

IIT GUWAHATI

Construction Technology and Management

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DATE OF PRESENTATION: 28.04.2023.



Teesta Stage- VI Hydroelectricity Project

Status: Ongoing

Project Proposed Completion: 2024

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Hydroelectricity: The form of electrical energy harnessed from the flow of moving water. It is a sustainable and clean form of energy (clean in respect of environmental perspectives).

Hydroelectricity has become one of the most used sources of electricity.

Hydroelectricity Powerplant: The hydroelectricity powerplant refers to the entire setup established to produce hydroelectricity.



The image shows several sheets of architectural blueprints for a hydroelectric project, likely the Teesta Stage-VI HE Project. The blueprints are spread out on a light-colored surface, showing various technical drawings, dimensions, and annotations. The drawings include structural details of buildings or dams, with numerous numerical values indicating measurements in millimeters or meters. Some drawings are partially unrolled, while others are still in their original rolled-up state. The overall scene is a close-up, top-down view of the engineering plans.

INTRODUCTION:

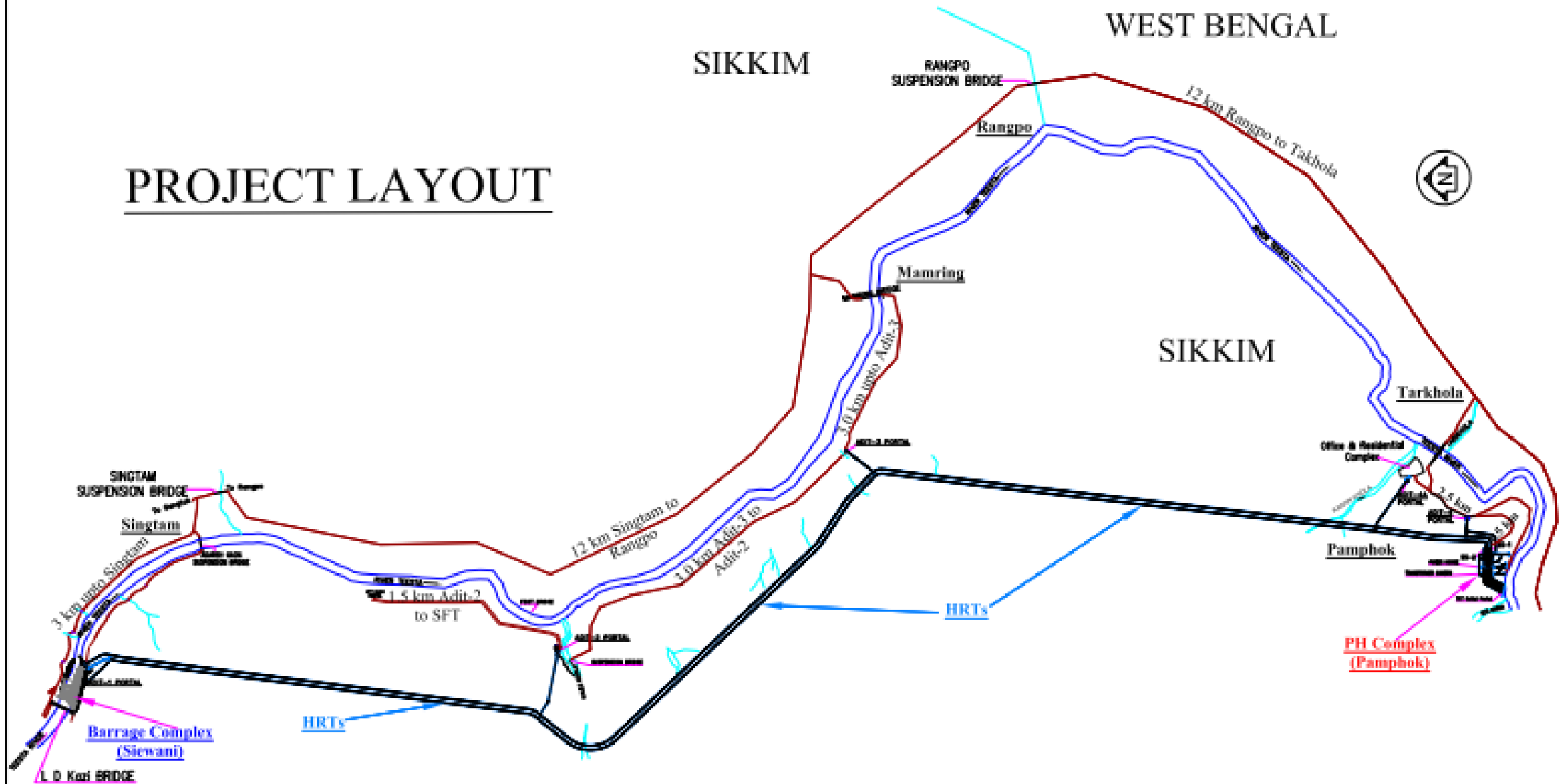
- ❖ Teesta Stage-VI HE Project is a half-completed 500 MW hydroelectric project in **Sirwani** Village of Sikkim to utilize the power potential of Teesta River Basin in a cascade manner.
- ❖ India's state-owned National Hydroelectric Power Corporation (NHPC), which already operates the 510 MW Teesta-V and currently developing the 520 MW Teesta-IV project, is the owner and developer of the project.
- ❖ The Project was earlier proposed to be developed by an SPV i.e. M/s Lanco Teesta Hydro Power Ltd (LTHPL), a subsidiary of Lanco Group, on Build, own, Operate, and Transfer (BOT) basis, but could not be developed by it due to financial crunch.

