Indian Institute of Engineering Science and Technology, Shibpur

Report on- Visit on Purulia pumped water storage hydropower plant

- NAME- Harshit Kasera
- Enrolment- 2022EEB103
- Semester- 4th

Acknowledgement

I would like to extend my sincere appreciation to Dr. Bhaskaran Barman for his invaluable contributions towards the successful organization of the educational trip to the Purulia Pumped Water Storage Plant.

Dr. Barman's expertise and guidance have been instrumental in shaping our understanding of the complexities involved in water storage and management systems. His insightful explanations and patient demeanor have truly enriched our learning experience.

I also deeply grateful to HOD mam Dr. Anindita Sengupta for her unwavering support and meticulous planning, which ensured a smooth and enriching educational journey for all participants. Her dedication to fostering educational opportunities is commendable and has left a lasting impact on our learning community.

The trip to the Purulia Pumped Water Storage Plant has been a remarkable learning experience for us, made possible by the efforts of Dr. Bhaskaran Barman and HOD Anindita Sengupta. Their commitment to academic excellence and their passion for sharing knowledge have inspired us to pursue further exploration in the field of water management.

Once again, I extend our heartfelt gratitude to Dr. Bhaskaran Barman and HOD Anindita Sengupta for their invaluable support and guidance.

Sincerely,

Harshit Kasera, 2022EEB103

PURULIA PUMPED STORAGE HYDROPOWER PLANT:

About –

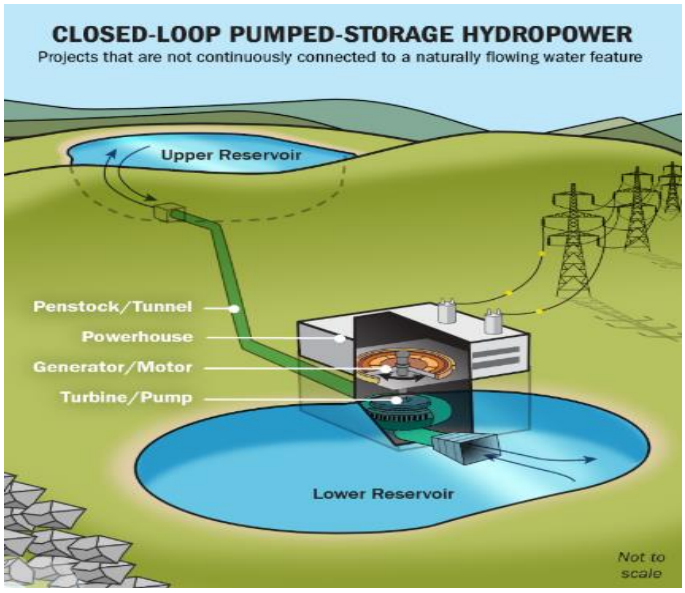
The Purulia Pumped Storage Project is a pumped storage hydroelectric power plant, located at Purulia district of West Bengal, India. The Ajodhya Hills offered suitable terrain for construction of upper and lower reservoirs. The scheme can supply a maximum power of 900-megawatt (1,200,000 hp).

The Purulia Pumped Storage Project is based on Closed-Loop Pumped Storage Hydropower.

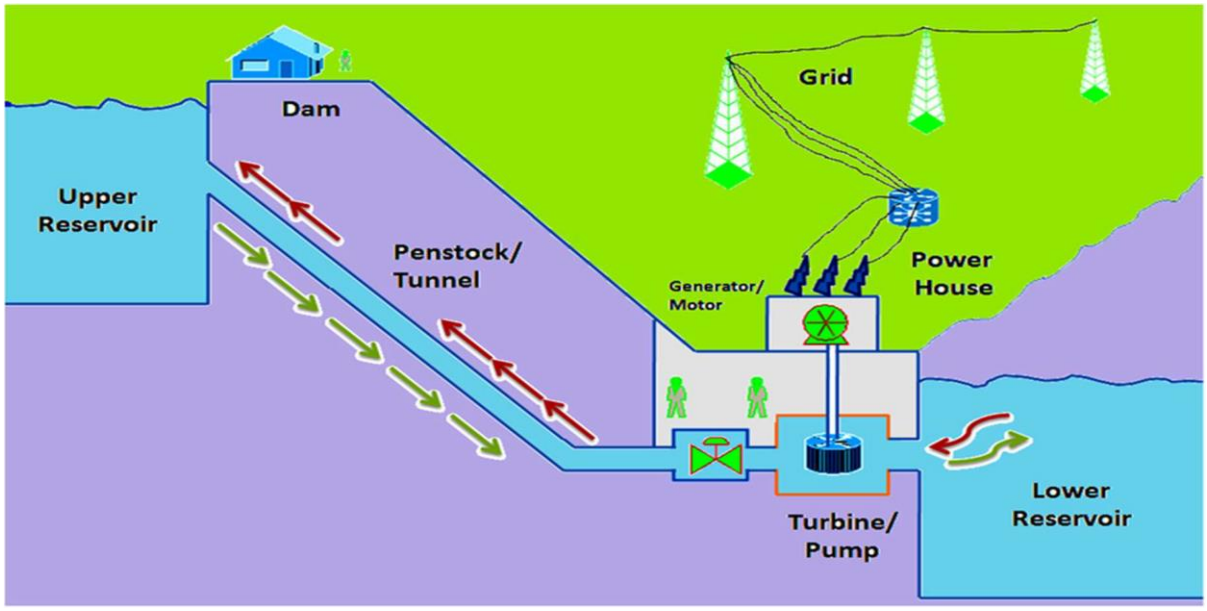
In this project, two dams are present lower dam and upper dam. The water stored in the upper dam is left open to lower dam and in between them the turbine is present and due to the kinetic energy of the water the turbines are rotated and hence electricity is generated.
Total of 4 turbines are present.

