THDC India Ltd.

International Conference on
HYDROPOWER AND DAMS DEVELOPMENT FOR WATER AND ENERGY SECURITY – UNDER CHANGING CLIMATE

New Delhi
Central Board of Irrigation & Power

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Indian National Committee on Large Dams

# BRIEF PRESENTATION
# ON
# PUMPED STORAGE DEVELOPMENT
# EMERGING CHALLENGES & AVAILABLE OPTIONS
## Case Studies


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जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

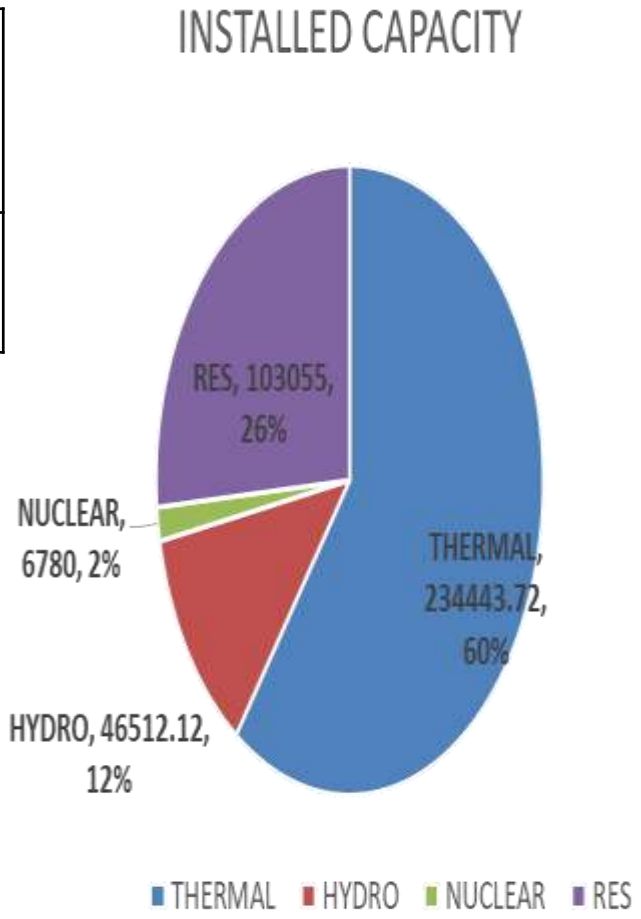

**8th April, 2022**
**Rishikesh**

- ➢ **Need of Pumped Storage**
  - ✓ Power Scenario- An Overview
  - ✓ Renewables - Projections
  - ✓ Challenges – Integration of Renewables
- ➢ **Pumped Storage Technology**
  - ✓ Pumped Storage Technology- Advantages
  - ✓ Key Challenges
- ➢ **Possible Options**
  - ✓ Case Studies
  - ✓ Key Challenges
- ➢ **Conclusion**

# POWER SCENARIO- AN OVERVIEW

**(as on 31.10.2021)**
**Source CEA**

| | Thermal | Hydro | Nuclear | RES | Total |
|---|---|---|---|---|---|
| All India | 234443 | 46512 | 6780 | 103055 | **390791** |




