Frequently Asked Questions (FAQs) on Hydropower

How much is the world's electricity supplied by Hydroelectric Power Plants?

± 2700 TWH is generated every year. Hydropower supplies at least 50% of electricity production in 66 countries and at least 90% in 24 countries.

What are the different types of turbines used in Hydroelectric Power Plants?

There are basically four types of power plants: -

1. **Pelton turbines** - It is impulse turbine which is normally used for more than 250 m of water head.

2. **Francis** - This is a reaction turbine which is used for head varying between 2.5m to 450m

3. **Kaplan** – It is propeller type of plant with adjustable blades which are used for heads varying between 1.5 m to 70 m

4. **Propeller** – It is used for head between 1.5 to 30 m

5. **Tubular** – This is used for low and medium height projects. Normally for head less than 15 m.

What are the major components of a Hydroelectric Power Plant?

The major components of a Hydroelectric Power Plant are:-

1. Dam/Barrage

Head works i.e. power intake, head regulator and desilting chambers etc.

2. Head race tunnels/channels
3. Surge shaft/surge chambers
4. Pressure shaft/Penstock
5. Underground and surface power house
6. Tailrace channel or tailrace tunnel.

What is the classification of Hydro Projects based on Installed Capacity?

Micro: upto 100 KW
Mini: 101KW to 2 MW
Small: 2 MW to 25 MW
Mega: Hydro projects with installed capacity >= 500 MW
Thermal Projects with installed capacity >=1500 MW

How energy is generated in Hydroelectric Power Plant?

A hydroelectric power plant consists of a high dam that is built across a large river to create a reservoir, and a station where the process of energy conversion to electricity takes place.

The first step in the generation of energy in a hydropower plant is the collection of run-off of seasonal rain and snow in lakes, streams and rivers, during the hydrological cycle. The run-off flows to dams downstream. The water falls through a dam, into the hydropower plant and turns a large wheel called a turbine. The turbine converts the energy of falling water into mechanical energy to drive the generator After this process has taken place electricity is transferred to the communities through transmission lines and the water is released back into the lakes, streams or rivers. This is entirely not harmful, because no pollutants are added to the water while it flows through the hydropower plant.

Which is the largest Hydropower station in the world?

Three Gorges project in China on Yang-Yang river is the largest power station in the world having installed capacity of around 22,500 MW.

How does cost of generation from Hydropower Plant compare with other sources of electricity?

The hydro power generation is highly capital-intensive mode of electricity generation but being renewable source of energy with no consumables involved; there is very little recurring cost and hence no high long term expenditure. It is cheaper as compared to electricity generated from coal and gas fired plants. It also reduces the financial losses due to frequency fluctuations and it is more reliable as it is inflation free due to not usage of fossil fuel.

Why hydropower is called renewable source of energy?

Hydropower is called renewable source of energy because it ***uses and not consumes*** the water for generation of electricity, and the hydropower leaves this vital resource available for other uses.

Which is the oldest Hydropower Plant in India?

The oldest Hydropower power plant is in Darjeeling District in West Bengal. It's installed capacity is 130KW and was commissioned in the year 1897.

What is the estimated total Hydropower potential of India?

The hydro power potential of India is around 1,48,701 MW and at 60% load factor, it can meet the demand of around 84,000 MW.

How much of the total Hydro power potential has been exploited so far in India?

Around 19.9% of Hydropower potential has been exploited in India.

What are the different types of dams?

Different types of dams are conventional concrete dam, Roller compacted concrete dam, rock fill dam, Concrete Faced Rock fill Dam(CFRD), Earth fill dam, arch dam, barrages etc.

Why the unit sizes of hydro generating machines are not standardized as in case of thermal power plants?

Since the size of hydro generating machines are based on availability of water in river and the water head available at a particular project site, the size of the machines keeps varying from location to location and river to river. The sizes are also based on logistics and variation of water in river during the year.

What is the record completion period of a Hydro Power Station in India of more than 100MW ?

Chamera – II HE Project (300 MW) in Distt. Chamba, HP. has been completed in a record period is Four & Half years .

Which Hydro Station has been completed recently which has the lowest tariff rate?

