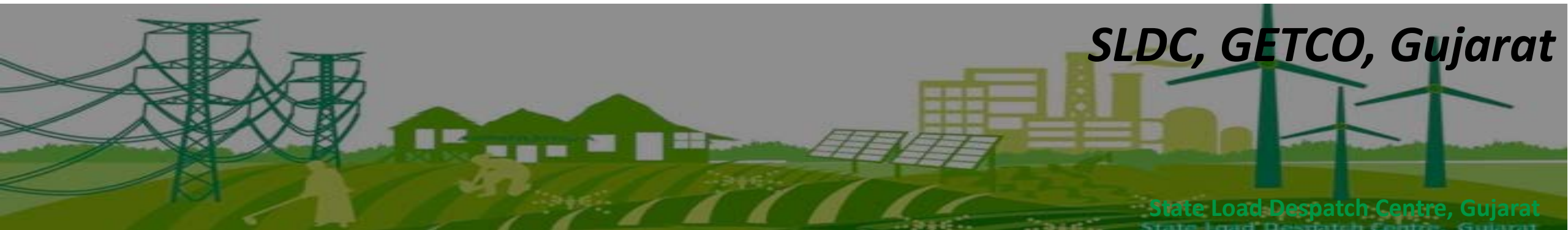


# Power System Balancing Issues in India

## Power Balancing Methods and Solutions



*SLDC, GETCO, Gujarat*

# Abstract

Renewable generation directly influence conventional power plants and grid operation.

Higher penetrations of RE require more flexibility in power system with pre-define solution.

It is a high time to decide on the balancing mechanism in rapidly, straightforwardly and economically fashion.



# RE Overview

RE Sources in <i>India</i>	Wind Power	Solar Power	Small Hydro Power	Bio Power	Total
Installed Capacity MW	32508	13115	4385	8296	58303
Percentage (%)	56	22	8	14	100

18 % RES Installed capacity of total installed capacity (i.e. 330 GW)

RE Sources in <i>Gujarat</i>	Wind Power	Solar Power	Mini Hydro Power	Bio-mass Power
Installed Capacity MW	5405	1262	9	41
Percentage (%)	20	5	0	0

25 % RES Installed capacity of total installed capacity (i.e. 27 GW)



# Present challenges to address variability of RE Generation



Variation of Wind Generation in MWH in a day in <b>Gujarat</b>	Nos. of days in Year			
	2013-14	2014-15	2015-16	2016-17
More than 1500	6	10	12	26
More than 1000	82	94	115	146
More than 500	267	257	296	293

- Solar Generation is highly ramp up and down at morning and evening.
- Extremely variable during monsoon and cloud cover.



# Present practice to address variability of RE Generation

To absorb variation of renewable generation by

- available conventional sources in the system or
- shed load or
- even backing down renewable generation.

Gas base generations are basic source followed by hydro generations then after thermal generations are utilized for balancing mechanism.



# POWER BALANCING METHOD, ISSUE, SOLUTION



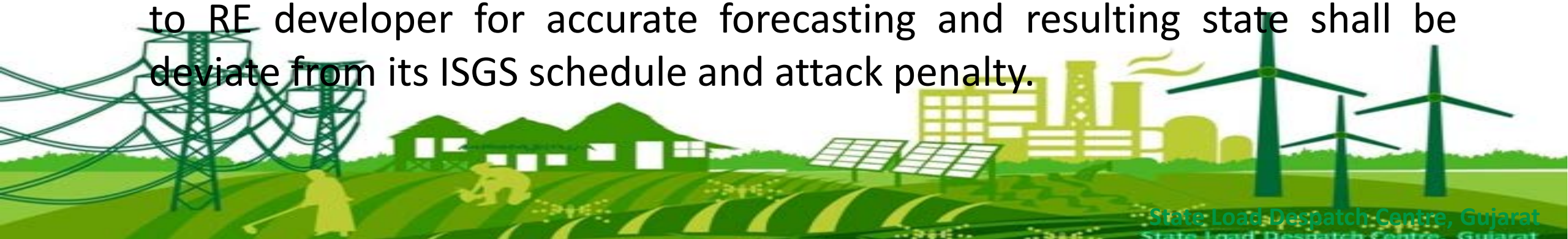
# RE generation forecasting with role and responsibility of each stake holder

## ***Method:***

- Renowned agencies from worldwide is forecasting by physics-based and statistical model by utilizing various static, variable data and weather input sources.