**Hydro Share (As on 31.03.2021) – 12 %**

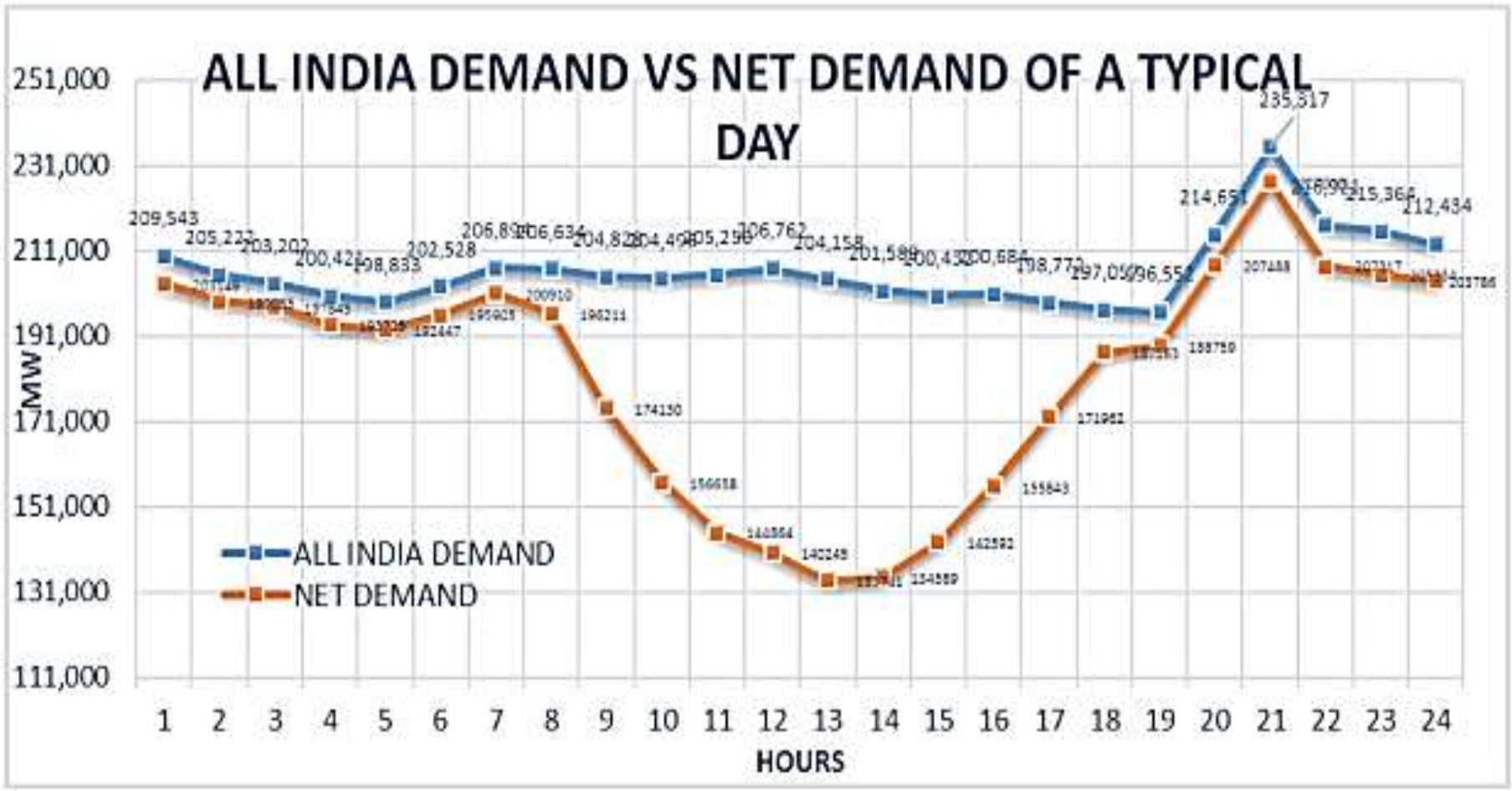
| | All India |
|---|---|
| Peak Demand Met (MW) | 174600 |
| Installed Capacity (MW) | **390791** |
| Ratio(IC/Peak Demand) | **2.24** |