Teesta HE Project-V (510 MW) in the State of Sikkim was completed in April, 2008. The sale rate of this project is @Rs.1.53 / Kwh(approx.) to beneficiary states of Eastern Region as per the petition filed in Central Electricity Regulatory Commission.(For FY 2008-09).

What are the different types of Hydro Schemes?

Different types of Hydro Schemes are :

i. Purely Run - of - River Power Station.

ii. Storage type Power Station.

iii. Run – of – River Stations with Pondage.

Which is the largest Operating Hydro Power Station in the World?

The world's Largest Hydro Electric Power Station is ITAIPU with installed capacity of 12600 MW and a reliable output of 75,000 MU in a year. It is located at the Border of Brazil and Paraguay.

What are the major reasons for balancing Hydro-thermal mix?

Seasonal load curves of our regional grids match with the pattern of hydro power generation. During summer/monsoon season when the generation at hydro power plants is high, the load factor of the system is high due to heavy agricultural load. During winter, the thermal stations operating at base load and hydro stations working as peak load stations will take care of weather beating loads. Thus the operational needs of hydro & thermal stations are complimentary and the balanced mix helps in optimal utilization of the capacity.

Why Hydropower stations are preferred solution for meeting peak loads in grids?

Due to its unique capabilities of quick starting and closing, hydropower stations are found to be economical choice to meet peak load in the grid.

What are approaches to tackle sedimentation problem of reservoir?

The following are some approaches to tackle sedimentation problem of reservoir:-

- Catchment Area Treatment (CAT) for reduction of silt load includes afforestation of the catchment area and Environmental works such as construction of check dams.
- Effective desilting arrangements for prevention of silt.
- Silt resistant equipments of withstanding the silt.
- Effective operation of the reservoir to minimize silt deposition.

What are the effects of sedimentation in Hydropower stations?

The major effects of reservoir sedimentation are :

- It reduces the active storage capacity, which may reduce the capability of the reservoir to deliver the benefits in course of time.

- It makes the flood management in the reservoir more difficult.
- Damages to turbines and other under water parts due to abrasive action of silt.

What are the major thrust areas in the field of Environmental Conservation & Management for developing hydropower?

Following safeguards/management plans are implemented at various NHPC projects to ensure development of hydropower in an environmentally sustainable manner:

- Compensatory Afforestation in lieu of forest land diverted for the project.
- Catchment Area Treatment (CAT) to minimise erosion in the catchment of the reservoir, thereby reducing siltation in the reservoir.
- Resettlement & Rehabilitation of Project Affected Population.
- Rejuvenation of Dumping Sites and Quarry Sites, using engineering and biological measures.
- Reservoir Rim Treatment plan to stabilise reservoir periphery.
- Conservation measures, to conserve flora and fauna native to the ecosystem of the area.
- Subsidized Fuel Distribution to worker population and project affected population to minimise fuel demands on the adjacent forests.
- Health Management Plan for the worker population and affected population to maintain optimum health standards.
- Fishery Management by construction of fish ladders, wherever possible, to enable migration of fishes and by promoting reservoir fisheries.
- Green Belt Plan to make the surroundings of project construction areas green.
- Dam Break Analysis and Disaster Management Plan for downstream areas vulnerable to flooding in case of Dam breach.

Do Hydropower projects involve large submergence of land?

Submergence of land, thereby loss of flora and fauna and large scale displacement, due to the hydropower projects is sometimes exaggerated. The following table shows that project catering only to hydro power needs, cause little submergence. A sample of following 13 projects contributing 6351 MW of power required/ will require submergence of only 4820 ha of land i.e. the area of submergence per MW is only 0.76 ha.

Sl. No	Name of the project	State	Capacity (in MW)	Submergence area (in ha)
1	Chamera-I	H.P.	540	975
2	Chamera-II	H.P.	300	25
3	Chamera-III	H.P	231	29.90
4	Parbati-II	H.P.	800	17.07
5	Parbati-III	H.P	520	21.61
6	Tanakpur	Uttarakhand	120	140

7	Dhauliganga-I	Uttarakhand	280	29
8	Rangit	Sikkim	60	13
9	Teesta-V	Sikkim	510	67.75
10	Uri	J&K	480	NIL
11	Dul Hasti	J&K	390	21.2
12	Sewa-II	J&K	120	44.62
13	Subansiri Lower	Arunachal Pradesh	2000	3436
Total			**6351**	**4820.15 ~ 4820**

Does development of Hydropower project leads to large scale displacement?

