CURRENT IMPETUS ON PSPs IN INDIA - IDEALISM VERSUS REALITY

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RENEWABLE ENERGY IN INDIA

India is leading the world's renewable energy revolution and is on track to achieve 175 GW of RE capacity by 2022.

As on December 2021, the total RE installed capacity is 152 GW which includes 46 GW in hydro. This represents 39% of countries total installed capacity.

The government plans to establish renewable energy capacity of 523 GW (including 73 GW from Hydro) by 2030.

NEED FOR PSPs

While battery storage solutions are still evolving, integrating Wind & Solar with time-tested and proven Pumped Storage solutions presents an optimal, economically, viable & scalable solution to supply Schedulable Power On Demand (SPOD) with both baseload and peak load capabilities to the Nation.

Pumped Storage solutions provide the necessary scale (large volume of energy storage) and have a long-life cycle resulting in reasonable cost of delivered SPOD energy over the life of the projects.

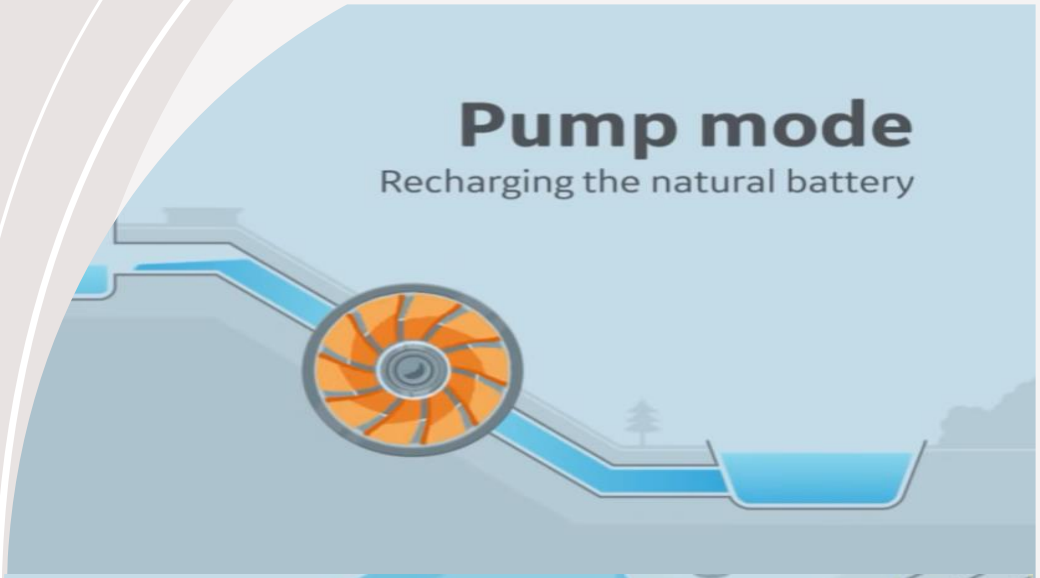
STATUS OF PUMPED STORAGE DEVELOPMENT IN INDIA

OTHER IDENTIFIED PSPs

CEA Identified Projects – 41 nos., total – 62815 MW in different Parts of the Country Majorly in Maharashtra

PFR for number of projects in Tamil Nadu has been initiated.

19 off-river project sites have been identified by New and Renewable Energy Development Corporation of Andhra Pradesh Ltd.