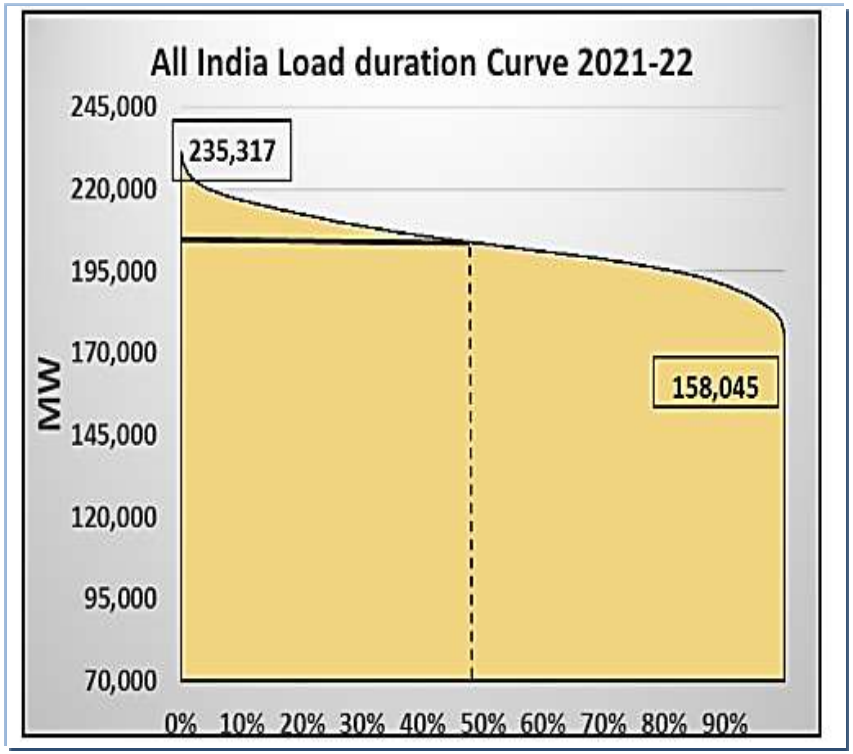
**All India Projected Peak Demand Vs Installed Capacity**
**(As per National Electricity Plan)**

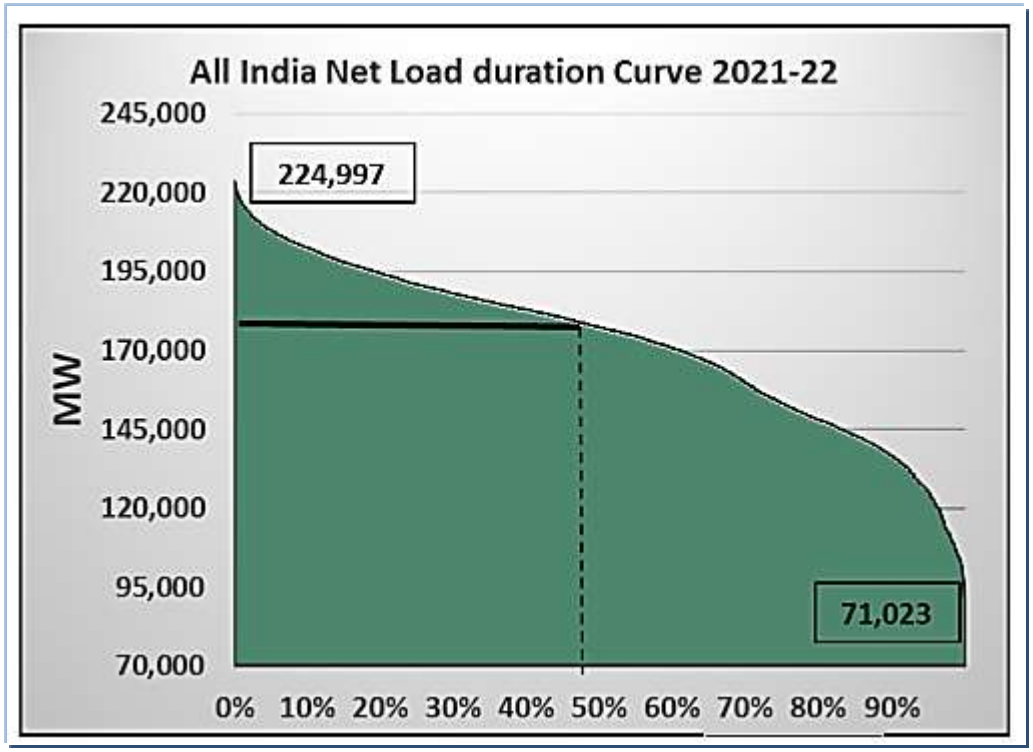
| | 2026-27 |
|---|---|
| Peak Demand (MW) | 298774 |
| Installed Capacity (MW) | 619066 |
| Ratio(IC/Peak Demand) | **2.07** |