This is not always true. The details of the affected families in some of the NHPC's commissioned Power Stations and under- construction / proposed projects are given below:

Sr. No.	Name of the project	Installed capacity (MW)	No. of families displaced	No. of families partially affected	Total number of affected families
1	Uri Power Station, J&K	480	77	169	246
2	Uri-II HE project, J&K	240	46	85	131
3	Nimoo- Bazgo H.E. Project, Leh, J&K	45	NIL	19	19
4	Chutak H. E. Project, Kargil, J&K	44	2	129	131
5	Sewa-II HE Project, J&K	120	68	155	223
6	Tanakpur Power Station, UK	120	60	218	278
7	Chamera Power Station Stage I, H.P	540	1174	380	1554
8	Chamera Power Station Stage II, H.P	300	30	63	93
9	Chamera HE Project Stage-III, H.P.	231	NIL	384	384
10	Parbati-II HEP	800	37	402	439
11	Parbati-III HEP	520	59	279	338
12	Dhauliganga Power Station, UK	280	36	545	581
13	Rangit Power Station, Sikkim	60	19	26	45
14	Teesta H.E. Project (Stage V), Sikkim	510	60	199	259
15	Subansiri Lower Project, Ar.Pradesh	2000	77	NIL	77
16	Teesta Low Dam H.E. Project Stage-III, WB	132	9	27	36
17	Teesta Low Dam Stage-IV	160	11	NIL	11

H.E. Project, WB					
	Total	**6582**	**1765**	**3080**	**4845**

From above table it can be seen that in 17 representative projects, number of displaced families per MW is only 0.26, whereas, number of affected families per MW is 0.74.

Do Hydropower projects cause huge destruction of forests?

By virtue of being located in hilly areas, where forest cover is comparatively better than plain areas, diversion of forest land is sometimes unavoidable. However, NHPC aims at minimum utilization of forests. Compensatory Afforestation is mandatory in accordance with Forest (Conservation) Act, 1980, which has to be fulfilled along with other conditions imposed by MOEF while according forest clearance to a project. Forest land diverted for a project may be a notified forest land, however, this land may include river bed and degraded forests also. The actual forest cover in such type of land may be quite low. Inspite of the fact, NHPC undertakes compensatory afforestation either on equal area of non forest land or on degraded forest land having double the area of forest land diverted.

Massive afforestation has been undertaken at the commissioned as well as ongoing projects of NHPC. In eight commissioned projects of NHPC viz. Tanakpur, Chamera-I, Chamera-II, Uri, Rangit, Dhauliganga, Dul Hasti, Teesta-V and six under construction projects viz., Parbati-II, Parbati-III, TLDP-III, TLDP-IV, Chamera-III, Sewa-II afforestation has been undertaken over an area of 4333 ha. of degraded/non forest land, in lieu of diversion of 2734.44 ha of forest land required. In these 14 projects, against 101781 affected trees, NHPC has planted more than 93 lakh trees under Compensatory Afforestation.

What is the project Cost and how it is funded?.

Total capital expenditure incurred for commissioning of a project is project cost and it is mainly funded by the equity and Loan.

What is the standard debt equity ratio for financing a hydropower project?

Standard Debt Equity Ratio is 70:30

Why, in the financing of project cost, Equity component is kept lower than Debt?

Since cost of equity is higher than cost of debt, so equity portion is kept low.

What are the main sources of Debt and Equity?

Generally main source of Debt is loan from Domestic Financial Institutions, Government of India and foreign Loan and Equity is sourced from Government of India and through IPO.

What are the objectives of Tariff Policy of Govt. dated 6.01.2006?

The objectives of the new Tariff Policy are :-

- To ensure availability of electricity to consumers at reasonable & competitive rates.
- To ensure financial viability of the sector & attract investments
- To promote transparency, consistency & predictability in regulatory approaches across jurisdictions & minimize perceptions of regulatory risks.
- Promote competition, efficiency in operations & improvement in quality of supply.

What is Availability Based Tariff (ABT)?