## ***Issue:***

- Real time data of each windmill / panel cannot be made available to FSP.
- Accuracy definition in regulation for RE forecasting shall not make sense to RE developer for accurate forecasting and resulting state shall be deviate from its ISGS schedule and attack penalty.



# RE generation forecasting with role and responsibility of each stake holder

## ***Solution:***

- Each stakeholder has to comply technical requirements of CEA / CERC Regulations.
- All the grid connected renewable generators has to provide and maintain real time data to respective SLDCs.
- All RE developer should undertake accurate forecasting of RE generation.
- Every SLDC has to implement the accurate load / demand and RE forecasting mechanism and capturing real-time data off all generators in the system.
- State has to support the strengthening of REC market and effective fulfilment of RPO targets.



# Introduction of ancillary services

## ***Method:***

- Ancillary services principally regulate the generators. The system operator uses ancillary services over various time frames to balance load and generation.

## ***Issue:***

- It would not replicate up to state level and not exclusive for renewable energy balance.
- Cyclic operation / load ramping capabilities of machines of different age and technology will pose difficulties in dealing with the impact of renewable generation variation.

# Introduction of ancillary services

## ***Solution:***

- Ancillary service would be introducing in the RE reach states.
- It should be link with RE variation so that conventional generation can be utilized as an ancillary, in case of wide fluctuation in RE generation.
- The generators which will be contribute, would be offer attractive price.



# Spot power market

## ***Method:***

- The present power exchange provides platform for buying and selling on day-ahead basis, also, intraday /contingency market for same day and next day delivery.

## ***Issue:***

- The above is yet to be exploited in a major way by the market players.
- It is expected that DISCOMs also operate in a 24 x 7 manner to reap the advantages from these extended market sessions.



# Spot power market

## ***Solution:***

- Spot power market particularly for RE power would be developed with the regulation.
- RE generators bound to absorb its deviation with respect to schedule with the help of power market.



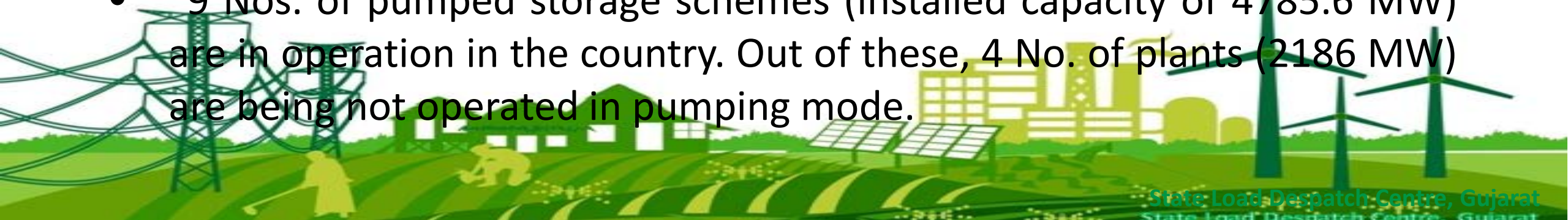
# Pump mode hydro station

## ***Method:***

- Pump hydro plant can store the energy in form of water, pumped from a lower elevation reservoir to higher during off pick or high RE generation and generate electricity during peak period or low RE generation.

## ***Issue:***

- The CEA report on 'Large Scale Grid Integration of Renewable Energy Sources' says
- "9 Nos. of pumped storage schemes (installed capacity of 4785.6 MW) are in operation in the country. Out of these, 4 No. of plants (2186 MW) are being not operated in pumping mode.