- An average of **20% of Installed Capacity** is expected to be Solar as per Government's Policy.
- The projected installed capacity for 2026-27 is are given below:

| | 2026-27 | |
|---|---|---|
| Fuel Type | **Capacity (MW)** | % |
| Hydro | **63,301** | |
| Coal + Lignite | **2,38,150** | |
| Gas | **25,735** | |
| Nuclear | **16,880** | |
| Total Conventional Capacity * | **3,44,066** | **55.6** |
| Total Renewable Capacity | 2,75,000 | **44.4** |
| Total Capacity by 2026-27 | **6,19,066** | 100% |


ALL INDIA DEMAND VS NET DEMAND OF A TYPICAL DAY
251,000
231,000
211,000
191,000
171,000
151,000
131,000
111,000
MW
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS
ALL INDIA DEMAND
NET DEMAND
209,543
205,223
203,202
200,424
198,833
202,528
206,836
206,634
204,828
204,496
205,296
206,762
204,158
201,588
200,432
200,686
198,772
197,056
196,554
214,651
235,517
215,366
212,434
200910
196211
174130
156658
140364
140249
134589
142592
155843
171961
158759
207488


All India Load duration Curve 2021-22
245,000
220,000
195,000
170,000
145,000
120,000
95,000
70,000
MW
235,317
158,045
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%


All India Net Load duration Curve 2021-22
245,000
220,000
195,000
170,000
145,000
120,000
95,000
70,000
MW
224,997
71,023
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%

- In order to address this problem the efforts were made to evolve various **ENERGY STORAGE** means.

## Technology Description:

- The basic arrangement - involves two storage reservoirs upper and lower separated at vertical difference with reversible turbine /pump between the two reservoirs.
- The technology is a **Mechanical Storage of the Eenergy.**
- Water is lifted to the upper reservoir by pumping mechanism through extra electricity during off-peak time.
- The stored potential energy in the upper reservoir is used to generate electricity by turbines when they are needed.
- Pumping is similar to **Charging the Batteries** for future use.

➢ **GRID LEVEL**

- It utilizes grid power during off peak hour when frequency is high and supply power during peak hour and whenever required.
- Regulates frequency to meet sudden load changes in the network
- Improve grid controllability, Grid stability and Security

➢ **THERMAL STATIONS**

- Increase capacity utilization of Thermal stations
- Reduce operational problem of thermal stations during light load period

➢ **GENERAL**

- Provides Black start facility
- It addresses intermittence of renewable energy to a large extent
- It improves voltage stability utilizing the unit as synchronous condenser
- It improves the tradability of power in the electricity market
- It improves hydro thermal mix ratio
- Availability of spinning reserve at almost no cost to the system
- Pumped Storage Schemes improve over all economy of power system operation

## ➢ General Challenges

➢ **Pumped Storage projects essentially require two reservoirs- results in increased possibility of following**

- ✓ Submergence Issues
- ✓ Land Requirement Issues
- ✓ R&R Issues
- ✓ More requirement of Construction material

## ➢ Site Specific Challenges

- Two reservoir to be in close vicinity due to L/H ratio – Difficult to find
- Desired topography and river meandering to have short WCS
- Desired topography and Geology conducive to have straight WCS
- Steep River gradient to have maximum head in minimum distance
- Difficulties in siting two Intake structures for upper and Lower pond
- Large head variations between FRL and MDDL and associated slope stability issues
- Large head variation impacts machine design

- **Commercial Viability Challenges**

✓ Pumping cost is added in to the tariff.

✓ Due to requirement of two dams with associated submergence the cost od dam complex is always higher.

✓ The viability of any Pumped Storage Project has always been an issue due to **cycle efficiency**

✓ **Due to absence of enabling policy framework which incentivizes the ancillary services being provided by PSP and non availability of variable tariff regime viability of PSP is always a challenge.**

✓ Hence identification of suitable site, planning and design requires utmost care and judicious decision making to develop Pumped storage projects.