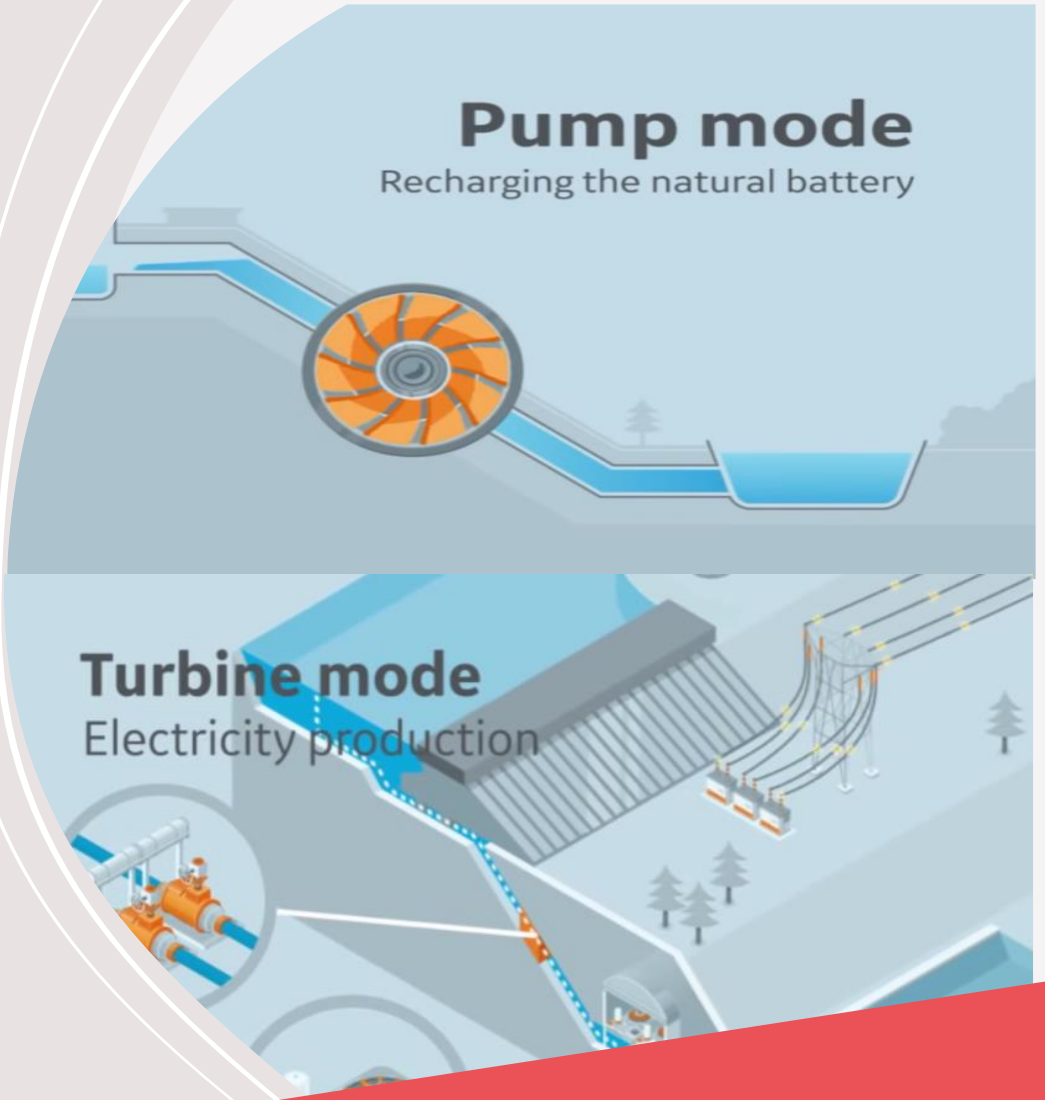


CONCEPT OF PSPs

The pumped storage hydropower project comprises an upper reservoir and lower reservoir interconnected with a waterway, a powerhouse that contains hydropower electrical mechanical equipment, and a transmission connection to the grid.

This project is operated when inexpensive electricity is available (which is typically available at night or on the weekends when power demand is low or excess solar generation in the daytime) is used to pump water from the lower reservoir to the upper reservoir. Water stored in the upper reservoir is then released during peak demand periods, delivering more valuable electricity to the grid.

With the introduction of renewable energy technologies, the operation of pumped storage hydropower facilities is being expanded to utilize excess energy from renewable energy systems for later use during peak demand periods.



TYPE OF PSPs

- Both upper and lower reservoirs existing
- Existing upper reservoir with new lower reservoir
- New upper reservoir with existing lower reservoir
- Both reservoir to be constructed

PSPS TYPE BASED UPON HEAD, DISCHARGE AND LENGTH OF WCS

High head, low discharge and short/long WCS (head 400 m or above)

Medium head, medium discharge and short/long WCS (head 150-400m range)

Lower head, high discharge and short/long WCS

The required reservoir volumes for upper and lower reservoirs will depends upon the plant capacity, head and discharge characteristic and number of generation hours per day.