INTRODUCTION(Contd.):

- ❖ NHPC became the successful bidder and has secured all approvals to take over the project, following insolvency and bankruptcy proceedings against the debt-laden Lanco Teesta Hydro Power.
- ❖ NHPC(National Hydroelectricity Power Corporation) is a Mini Ratna Category-I PSU.
- ❖ Vast past experiences of NHPC in the field.



PROJECT LAYOUT



SALIENT FEATURES OF TEESTA VI HE PROJECT

Location

a)	Site Location	South & East Sikkim
b)	Type of Scheme	Run of the river
c)	Barrage Site	Downstream of L. D. Kazi Bridge
d)	Power House Site	Pamphok (R/B of Teesta)

Hydrology

a)	Catchment Area	4,558sq km
b)	Standard Project Flood (SPF)	11,600 Cumecs

Reservoir

a)	Full Reservoir Level (FRL)	El 360 M
b)	Minimum Draw Down Level	El 354 M
c)	Live Storage	1.83 Mcum

Barrage Complex

a)	Type & Top Elevation	Concrete, El 369 M
b)	Length at Top	105 m
c)	Height from River Bed	26.5 m
d)	No. & Size of Bays	5 Nos., 15 m (W) x 17.5 m (H)
e)	Min. Environmental Flow	8.252 cumecs

De-silting Basins

a)	Type & No. of Basins	Dufour, 2 Nos.
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Head Race Tunnels

a)	No., Shape & Size	2, Modified Horseshoe, 9.8 m dia
b)	Length	13.76 km each (Approx.)
c)	Design Discharge	531 cumecs (Cumulative)
d)	Adits	Five Nos.

Power House

a)	Type	Underground
b)	Type of Turbine	Francis (Vertical Axis)
c)	Installed Capacity	500 MW (4 x 125 MW)
d)	Size of PH Cavern	142.75m (L) x 18.5m (W) x 52.44m (H)
e)	Size of Transformer-cum- GIS Cavern	128 m (L) x 14.5 m (W) x 21 m (H)
f)	Rated Head	105.4 m
g)	Type of Switchgear	GIS (Indoor)
h)	Annual Energy Generation	2400 MU

Tail Race Tunnels

a)	No., Shape & Size	4, D-shaped, 8.5 m (W) x 7.5 m (H)
b)	Average Length	247 m (Approx.)

Financial Aspects

a)	Project Cost	₹ 5748.04 Crores (At July 2018 PL)
b)	1 st Year Tariff	₹ 4.59 / kwh
c)	Levellised Tariff	₹ 4.07 / kwh