## Options

- Given the paucity of new sites, it is difficult to find new sites for installation of Pumped Storage Projects various innovative combinations must be considered for installing Pumped Storage Project.
- Special efforts should be made to utilise existing H.E. projects with adequate reservoir storage.
- following combinations are possible:

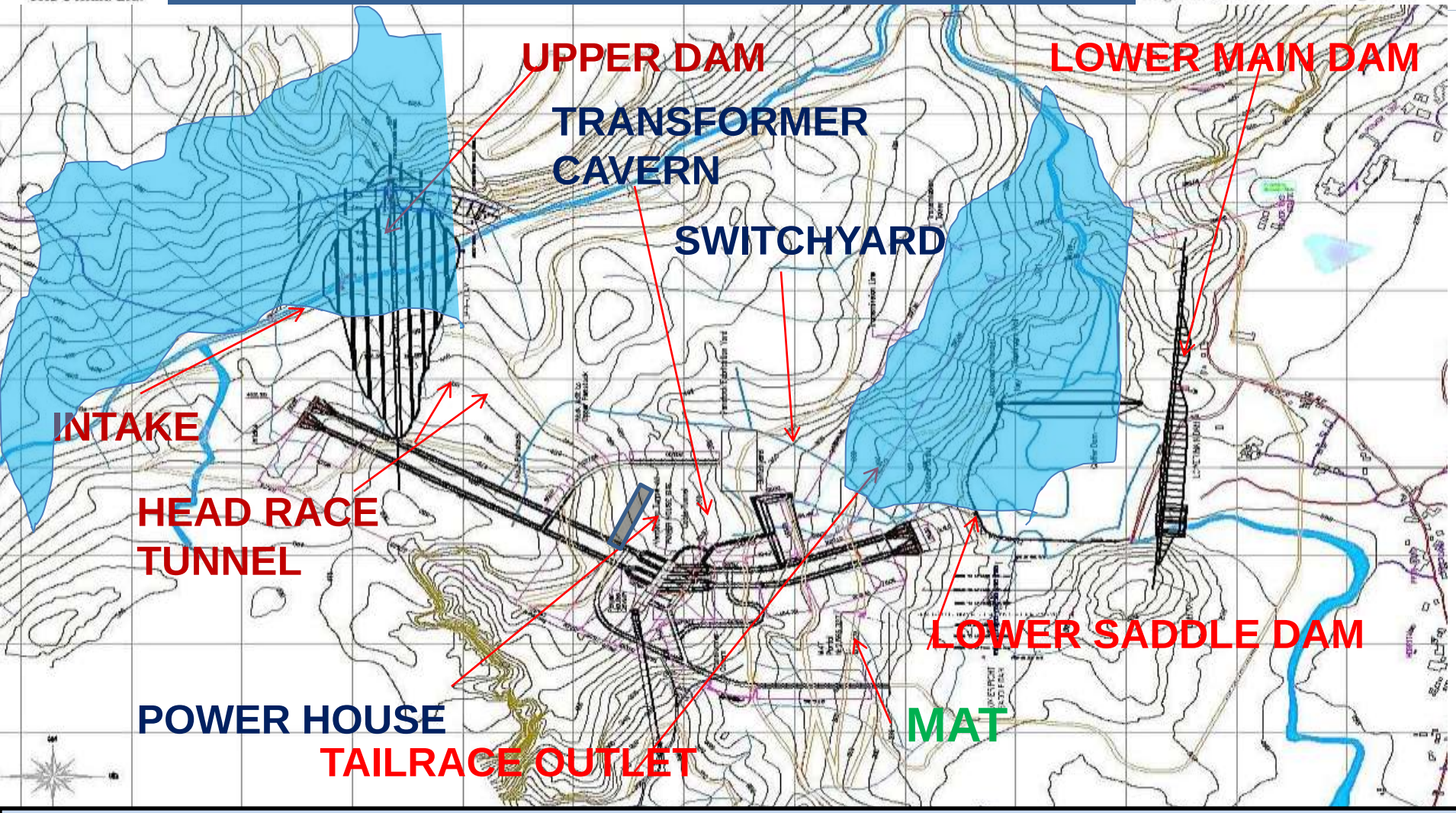
• **Within the Existing Projects** ( One Reservoir exists and One new reservoir is to be made)

• **Within the Existing projects** ( Both reservoirs exists)

- The planning and design of each of the above types are distinctly different from each other and require meticulous planning at each stage of development

