THDC India Ltd.

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

New Delhi
Central Board of Irrigation & Power

INCOLD
Indian National Committee on Large Dams

"Pumped storage development – Current trends and future challenges"

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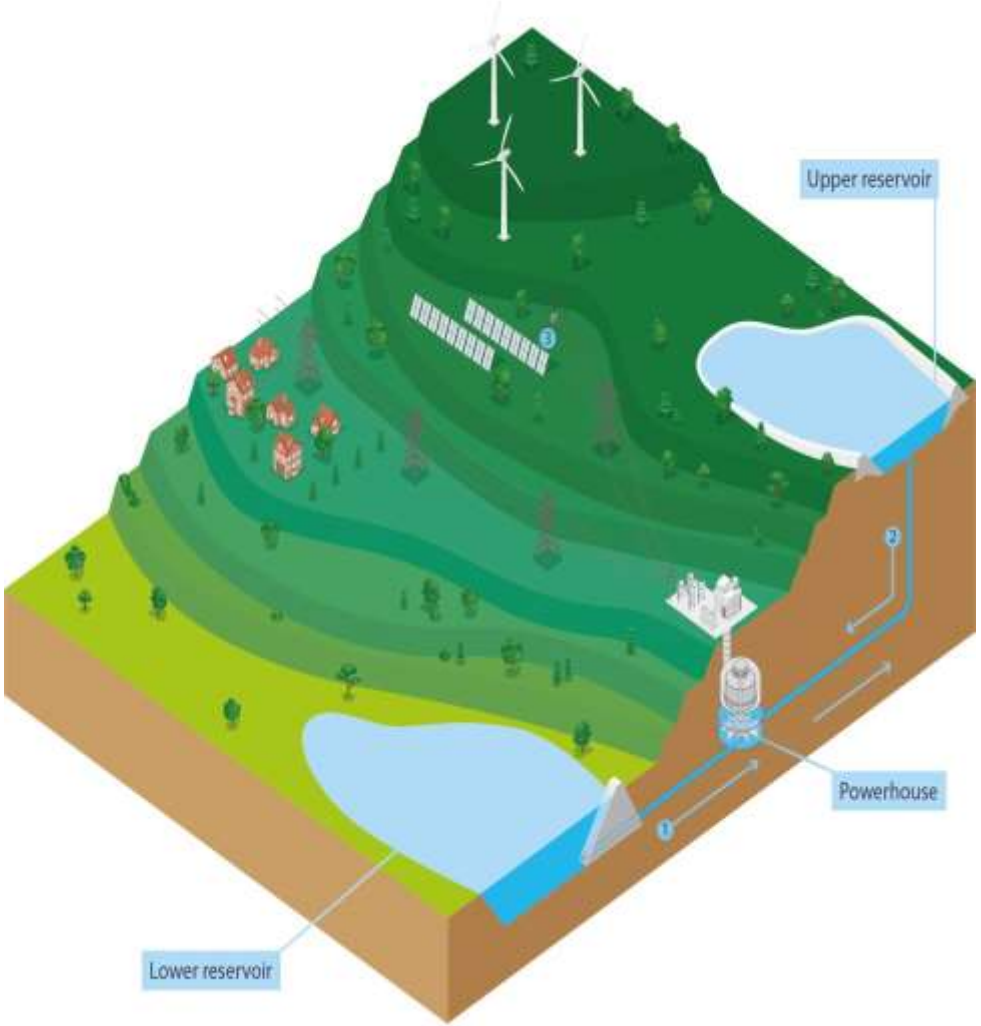
Pumped Storage Power Plants



Pumped storage hydropower-TYPES

Closed loop/ off-stream

- No need for new dams on main stem rivers, uses existing infrastructure
- sidesteps the constraint of site availability thus minimizing environmental impacts

Open loop

where there is an on-going hydrologic connection to a natural body of water

Introduction

- India has committed to increase share of renewables to 50% **and achieve 500 GW** of non-fossil fuel-based energy capacity by the year 2030
- Therefore, need for developing Flexible Energy Generation Assets like Pumped Storage Projects (PSPs)
- Pumped hydro are known as '**the world's water battery**' and is **rugged, long-lived, mature and proven technology**
- Globally, Pumped storage accounts for over 95 per cent of installed energy storage capacity, well ahead of other storage technologies
- International Hydropower Association have estimated that PSPs worldwide store up to 9,000 gigawatt hours of electricity.