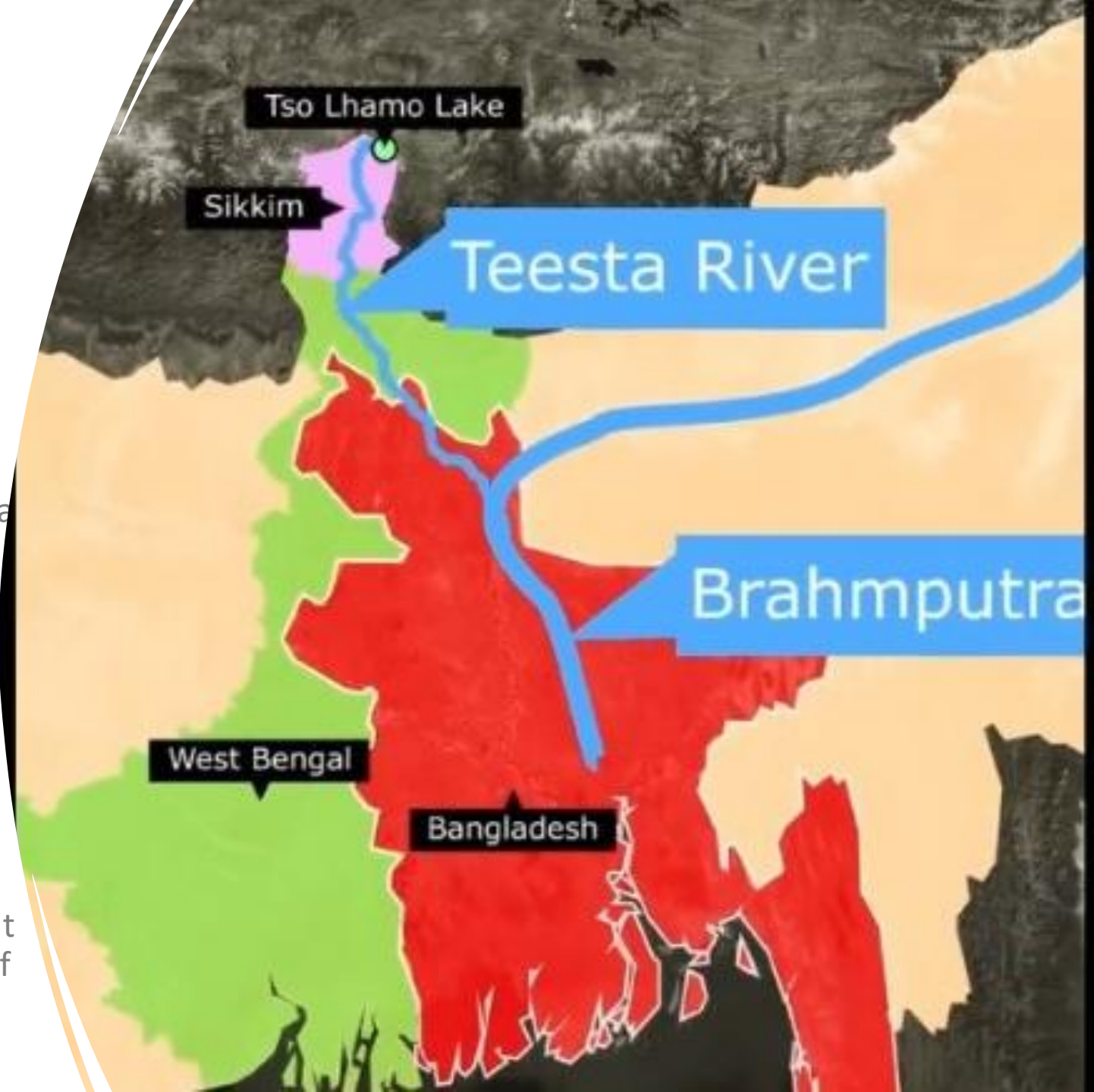
Evacuation System

a)	Transmission Line	About 12 km from PH to Rangpo Pooling Station
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Importance of TEESTA River

There are a total of 54 transboundary rivers,

- The Teesta River is a tributary of the Brahmaputra River and flows through Bangladesh. However,
- there is an ongoing conflict between India and Bangladesh over water sharing in the Brahmaputra River.
- China and Bangladesh are currently negotiating over the river, particularly for dredging purposes.
- The presence of China in northern Bangladesh is seen as a security challenge because it is close to India's "chicken neck" - a narrow strip of land that connects India's northeastern states to the rest of the country



Mapping The River Flows of Bangladesh's Teesta & India's Brahmaputra River



Teesta River



Brahmaputra River



Water (River) Flow from
Bangladesh's Teesta River



Water (River) Flow from India's
Brahmaputra River

Salient Features of The Project

1. Location: On River Teesta near Subin Khore Village, Southern Sikkim, State - Sikkim

2. Design Energy: The project would generate 2,400 million units of electricity

3. Power Capacity: 500 MW (4x125MW)

4.. Date of Commercial Operation (COD): 5 years from the date of sanction by Govt. of India i.e., March 2024