- **Within the Existing Projects** ( One Reservoir exists and One new reservoir is to be made)-**Turga Pumped Storage Project, 4X250 MW, West Bengal**

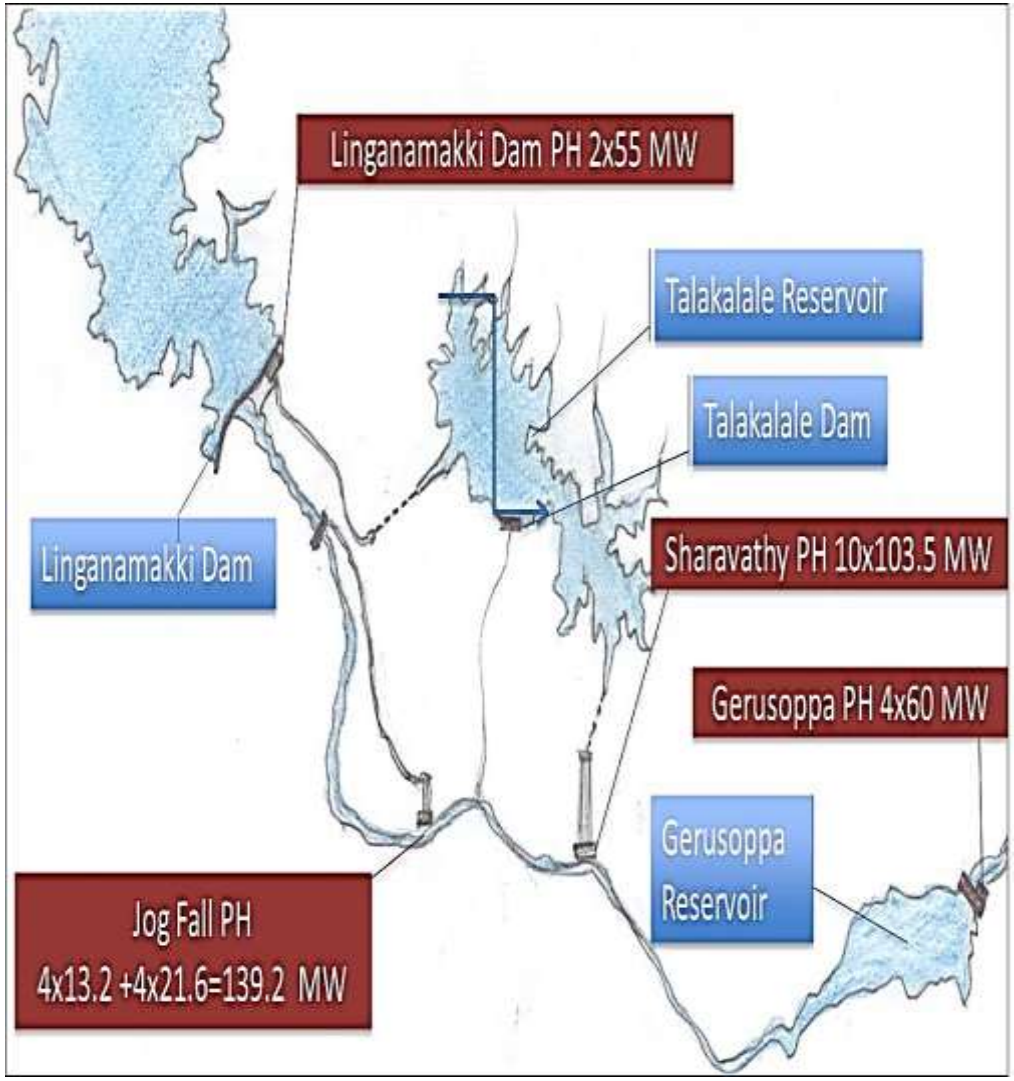
- **Within the Existing projects** ( Both reservoirs exists)-**Sharavathy Pumped Storage Project, 8X250 MW, Karnataka**




**Within the Existing Projects** ( One Reservoir exists and One new reservoir is to be made)-**Turga Pumped Storage Project, 4X250 MW), West Bengal**