Upper dam

- Location : Ayodhya hills, in Purulia district,
  West Bengal, India
- Capacity : 4 X 225MW
- Project Cost : 2476 Crore Project
- Completion date : December 2007

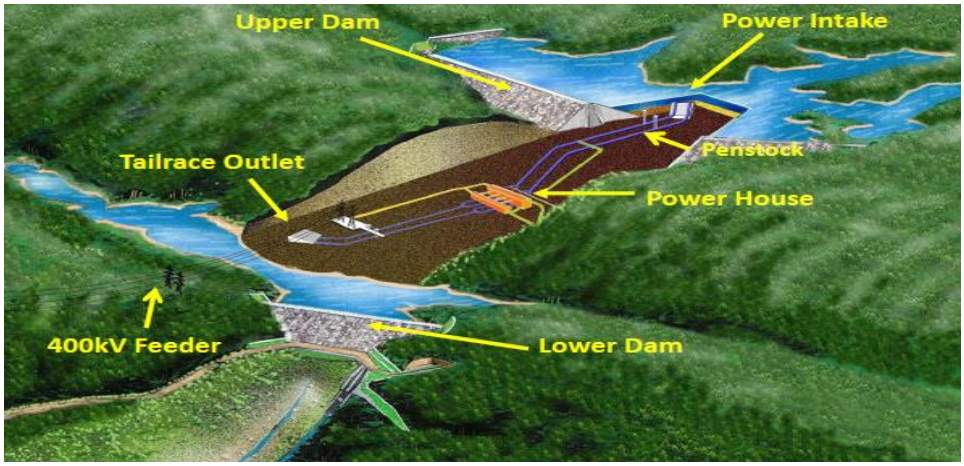


The water stored in the lower dam is again pumped up to the upper reservoir and hence this cycle is maintained.



The main structures involved in the project are two Rockfill dams (Upper and Lower Dam) with central clay core for upper and lower reservoirs with a live storage of 13 million cum each, twin water conductor, an underground power house (157 m long, 22.5 m width, 48.7 m height) to accommodate four reversible pump turbines (vertical Francis, rated head 177m, maximum power discharge : 150 cum/sec) of 225 MW each, an underground transformer (280MVA of Four nos. 16.5kv/400kv) cavern (119 m long, 17 m width, 17 m height), an access tunnel to power house and 400 KV gas insulated substation linked through a cable tunnel. Two 400 KV double circuit transmission lines connecting Durgapur Sub-station and Arambagh Sub-station with the project has been developed to transmit and receive power.

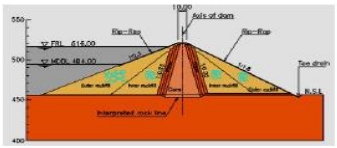
PPSP has four type operation mode; Generation, Pumping, Synchronous Condenser and Line Charging (up to 400kV Bus) mode. Generation voltage is 16.5kV.

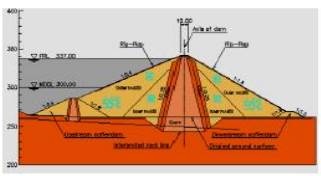


❖ Upper Reservoir

High water level	EL.516.00 m
Low water level	EL.494.00 m
Available draw down 22.0 m	
Full water capacity	16,404,924 m3
Available capacity	13,371,025 m3

(used about 6 hour by 600m3/s)





❖ Lower Reservoir

High water level	EL.337.00 m
Low water level	EL.300.00 m
Available draw down	37.0 m
Full water capacity	17,253,036 m3
Available capacity	14,475,571 m3

(used about 6 hour by 600m3/s)