Technical Features

- **Barrage dam:** 26.5m high,
- 5 Nos. **Radial Gates**, 15m (W) x 17.5m (H)
- **Head race tunnel:** 2 nos. D-Shape 8 m diameter Length 71 m & 92.6m Horseshoe-Shape 9.8 m diameter Length 13.75 km & 13.63km
- **Surge Shaft:** 2 no, 16m diameter
- **Pressure Shafts:** 4 nos. Pressure Shafts, 5.4m diameter. (Steel lined), length varying from 151m to 198m
- **Powerhouse:** Underground, 142.75m (L) x 18.5m (W) x 52.44m (H), 4 units of 125 MW each
- **Type of Turbine :** Francis, Vertical Axis
- **TRT:** 4 nos. D-Shape 8.5m(W) x 7.5m(H), Length 270m

Contract Details

- The project was allotted by the Govt. of Sikkim to **M/s Lanco Energy Pvt. Ltd. (LANCO)** for its development on 08.04.2005.
- An agreement was signed between Power Department Government of Sikkim and M/s Lanco Energy Pvt. Ltd. on 07.12.2005 for implementation/execution of Teesta-VI HEP
- Project type was on **build, own, operate and transfer (BOOT)** basis with 26 % equity participation by Government of Sikkim
- Detailed Project Report of the project was concurred by CEA on 27.12.2006 for execution by M/s Lanco Energy Pvt. Ltd. with completion cost of Rs. 3283.08 Crores including IDC & FC of Rs.415.73 Crores.
- The construction works of the project was taken up by M/s Lanco Teesta Hydro Power Pvt. Ltd. and was stalled since April, 2014 due to **financial crunch**
- Insolvency Resolution Process (CIRP) was initiated vide order dated 16.03.2018 of Hon'ble NCLT, Hyderabad Bench
- **NHPC** emerged as successful bidder for acquisition of LTHPL.
- the investment proposal for an estimated cost of Rs 5748.04 crores (Jul'18 PL), which includes Bid amount of Rs. 907 crores for acquisition of LTHPL;
- estimated cost of balance work of Rs. 3863.95 crores and IDC & FC of Rs. 977.09 crores with completion period of 60 months was approved by the CCEA on 08.03.2019 for investment, acquisition of M/s LTHPL and execution of balance works of Teesta-VI HE Project by NHPC.
- The consideration amount of Rs. 897.50 Crore was released by NHPC on 09.10.2019 and the Company was taken over along with all assets and documents as a 'Going concern' completed w.e.f. 09.10.2019. NHPC informed CEA on 08.01.2020 that acquisition of Lanco Teesta Hydro Power Ltd. (LTHPL) has been completed.

Description of Contract	Brief details of Contract	Name of the agency to whom contract Awarded	Value of Contract (Rs. In Crores)	Date of Contract	Contracted Completion Period
Civil Works					
Lot-I(Civil works(Construction of Balance Civil Works of Barrage, Desilting Basins, SFT, Intake Structure, Part of HRT-I & HRT-II upto 6100 mtr from Barrage and other associated Structures etc	M/s Jaiprakash Associates Ltd	1710.00	31.03.2020	52 months 8 days
Lot-II	Balance Civil works of part HRT-I & HRT-II beyond 6100 mtr , Surge Shaft, Pressure Shaft, Power House, TRT)	M/s Patel Engg Ltd	1251.00	22.09.2021	42 months
Hydromechanical Works					
H.M Works	Design, Manufacturing, Supply, Erection and commissioning Entire HM works	M/s PES Engineers Pvt Ltd	110.76(INR)+1757600.13 EURO	27.10.2020	50 months
Electromechanical Works					
EM-I	Design, Manufacturing, Supply, Erection and commissioning Turbine Generator, MIV, cabling etc.	M/s GE Power	107.49	14.12.2020	42 months
EM-II	Design, Manufacturing, Supply, Erection and commissioning Transformers, GIS, XLPE cables etc.	M/s BHEL	150.10	04.09.2020	47 months