## The Turga Pumped Storage project envisages construction of:

- A 63.50 m high Rockfill New upper dam with central impervious clay core.
- Live storage of **14.20 M cum** with FRL at 464.0 m and MDDL at 444.40 m;
- A 64 m high concrete dam **modified at existing lower dam location**.
- live storage of 14.20 M cum with FRL at 316.50 m and MDDL at 280.40 m;
- 2 (two) No. 932 m long, 9.0 m diameter circular steel lined headrace tunnel
- An underground power house having an installation of 4 Francis type reversible pump-turbine driven generating units of 250MW capacity each
- 2 (two) No. 10m dia 605 m long tail race tunnels to carry the power house releases to lower reservoir.
- An installed capacity of 1000 MW has been adopted based on the simulation studies carried out for different FRLs and installed capacities to provide peaking benefits for 5 hours.




- Project with installed capacity of 2000 MW is planned between existing Talakalale and Gerusoppa reservoir The proposed pumped storage project is an additional installation utilising the existing Sharavathy system consisting of Liganamakhi, Talakalale Dam and Gerusoppa Dam.
- Five (5) reservoirs regulate monsoon surplus waters of the Sharavathy and adjacent streams.
- KPCL has three major hydroelectric stations in the basin with a total installed capacity of 1330 MW.

## Available Storages in Sharavathy Reservoirs

| Sr. No. | Reservoir | FRL (m) | MDDL (m) | Live Storage (MCM) |
|---|---|---|---|---|
| 1 | Talakalale | 522.12 | 520.59 | 13.6 |
| 2 | Gerusoppa | 55.00 | 43.50 | 58.21 |

| Installed Capacity (MW) | Total Storage Requirement (MCM) | Storage Required for existing Sharavathy HEP (MCM)* | Storage Required for Sharavathy PSS (MCM) |
|---|---|---|---|
| 1000 | 6.81 | 1.63 | 5.18 |
| 1250 | 8.11 | 1.63 | 6.48 |
| 1500 | 9.41 | 1.63 | 7.78 |
| 1750 | 10.7 | 1.63 | 9.07 |
| 2000 | 12.0 | 1.63 | 10.37 |

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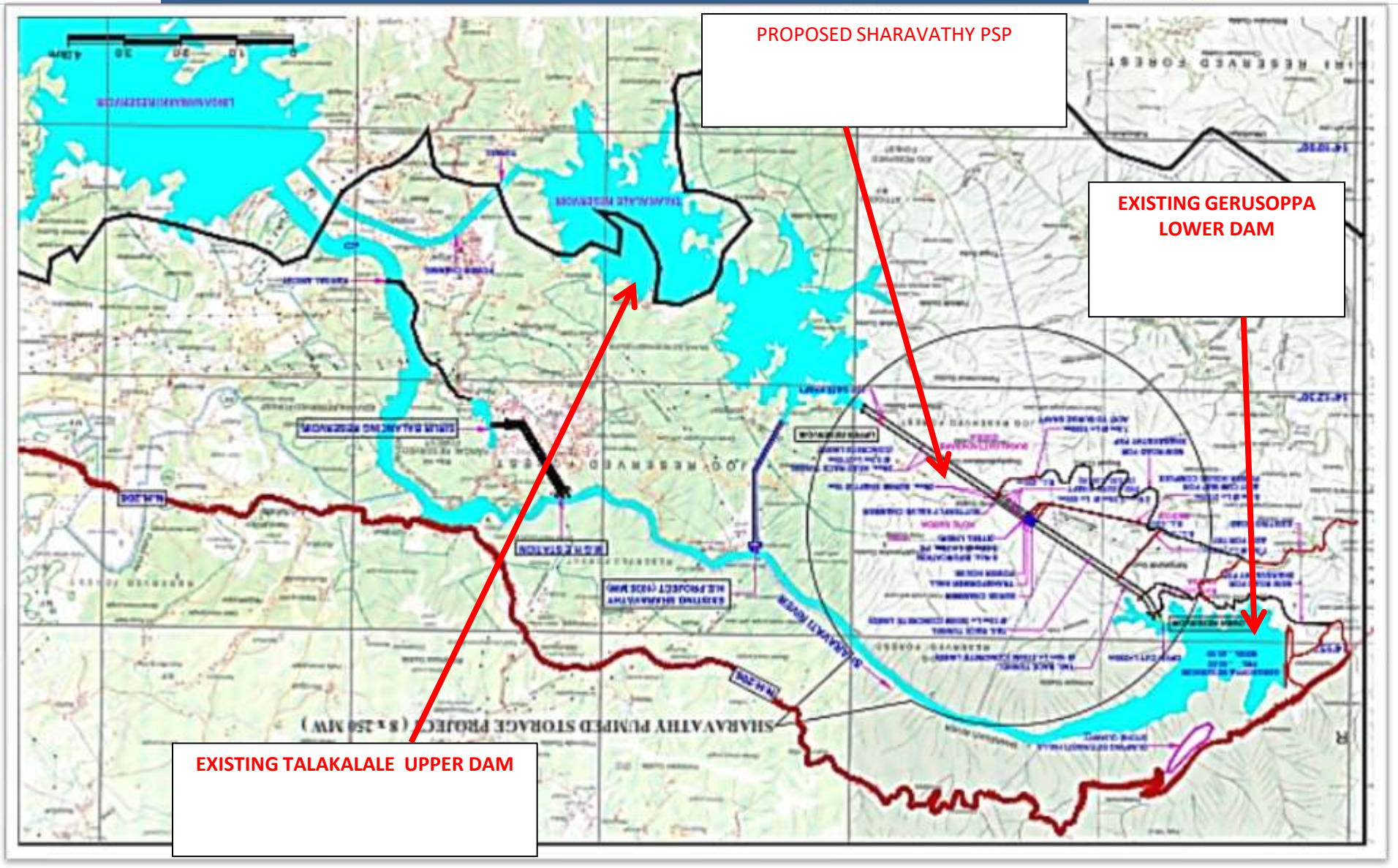