# Pump mode hydro station

## ***Solution:***

- Expedite Non-working Pump mode hydro stations put back in service.
- Create a regional / national pool of pump mode hydro stations and same will operated only to absorb RE generation variability as per State request.



# Development of Renewable Energy Management Centre (REMC)



## **Method:**

- REMC is a worldwide accepted concept.
- Forecasting, scheduling, real time data monitoring for plant wise, area wise is key functionality of REMC.

## **Issue:**

- Yet in no RE reach state REMC is functioned full flange.
- *The balancing sources shall still require to maintain the system operation at stage of abnormal predefine scenario of RE generations and other conventional generation availability at that time plus any other uncertain grid parameters like over generation / under generation / line overloading / line underutilization / tripping etc.*

# Development of Renewable Energy Management Centre (REMC)



## *Solution:*

- In India, development of REMC is under process in RE rich states, regions as well national level.
- REMC will monitor the forecasted Vs real-time RE generation data at station wise, area wise and State as a whole.
- However, balancing sources can well support the REMC functionalities.





# Installation of energy storage technology

## ***Method:***

- Technology can store the energy when demand is low and same can be utilized when demand is high.
- Energy storage technologies are: Various types of battery (Lead acid battery, Nickel chromium battery, Redox flow battery, Sodium Sulphur battery, Nickel Manganese Spinal (NMS) cathode based battery etc.), Compressed Air Energy storage (CAES), Flywheel, Fuel cells and Gravity power.



# Installation of energy storage technology

## *Issue:*

- Costly,
- Most of the technologies are under development stage so having limited capacity in KW, Not possible at MW level.
- Technology has required large space.
- At present, there is No regulation for energy storage in India and key point is “Distribution Company has to accept / absorb the store energy at the same PPA (Power Purchase Agreement) rate if it is injected in the grid when required.



# Installation of energy storage technology

## ***Solution:***

- More reliable and efficient storage technology is under process and likely to get cheaper and also, higher capacity energy storage technology in near future. Many countries have started using in their utility / distribution companies.



# WAY FORWARD



# Best option for balancing mechanism

*which can be put in operation within short span.*

- ***Flexible operation of Thermal plant***
  - Flexible operation of coal based thermal units embedded in state (55% Technical Minimum) to be mandated with suitable commercial signals.
  - In future, Special fund with commercial agreement to be issued for modification in design of conventional power plant.
  - Clear roadmap is required for availability of primary control/response and implementation of Automatic Generation Control (AGC) for secondary control in all the state generating units.



# Best option for balancing mechanism

## ○ ***Availability of gas***

- Special APM gas allocation for a limited quantity to high RE potential State may also help to overcome RE variations.
- In future, developing gas based generating station with RE station so that variation can be balanced to some extent.

## ○ ***Hydro operation***

- All the operative hydro stations will be pooled at national level and its dispatch will be controlled by NLDC.
- NLDC has to publish capacity on website with relevant tariff plus other impact up to State periphery and then only needy State shall able to avail.

# Best option for balancing mechanism

- ***Multiple charging station for BOV (Battery Operated Vehicle)***
- All Govt. owned vehicle / State transport / City bus to be converted to battery operated and all new vehicle should be electric battery operated.
- Multiple charging station like. Petrol pump.
- Mainly charged BOV during night hours (Non operative / rest hours of vehicles).



# Best option for balancing mechanism

## ○ *Pump mode Operation*

- At this instant, the operation / utilization of balancing plant of other State should be materialized with mutual agreement and RLDC should encourage without any additional charges up to transmission capacity.
- Special focus on large size balancing with multi State beneficiary either of existing / inoperative / under construction project is MUST.
- In future, existing idle / inoperative pumped storage projects to be made operational on highest priority with time band program, plant wise follow up and monitoring.