NEED for Energy Storage Technologies

Energy storage technologies are crucial to grid reliability and facilitate:

- Quickly accommodate over-generation
- Flexibility to change on real-time basis by ramping up/ down as per needs of intra-hour balancing
- RE generation of one state can be stored in other state
- Defers the upgrading of transmission lines

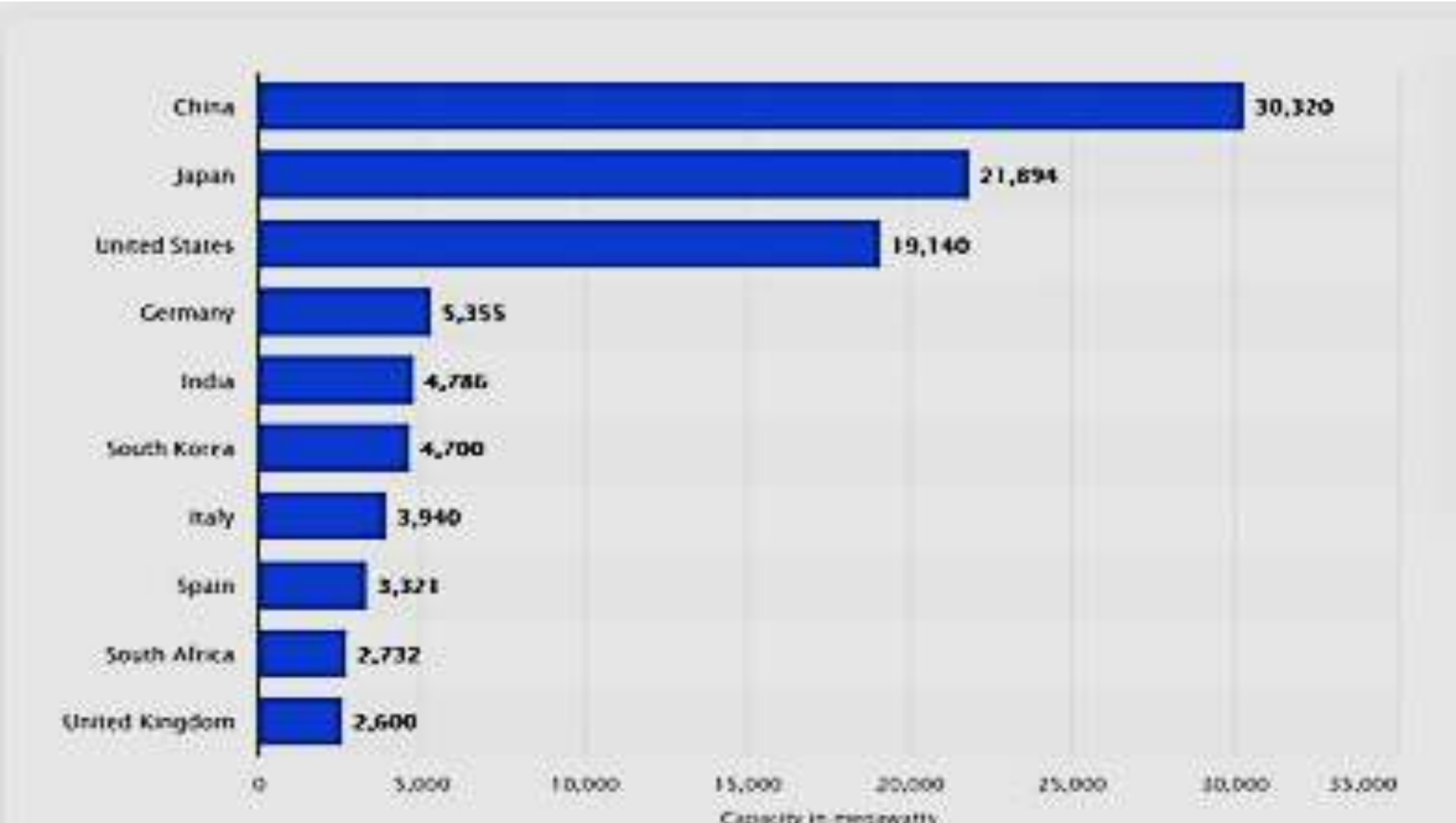
Advantages - PSPs

- Technically proven, **mature, highly efficient and flexible technology** of energy storage on a large scale to store **intermittent and variable** generation from solar and wind. **Reduces RE curtailment.**
- Improves overall economy of power system operation, provides balancing, operational flexibility and stability to the system etc.
- Reduces operational problems of thermal stations during low load period e.g. allows TPS to operate at peak efficiency, lesser pollution
- Ability to **provide ancillary benefits** such as flexible capacity, voltage support and Black start etc.
- PSH should be considered as a **key enabler of the clean energy transition**, alongside other energy storage technologies.

CURRENT SCENARIO: GLOBAL

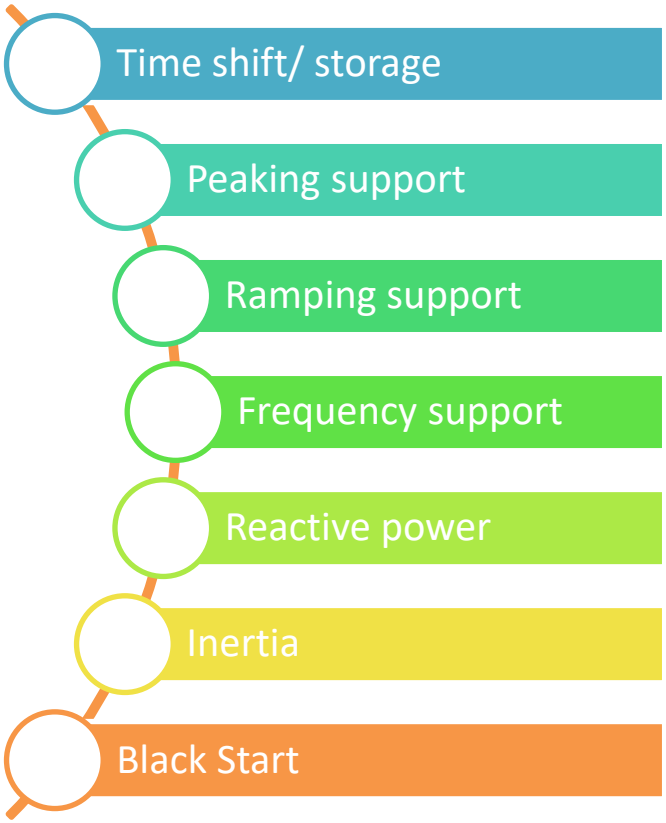
- By the end of 2020, there was **160 GW** of pumped storage hydropower installed globally, comprising **95 per cent** of all total installed energy storage.
- **China (30 GW) of PSP is world leader followed by Japan (22 GW) and America (19 GW).**

CAPACITY OF PSH WORLD WIDE(2020) in MW



Relevance of PSP in increasing VRE penetration..

…renewable energy addition poses grid stability challenges



PSPs : INDIAN SCENARIO

Description	Pumped Storage	
	Nos.	I.C. (MW)
Identified Pumped Storage Capacity in 1987	63	96529.6
Schemes not found feasible	20	30170
Total identified Potential incl additional identified PSPs	86	97625.60
In operation	8	4745.6
Under construction	3	1580
Under development		
(i) Cleared by CEA /to be taken up for construction	2	2200
(i) Under S&I	17	16770
Sub-total (i-iii)	19	18970
Total (I+II+III)	30	25295.6

CURRENT SCENARIO : INDIAN SCENARIO

- Pumped storage potential in different states vary from as low as 570 MW in Bihar to almost 35,000 MW in Maharashtra.

- States like Andhra Pradesh are putting all out efforts for development of pumped storage potential while in other states the development of PSPs remains sluggish.