## The Sharavathy Pumped Storage project envisages construction of:

- 2 (two) No. intake with trash racks having mechanical raking arrangement.
- 2 (two) No. 2.726 Km long, 9 m diameter circular concrete lined headrace tunnels including cut & cover.
- 2 (two) No. 0.828 Km long, 5.25m diameter inclined circular steel lined (including horizontal) pressure shafts
- 2(two) no. 16m dia circular Surge Shafts 52m high.
- An underground power house having an installation of 8 Francis type reversible pump-turbine driven generating units of 250MW capacity each
- 2 (two) no. 3.780 Km & 3.830 Km long concrete lined tail race tunnels to carry the power house releases to lower reservoir.

- **Planning of new Pumped Storage projects should ensure following:**

✓ No interference with operation of existing projects be it HEP or Multipurpose.

✓ No change in the operating levels of existing reservoirs to the extent possible.

✓ No major modification in the existing structures such as dam etc.

✓ To ensure adequacy and safety of existing structures.

✓ Hydrological balance to be maintained as pre PSP scenario.

✓ The location of both the reservoir should not be prohibitive in terms of L/H ratio

✓ Power planning of both projects is a delicate exercise in which the fine balance and pragmatic trade offs in order to maximise net benefit must be planned

- In view of large scale induction of Renewables in near future development of Pumped Storage projects needs focused attention and support.
- The existing Hydropower Projects planned about 50-60 years back with higher load factor and have huge storages available which is unutilised to the extent of 50% in many cases.
- **As new projects are hard to come by due to stringent Environmental guidelines , new PSP's can be the solution to utilise the balance surplus water with minimum cost and minimum interference to the environment.**

- Many identified sites have now become unavailable due to stringent Environmental , and Social stipulations together with difficulties in land acquisition.
- Many sites may be unavailable due to proximities to the national Parks etc.
- In view of above , it is of utmost importance that all the possible new sites are explored in totality.
- Efforts should be made to study all the existing projects having one reservoir or two reservoir in proximity and explore the possibility of installation of Pumped Storage projects within the existing system.
- This will minimize many adverse impacts and address developmental challenges.
- The PSP development within existing projects will greatly reduce the cost and help making Pumped storage project economically viable.


Thank you