Description of Contract	Brief details of Contract	Name of the agency to whom contract Awarded	Value of Contract (Rs. In Crores)	Date of Contract	Contracted Completion Period
EM-III	Design, Manufacturing, Supply, Erection and commissioning of Fire fighting	M/s Technico India Pvt. Ltd	3.98	22.09.2020	36 months
EM-IV	Design, Manufacturing, Supply, Erection and commissioning DG system	M/s Jakson Ltd, Noida	3.07	01.10.2020	24 months
EM-V	Supply, Erection and commissioning HVAC system	M/s SHES AIR Automation	5.63	06.08.2021	39 months
EM-VI	Design, Manufacturing, Supply, Erection and commissioning Illumination system	M/s Avids Technovators Pvt Ltd	3.80	16.04.2021	39 months
EM-VII	Transmission work	M/s PGCIL	55.57	Deposit work basis signed on 21.12.2020	32 months form the date of signing of Project Specific Agreement
EM-VIII	Design, Manufacturing, Supply, Erection and commissioning Drainage & dewatering & compressed air system	M/s B C Technomation Pvt Ltd	6.23	28.08.2020.	36 months
Other Packages					
	Refurbishment work of 2 Nos. 200/30/10 Ton Electric Overhead Travelling (EOT) Crane of Power House	M/s Cranex	5.78	16.10.2020	10 months

TIMELINE

- The intended start date for the Teesta Barrage Project was 1960–1961, according to the Project Proforma (PP).
- A committee was established in 1974 to investigate Sikkim's hydropower potential.
- The barrage's construction began in 1979 and finished in 1992. The Teesta Barrage Project's Phase-I, situated 20 km south of the Indian border, was completed in 1998.
- Due to insufficient water flow during the non-monsoon season, the project must finish after Phase II, which started in 2005.
- The West Bengal government designed the Teesta Barrage Project at Gajaldoba in 1975–1976 to produce electricity, supply drinking water to Shiliguri town, and construct new irrigable land in six northern West Bengal districts.





TIMELINE(CONTD.)

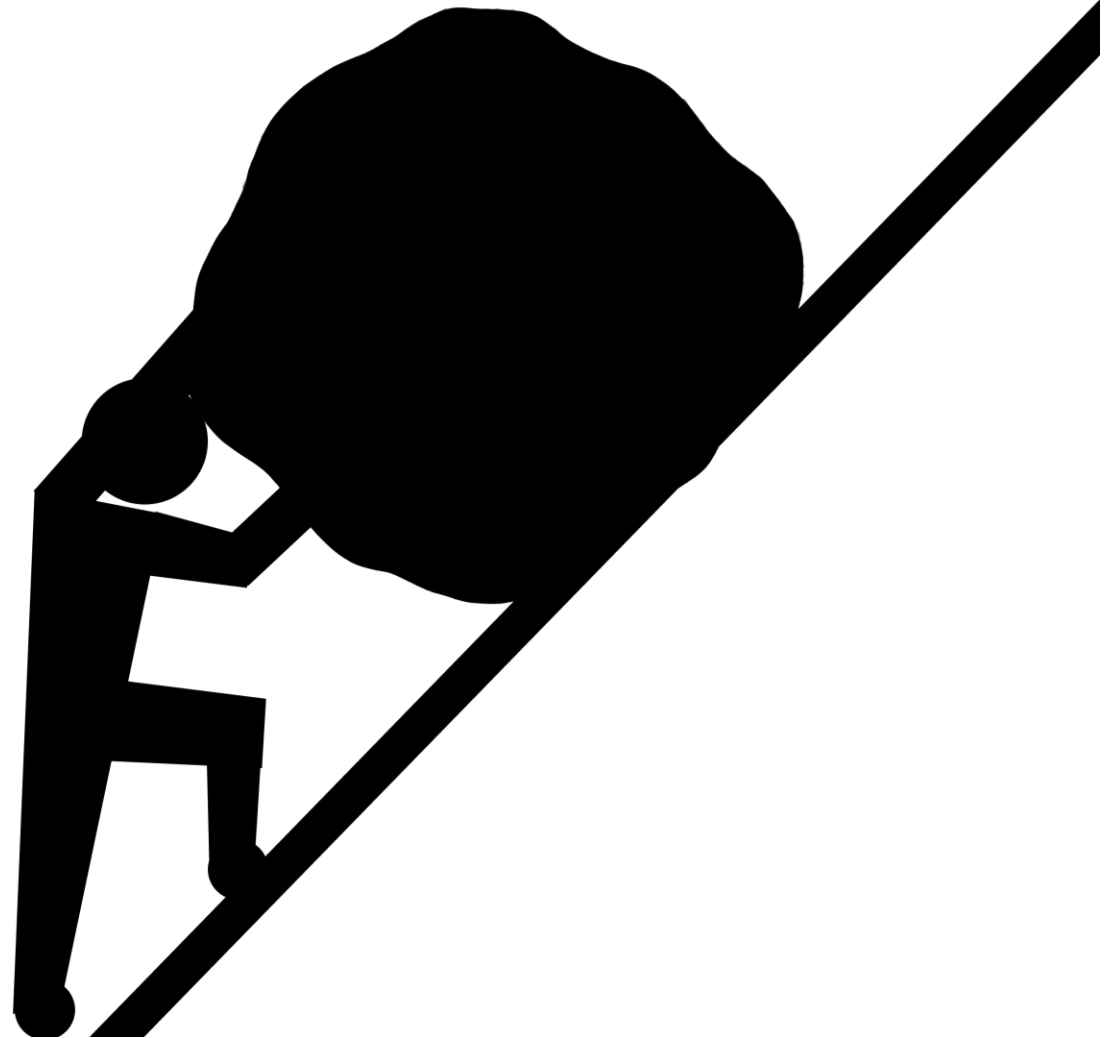
- The funding ratio for the Teesta Barrage Project ranged from 1:1 to 1:3 under India's Accelerated Irrigation Benefit Program (AIBP). (Central: State).
- The first phase was supposed to be finished by March 2015. However, work is still under process. Bangladesh and India inked an ad hoc agreement in 1983.
- India and Bangladesh are supposed to share 39% and 36% of the water, respectively, under that arrangement. The environment received the remaining 25% of the water.
- The 1983 ad hoc arrangement was extended until 1987, but the governments of Bangladesh and India signed no treaty regarding the sharing of Teesta River water.
- The Central Electricity Authority of India issued a preliminary feasibility report on 162 new hydropower projects in 2004.