PUMPED STORAGE UNIT –

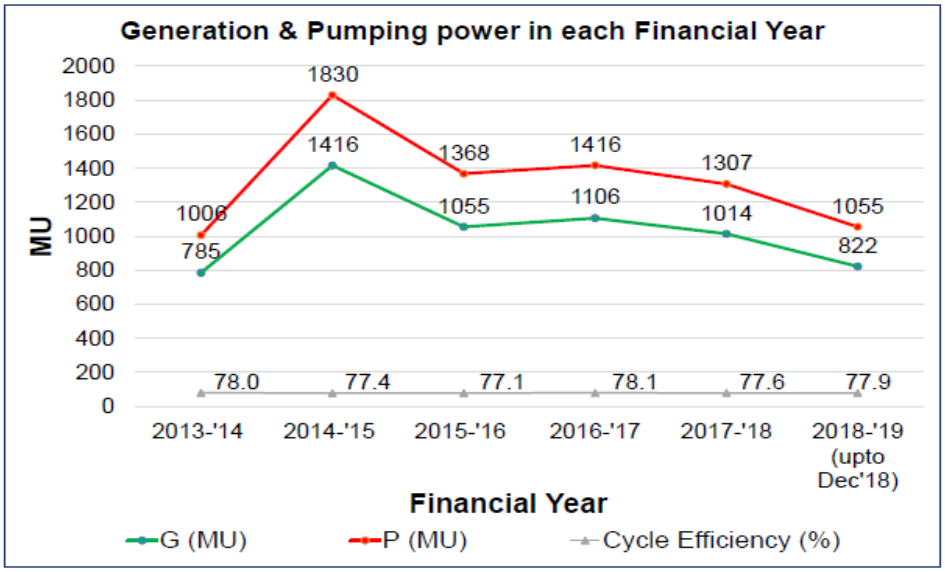
- Capacity, Upper dam + Lower dam = $23000x10^3$ cm^3
- An underground power house, measuring 157meters in length, 22.5 meters in width, and 48.7 meters in height, has been constructed to accommodate four reversible pump turbines. These turbines, featuring a vertical Francis design, are rated for a head of 177 meters and have a maximum power discharge of 150 cubic meters per second, each with a capacity of 225 megawatts.
- Access tunnels have been constructed to facilitate entry to the power house, while a cable tunnel links the underground power house to the 400-kilovolt gas.
- Generator Circuit Breaker technique is used to control the generation.
- The back-to-back starting method ensures smooth and controlled turbine activation, further enhancing overall efficiency and reliability.
- By-pass valves are provided to maintain the pressure.
- Penstocks- Route of water to turbine.

PUMPING MODE:

- The unit takes starting power (Max 11.5 MW) through Static Frequency Controller(SFC) or Back to Back (BTB) operation & the unit rotates in clockwise direction when viewed from the top of G/M.
- After synchronization with grid the Turbine operates as Pump & Generator as Motor. Motor takes active & reactive power from 400 KV grid.

- Water of the Lower Reservoir is pumped up & stored in the Upper Reservoir as Potential Energy for using it at peak demand of 400 KV grid by converting it into Electrical Energy.
- The Guide vane of the P/T is controlled to the optimum opening position of the Guide Vane by Governor System for the entire water head of the Upper reservoir (EL 516m 494 m) & the Lower Reservoir (EL 337m 300m).

Generation & Pumping Data of PPSP for last 5 years



MACHINES:

1. GENERATOR (3 Phase, 24 Pole):
    - 16,500 V
    - 8748 A
    - 0.9 Power Factor250 RPM
2. MOTOR (3 Phase, 24 pole):
    - 16,500 V
    - 9546 A(12000 A at Peak Torque)
    - 0.95 Power Factor
    - 250 RPM

3. TRANSFORMER:
    - Load tap changing transformer
    - Star-delta, Dy_{11}
    - Cooling – Oil Direct Water Forced (ODWF) cooling system.
    - Total capacity – 280MVA
    - Operating point – Primary – 16.8kV, Secondary – 400kV.

Conclusion –

The Purulia Pumped Storage Plant (PPSP) emerges not just as a symbol of engineering prowess but as a beacon of innovation and sustainability in the realm of energy generation. Nestled amidst the serene landscapes of Purulia, India, PPSP embodies the integration of advanced technologies, meticulous planning, and a commitment to environmental stewardship.

In conclusion, PPSP stands as a testament to human innovation and environmental responsibility, embodying the harmonious coexistence of technology and sustainability. As we look to the future, PPSP serves not just as a power generation facility but as a model for sustainable development, paving the way for a greener and more resilient energy landscape for generations to come.

Bibliography –

- https://india.mongabay.com/2022/01/purulia-pumped-storage-project-shows-why-pumped-hydropower-may-not-be-clean/
- https://www.power-technology.com/data-insights/power-plant-profile-purulia-psp-india/
- https://electricalvoice.com/pumped-storage-plant-principle-of-operation/
- https://en.wikipedia.org/wiki/Purulia_Pumped_Storage_Power_Station