ABT is a mechanism for recovery of fixed charges of a generating station or transmission licensee through the commercial means of incentives or disincentives.

- It is a performance-based tariff for the supply of electricity by generators owned and controlled by the central government or those which involved in selling power in more than one state.
- It is also a new system of scheduling and despatch, which requires both generators and beneficiaries to commit to day-ahead schedules.
- It is a system of rewards and penalties seeking to enforce day ahead pre-committed schedules, though variations are permitted if notified One and on half hours in advance.
- It facilitates grid discipline.
- It helps in trading of capacity and energy and facilitates the merit order despatch.

It has three parts

- A fixed charge (FC) payable every month by each beneficiary to the generator for making capacity available for use. The FC is not the same for each beneficiary. It varies with the share of a beneficiary in a generators capacity. The FC, payable by each beneficiary, will also vary with the level of availability achieved by a generator.
- An energy charge (defined as per the prevailing operational cost norms) per kwh of energy supplied as per a pre-committed schedule of supply drawn upon a daily basis.
- A charge for unscheduled interchange (UI charge) for the supply and consumption of energy in variation from the pre-committed daily schedule. This charge varies inversely with the system frequency prevailing at the time of supply/ consumption.

What are the components of Bulk Electricity tariff of Hydro Plants?

Hydro tariff (for central generating company or the generating company which sells power to more than one state) means the Annual Fixed Charges (AFC) in respect of each Hydro Generating Station which is determined by the Central Electricity Regulatory Commission. The components of AFC are :

1. Interest on loan capital
2. Depreciation.
3. Return on equity.
4. Operation and maintenance expenses.
5. Interest on working capital.

The AFC is recovered in the form of capacity charges (50% of AFC) and energy charges (50% of AFC).

How much Return on Equity is allowed to Hydro Generating Stations?

Return on Equity is allowed on pre tax basis at the base rate of 15.5%.

$$\text{Rate of pre tax return on equity} = \frac{15.5}{(1-t)}$$

t = applicable tax rate.

What are the 'pass through' components in the tariff of Hydro Generating Stations?

Only Foreign Exchange Rate Variations (FERV) as pass through component in tariff w.e.f 01.04.2009.

What is Net Present Value (NPV)?

NPV is present value of future cash flows. NPV compares value of money today to the value of that money in the future taking inflation & returns into account. If the NPV of a project is positive then the project is financially viable. If NPV of a project is negative the project is not viable.

What is Internal Rate of Return (IRR)?

It is interest rate that makes NPV of all cash flows of a project equal to Zero. Essentially this is the return that a project would earn if it invest money in itself rather than elsewhere. This is the rate which equates discounted cash outflows flows & discounted cash inflows. Higher the IRR of the project better is the financial return on the Investment.

What are the benefits of hydropower projects?

Hydropower is a renewable, economic, non polluting and environmentally benign source of energy. It saves scarce fossil fuel resources of the country, which are non renewable. Hydropower projects have certain distinctive advantages over other sources of electricity generation, as discussed below:

a) Technical Benefits

Hydropower projects are known to have much longer life and provide cheaper electricity as there is no fuel cost and the recurring cost involved in generation, operation and maintenance is lower than that in case of other sources of energy.

b) Environmental Benefits

- Uses renewable and pollution free source i.e water
- Increase in Agriculture Productivity through development of irrigation and multipurpose schemes, having generation of electricity as one of the objectives, wherever possible and feasible.
- Avoided Green House Gas (GHG) emissions from equivalent thermal and other fuel based power projects.
- Involve large scale afforestation activities under various schemes like Compensatory Afforestation, Catchment Area Treatment, Green Belt Development, Voluntary Afforestation etc. which ultimately improve the environmental quality of the project area.
- Flood Mitigation through large storage dams.
- Source of Drinking Water

c) Social Benefits

Hydro projects are a boon to the society and the population in and around the projects. With enhanced employment opportunities, increased earnings, enriched life style and improved standard of living, the people in these localities experience an economic and social upliftment. Reservoir area is an ideal place for recreation and source of eco-tourism promotion in the area. The reservoirs are also used for promoting pisciculture. There are other direct benefits accruing from hydro projects and dams such as increased water for improved irrigation, and drinking water to villages and people living in and around the project area.