TIMELINE(CONTD.)

- Fifteen hydropower development projects are now in various phases of construction. All of these projects will be finished by 2022
- The Teesta III hydropower project's original contracted duration of 46 months, from its inception to the completion of its final unit, had to be amended due to a significant earthquake that struck the project site in September 2011.
- For 23 months, major shipment transit was hampered by the bridge's breakdown. It has accomplished the crucial duty of lowering the rotor into each of the first three units.
- A diversified group of European and Indian supervisors is in charge of the three other units' erection work, which is also going on.
- In January 2015, the first unit was anticipated to be put into service. The full facility will then be put into service in June 2015

Challenges Faced in the Project





[pngtree.com](https://www.pngtree.com)

•1. Financial Crunch: -

- The construction works of the project were taken up by M/s Lanco Teesta Hydro Power Pvt. Ltd. (SPV of Lanco group for the execution of Teesta-VI HEP) and was stalled since April 2014 due to a financial crunch.
- The project was started by LTHPL in March 2007. However, the construction of the Project stuck up since 2012 and after approval of the Resolution Plan by the Hon'ble National Company Law Tribunal, NHPC Ltd. has acquired the LTHPL w.e.f. 09.10.2019.



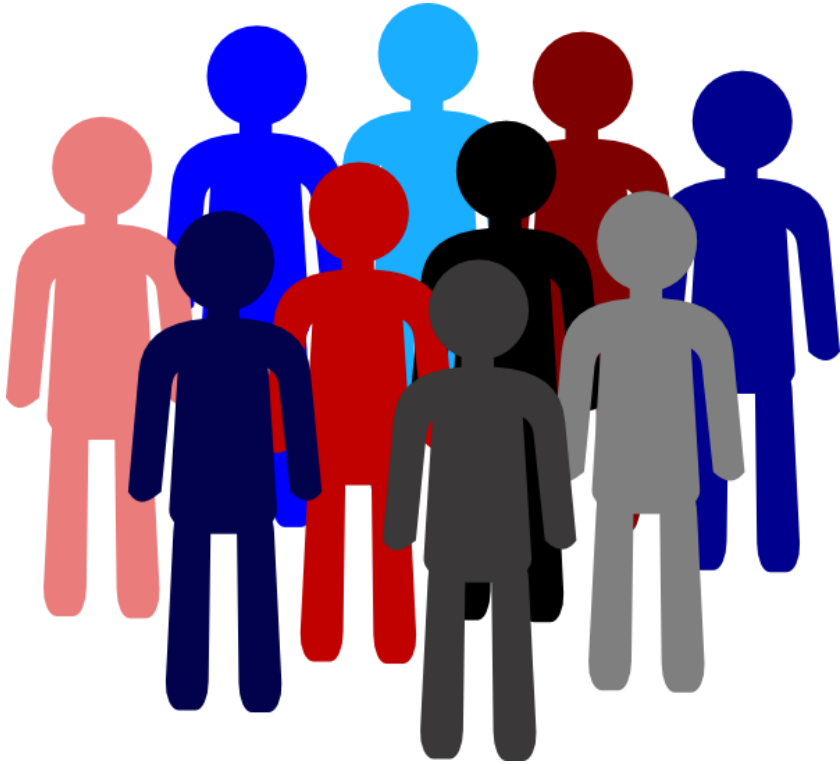
•2. Covid-19: -

- The signs of progress of work had been hampered on account of 1st & the 2nd wave of Covid-19 and have been subjected to a series of lockdowns and restrictions imposed by the Central/ State Govt.