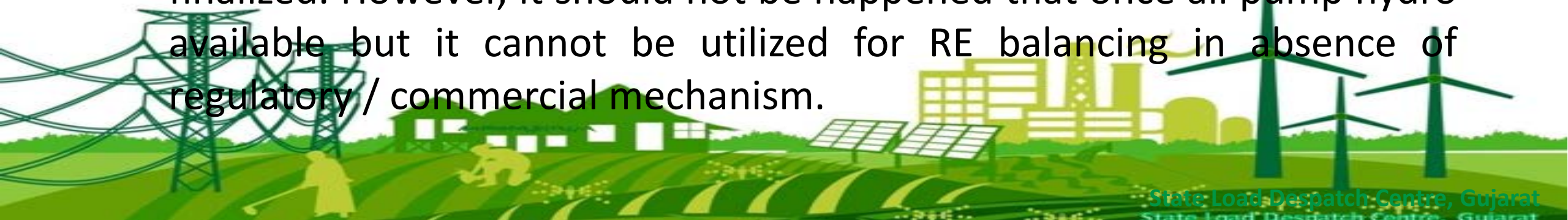




# Best option for balancing mechanism

## ○ *Pump mode Operation*

- A research work may be entrusted to renowned institute for converting conventional hydro in to pump mode by change in turbine, additional tail race etc. which shall be mandatory in future.
- It is suggested to pool such sources at regional level and use them in the grid as and when required.
- The operation of balancing plant in State or for other State, policy to be finalized. However, it should not be happened that once all pump hydro available but it cannot be utilized for RE balancing in absence of regulatory / commercial mechanism.



# Best option for balancing mechanism

## ○ ***Energy Banking***

- The energy banking between two State without any financial transaction is seems to be very viable solution. Only RLDC need to be flexible encourage such transaction.
- Special intervention of higher / appropriate authority to RLDC with suitable arrangement for ease of transmission with energy banking philosophy between States is required or
- otherwise Hon'ble regulatory consider a real time product of energy trading (banking) between utilities which needs to be flexible unlike the present rigid STOA (Short Term Open Access) regulations. Such contract should be direction specific and stipulate the precise period for transaction.

# KEY TECHNICAL BENEFITS OF BALANCING POWER & CONCLUSION

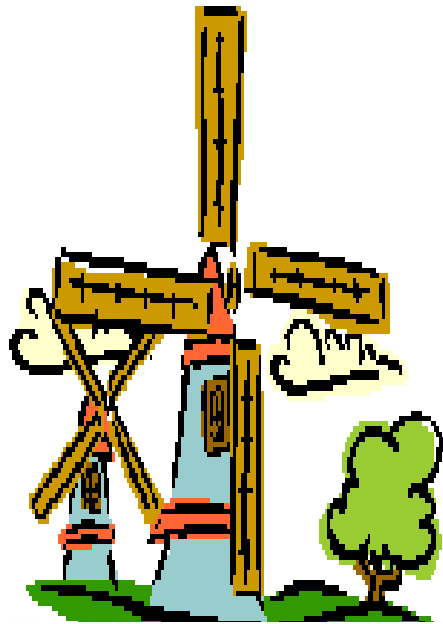


# Key technical benefit of balancing

- Grid stabilization,
- Grid operational support (frequency regulation services, contingency reserves, voltage support and black start),
- Power quality and reliability,
- Load shifting,
- Supporting the integration of intermittent renewable energy sources,
- It shall reduce the frequent pick-up and back-down of conventional generators thus improving their performance and avoid its damages.

# Conclusion

- **When India is having an ambitious target of 60 GW wind generations and 100 GW solar generations by 2020 - 22, solely monitoring of curtailment may not bring the result but immediate provision of balancing mechanism to be made available for reducing curtailment and owing Must Run status.**
- ***Pump mode hydro and energy banking is reasonable and reliable balancing sources which can smoothly put in operation by modifying some of its mechanism by effective attempt.***



*Thanking you!!!*