Emerging innovations

- **Off river sites - Closed-loop**
- Upper reservoir often located on hill top
- Typically smaller reservoirs, minimal environment impact, no longitudinal connectivity or e-flow issues
- May not involve any significant inter-state issues
- No need of complex civil structures like huge dam and spillway/ structures and desilting chambers
- Faster accomplishment at much lower cost
- No impact on existing water/ irrigation system or river basin

Current Challenges

- The sites for off-river closed loop system are yet to be identified in India.
- Growing research on possibilities for retrofitting disused mines, underground caverns, non-powered dams and conventional hydro plants.
- Monetisation/ Valuation of Services

IMPEDIMENT IN GROWTH PSP IN INDIA

- Pumped Storage Projects do not generate but transform off-peak energy available in the Grid System into peak energy. So certain **INPUT ENERGY** is needed.
- There is certain amount of **loss in the conversion process**. Cycle efficiency is about 80%.
- Relatively higher cost of these projects vis-à-vis batteries affects their **viability**
- Require **TWO reservoirs** against ONE in conventional Hydro
- Availability of **off-peak energy** at a cheaper rate would ensure viability of these projects.

ISSUES INVOLVED IN SLOW PACE

a) Environment and Forest issues
b) Land Acquisition & R&R Issues
c) Inadequate Infrastructural facilities
d) Law & Order / Local issues
e) Geological Surprises
f) Natural Calamities
g) Inter-state Issues
h) Financial Health of Contractors
i) High Tariff

Government measures for Promotion of PSPs

Measures to promote hydropower including Pumped Storage projects

- Policy Measures notified by Ministry of Power in March 2019 including **Tariff Rationalization Measures & Budgetary support for Enabling Infrastructure** i.e., Roads/Bridges, which would be beneficial in reducing the cost of development of Pumped Storage projects.
- Inter-state transmission charges have been waived off if at least 70% pumping requirement is met from RE sources, by Ministry of Power in June 2021.
- Bundling of RE Power with PSP has also been notified by Ministry of Power in November 2021.
- CPSUs identified State-wise for implementing PSPs e.g. NHPC in J&K, M.P. Odisha, Sikkim etc., THDC in Kerala, TN, UP, Chattisgarh, Uttarakhand etc. BBMB in Punjab, Harayan, Rajasthan, SJVN in H.P. Bihar, Karnataka etc

STEPS for promoting investments in PSPs

Incentivizing investments in PSPs

- No free power since net consumer of electricity
- GST may be reduced to around 5% on machine items used in PSP.
- Treat PSPs as "System Tool" rather than a typical HE project and putting them at disposal of Grid Operators for Grid Balancing
- Faster Clearance Norms in Off stream projects and relaxation in clearances
- PSPs could be categorized as "must and first run Projects" during variable and intermittent generation
- Saperate Peak, off peak tariff
- Evaluation of PSPs in terms of Transformation cost of Energy (from off peak to peak) n
- low interest bearing long term loans, freen funding and VGF for PSPs
- Involvement of CPSUs in a big way for development of PSPs
- Debt equity ratio of 80:20 instead of 70:30 is proposed for funding of PSPs

THANK YOU

Recommendations

- A rolling 5 to 7 years Resource adequacy plan including reserve and storage requirements for grid balancing and grid security should be prepared by CEA in consultation with POSOCO and CTU.
- Based on the Resource adequacy plan of CEA, grid balancing and security requirement POSOCO shall regularly identify requirement of Primary, secondary and tertiary reserve for peaking and ancillary service requirements
- Based on the requirement estimated in the Resource adequacy plan (including that of Discoms/States), the reserve capacity/ storage capacity procurement should be through the competitive route and the power purchase agreement may be for a period of at least 15 years
- The competitive procurement of reserve capacity can be in three time frames i.e the reserve capacity that is required to be added in time frames of (i) 0-3 years (short term for existing unused capacity), (ii) 4-7 years (for new capacity like Hydro PSP, BESS also) and (iii) for more than 7 years (for long term assets like Hydro PSP).
- Procurement can be through mix mode i.e. around 80% to 90% of the plant capacity is committed through power purchase agreements and remaining 10% to 20% of the Capacity can participate in the energy market and/or ancillary services/ ancillary services market etc.