- However, LTHPL is making efforts to balance work to the extent possible. As discussed with the project authorities, adverse geological conditions affect the progress of the works of HRT.
- The presence of a pedestal of an Electrical tower in Face 4B of Adit III & seepage 7 from Kalez Khola nallah are some hindrances that are delaying the completion of the HRT.



•Fishery: -

- Consultancy work for fish farm/hatchery for the propagation of migratory fish species was awarded to Directorate of Coldwater Fisheries Research (DCFR, Bhimtal (Formerly National Research Centre on Cold Water Fisheries (NRCCWF). Scientists from DCFR, Bhimtal visited the area and identified the site for the development of a Fish Farm. Rs. 50 lakhs deposited to State Forest Department for Fish Management under Biodiversity Management Plan.



• **Effect on population: -**

- Teesta-VI HEP is in an area of low population density. A population of about 400 to 500 belonging to 111 families has been affected due to the acquisition of some portion of land.

- The caste details of PAFs as per EIA, are as under

- (a) Scheduled Tribes (STs) 41,
- (b) Scheduled Castes (SCs) 6,
- (c) Most Backward Classes (MBCs) 8,
- (d) Other Backward Classes (OBCs) 55,
- (e) Others 1.

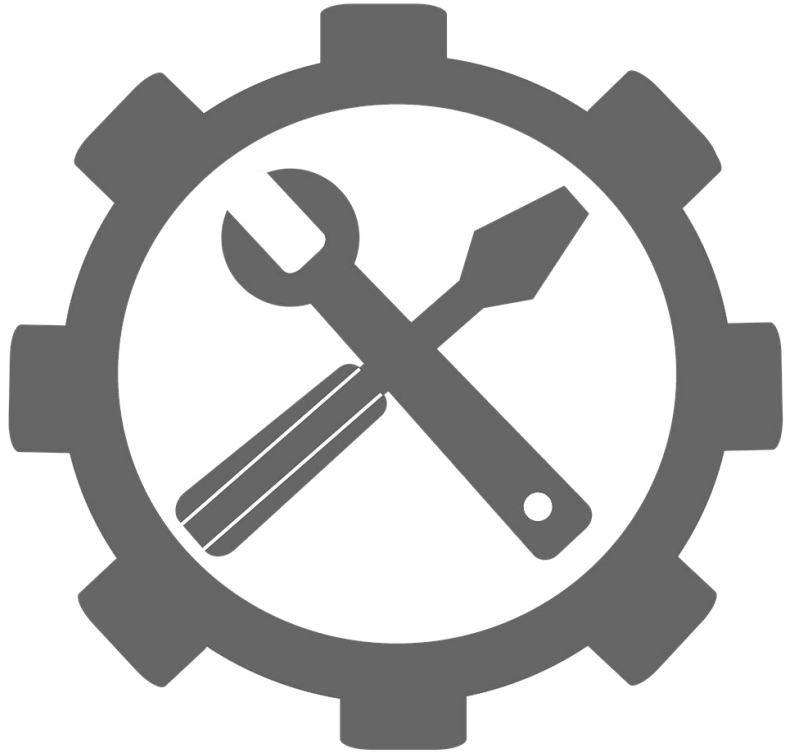
Only part of their private land has come under acquisition, no family has become landless. No structure is involved in the land acquisition hence no Rehabilitation & Resettlement plan was proposed. No archaeological, cultural, or historic resources on site, or within the area will be adversely affected by the construction.