Long Water Conductor System requires upstream and downstream surge tanks.

PLANT LOAD FACTOR OF PSPs

Plant load factors of PSPs will depend upon number of generation hours per day.

For 10hour generation per day PLF will be 41%

For 7-hour generation per day PLF will be 29%

For 6-hour generation, PLF will be 25%

For generation less than 6-hours , PLF will be further reduced below 25%

CYCLE EFFICIENCY FOR PSPs

Cycle efficiency of a pumped storage project can be defined as the ratio of energy generated while water is moved from upper reservoir to lower reservoir and energy spent to pump the same volume of water from lower reservoir to upper reservoir over a cycle of 24 hours.

In turn, cycle efficiency depends upon the multiplication of the following efficiencies:

- Hydraulic efficiency of water conductor system between upper reservoir and lower reservoir in generation mode viz-a-viz pumping mode (EWCS)
- Efficiency of turbine in the generation mode (Eturbine)
- Efficiency of turbine/pump in pumping mode (Epump)
- Efficiency of the generator in the generation mode (Egenerator)
- Efficiency of the generator/motor in pumping mode (Emotor)

CYCLE EFFICIENCY FOR PSPs (CONT.)

EWCS can be calculated as:

EWCS = [Gross head - Head losses during generation mode]/[Gross head +Head losses during pumping mode]

- **Head loss in the water conductor system mainly depends upon the velocity of flow in the pipe, length of the pipe, diameter of the pipe, and roughness of the pipe and thus governed by the configuration of civil structure.**
- **The efficiency turbine/pump and generator/motor are as per the manufacturer design of the equipment and are guaranteed by the manufacturer.**

CYCLE EFFICIENCY FOR PSPs (CONT.)

If we take the following efficiencies:

- Ewcs = 95 %
- Eturbine = 93.08 %
- Egenerator = 98.24%
- Epump = 91.68% (assumed)
- Emotor = 98% (assumed)

$$\text{Cycle efficiency} = E_{WCS} \times E_{turbine} \times E_{generator} \times E_{pump} \times E_{motor}$$
$$= 0.95 \times (93.08/100) \times (98.24/100) \times (91.68/100) \times (98/100)$$
$$= 78\%$$

Note: This does not consider Transformation Losses

CONSTRUCTION AND SCHEDULE ASPECTS OF THE PSPs

PSPs can have similar construction and schedule challenges as our faced by conventional hydropower projects.

- Environment , Forest & Land Issues.
- Geological Surprises
- Time & Cost Overrun

CONSTRUCTION COST OF THE PSPs

The construction cost of the PSPs are similar to conventional hydropower projects except that dam and reservoir cost can be significantly less due to the availability of reservoirs.

- Typical Costs are Rs 4 Cr/MW

SUITABLE SITES FOR PSPs

Central and South India's Topography offers better PSPs sites than the Himalayan region.

In some of the project sites environmental and social issues can be significantly less due to the availability of existing reservoirs.

ECONOMICS OF PSPs

PSPS relies on availability of cheap source off-peak power. However the cost of generation from PSPs projects will always be significantly higher than the conventional hydropower projects.

- Cost of Off-Peak Power
- Cycle Efficiency
- Plant Load Factor

WHO SHOULD OWN PSPs

- Distribution companies
- State Grid
- Central Grid
- Generating Companies
- IPPS

CHALLENGES

- Challenge of PPA
- Challenges of Funding
- Challenges of Economics
- Challenges of Execution
- Challenges of Time and Cost Overrun

EMERGING SCENARIO

With RE penetration, grid stability is going to be challenging

With RE and PSPs, while the availability of power may increase, the cost of power to consumer could significantly increase.

With finance of distribution companies being precarious even at present, there will be further stress on financial liquidity of the system which may result in poor utilization of PSPs resulting in further per unit cost of generation. This may make PSPs as financially unattractive although technical merits will justify the investment.

Thank You