Recommendations

- As PSP is site specific, Case-2 type bidding may be appropriate for it. Draft Bidding Guidelines may be prepared by SECI and finalized by Ministry of Power after consultation with the Stakeholders. Bidding guidelines may also include the following:-
  - Grid Operator(s) (POSOCO/SLDCs) to manage the capacity allotted for ancillary services. Surplus power, if any, may be sold in the power exchange by the Grid operator or by the Hydro Pumped storage Plant (PSP) after issuance of NOC by the Grid operator.
  - As far as possible, Hydro PSP will be collocated with the nearest solar or wind power plants so as to avoid extra transmission cost. However, if this is not possible as Hydro PSPs are site specific, ISTS charges waiver may be given to energy transmitted by Hydro PSP.
  - Aggregator / SECI to do the bidding and procure power from hydro PSP through PPA with a back to back power supply agreement (PSA) with the procurers of power from such Hydro PSPs.
  - If there are uncommitted solar or wind capacity with the Aggregator / SECI, or in case of committed RE power, if the procurer wants to avail a part of power during peak hours a bidding can be done to explore the possibility of using the existing Hydro PSP which are not running in pump storage mode to supply power during peak hours.

Summary of PSP development – State-wise

Sr. No.	State	Total Potential Identified		In-operation		Under-const.		Concurred/ UE		S&I		Balance Identified	
		No.	MW	No.	MW	No.	MW	No.	MW	No.	MW	No.	MW
1.	Maharashtra	32	34965	2	400	1	80	0	0	2	1860	27	32625
2.	Gujarat	2	1440	2	1440	0	0	0	0	0	0	0	0
3.	M.P.	1	1440	0	0	0	0	0	0	1	1440	0	0
4.	Telangana	2	1605.6	2	1605.6	0	0	0	0	0	0	0	0
5.	Andhra Pr.	10	10600	0	0	0	0	1	1200	8	7750	1	1650
6.	Tamil Nadu	6	5300	1	400	1	500	0	0	2	1500	2	2900
7.	Karnataka	3	3960	0	0	0	0	0	0	2	3260	1	700
8.	Kerala	2	900	0	0	0	0	0	0	0	0	2	900
9.	Odisha	4	3920	0	0	0	0	0	0	3	1420	1	2500
10.	West Bengal	6	5010	1	900	0	0	1	1000	1	900	3	2210
11.	Jharkhand	1	2800	0	0	0	0	0	0	0	0	1	2800
12.	Bihar	2	570	0	0	0	0	0	0	0	0	2	570
13.	NER	10	16900	0	0	0	0	0	0	0	0	10	16900
14.	Chhattisgarh	0	0	0	0	0	0	0	0	0	0	0	0
15.	H.P.	2	3430	0	0	0	0	0	0	0	0	2	3430
16.	J&K	1	1650	0	0	0	0	0	0	0	0	1	1650
17.	Uttarakhand	2	2935	0	0	1	1000	0	0	0	0	1	1935
Grand Total		86	97625.6	8	4745.6	3	1580	2	2200	17	16770		

Recommendations

- The following incentives may be given to promote pump storage plants:-
  - **ISTS charges may be waived off if atleast 70% pumping requirement is met from RE sources.**
  - **ISTS charges for power generated from Hydro PSP may be levied gradually**
  - Renewable Energy Certificate (REC) may be issued for each Mega Watt Hour (MWh) of generation from Hydro PSP. REC may be issued to the procurer of electricity and procurer can sell these RECs in the REC market and mitigate his risk.
  - The associated infrastructure development (say approach road etc) cost may be borne by the Government and may not form a part of the tariff.
  - GST on various machine items used in Hydro PSP may be reduced to around 5%;
  - Interest subvention or sub-ordinate debt for construction of PSP: 2-3% of interest subvention on debt for development of PSP is suggested. Accordingly, the cost of generation will reduce.
  - Debt equity ratio of 80:20 instead of 70:30 is proposed for funding of Hydro PSPs.
- Clearance for the Hydro PSP project should be time bound at all level (state, CEA, etc.). CEA to review and revise the process of giving clearance for the Hydro pumped storage projects.