•Landside prone:

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- Landside-prone and slide-prone areas, tunneling is being carried out with properly controlled blasting or by mechanical means and by providing an adequate support system.



• **Technical Challenges: -**

- The Teesta VI hydropower project is in a high-altitude area with challenging terrain. Constructing the project required overcoming technical challenges like tunneling through rock, building access roads, and transporting equipment to the site.



•Political Issues: -

- The project faced political issues, with some local politicians opposing it due to concerns about displacement and environmental impact. This led to delays and legal challenges.

Other Hydroelectricity Projects on Teesta River:

- **Teesta Low Dam I and II (Combined) (Upcoming):**

Location: West Bengal Installed **Capacity:** 81 MW **Latest**

Remark: MoU/IA signed with NHPC in July 2015

- **Teesta Low Dam III (Existing):**

Location: West Bengal Installed **Capacity:** 132 MW **Latest**

Remark: In operation. Commissioned in March 2013 completed by NHPC

- **Teesta Low Dam IV (Existing):**

Location: West Bengal Installed **Capacity:** 160 MW **Latest**

Remark: In operation. Commissioned in August 2016 completed by NHPC

Other Hydroelectricity Projects on Teesta River:

- **Teesta Low Dam V (Upcoming):**
- **Location:** West Bengal **Installed Capacity:** 80 MW **Latest Remark:** MoU/IA signed with NHPC in July 2015
- **Teesta Intermediate Stage (Upcoming):**
- **Location:** West Bengal **Installed Capacity:** 84 MW **Latest Remark:** MoU/IA signed with NHPC in July 2015
- **Teesta Stage I (Upcoming):**
- **Location:** North Sikkim **Installed Capacity:** 280 MW **Latest Remark:** MoU/IA cancelled as this area fell within the vicinity of Kanchanjonga National Park 14

Other Hydroelectricity Projects on Teesta River:

- **Teesta Stage II (Upcoming):**

Location: North Sikkim Installed **Capacity:** 330 MW **Latest**

Remark: MoU/IA terminated in September 2018 due to non-performance of Him Urja Infra Pvt. Ltd

- **Teesta Stage III (Ongoing):**

Location: North Sikkim Installed **Capacity:** 1200 MW **Latest**

Remark: Project under construction by Teesta Urja Limited. As per MoU, the date of commissioning was December 2013 and the project declared Commercial Operation Date in February 2017

Other Hydroelectricity Projects on Teesta River:

- **Teesta Stage IV (Ongoing):**
- **Location:** North Sikkim **Installed Capacity:** 520 MW **Latest Remark:** Project under construction by NHPC. Only preliminary construction works started. First-stage environment clearance is obtained.
- **Teesta Stage V (Existing):**
- **Location:** East Sikkim **Installed Capacity:** 510 MW **Latest Remark:** In operation. Commissioned in March 2008 and completed by NHPC

Tour Report of the site visit of Teesta Stage - VI HE Project (500 MW), Sikkim being executed by M/s NHPC Ltd.

As per Teesta Basin Study report, cascade development of six hydro schemes were identified by CWC on Teesta river for power generation in Sikkim. Summary of these hydro schemes are as under:

Sl. No.	Name of the Project	Installed Capacity (MW)	Present Status
1	Teesta Stage-I	320	Not feasible.
2	Teesta Stage-II	480	Not feasible.
3	Teesta Stage-III	1200	In operation
4	Teesta Stage-IV	520	Concurred by CEA and yet to be taken up for construction.
5	Teesta Stage-V	510	In operation
6	Teesta Stage-VI	500	Under Construction

The upstream project is Teesta Stage- V HEP while no project is in downstream of Teesta Stage – VI HEP in Sikkim. The Teesta Stage – VI HEP (500 MW) is presently under construction by NHPC Ltd. and likely/ anticipated commissioning is 2023-24 (Mar' 2024).

COMPONENTS OF PROJECT

- Barrage: 26.5 m height from Riverbed, 105 m long, 5 Nos. Radial Gates, site located Downstream of L.D. Kazi Bridge on Teesta River at Sirwani.
- Head Race Tunnels: 2 nos. Modified Horseshoe-Shape, 13.76 km each (approx.), 9.8 m diameter (finished)
- Surge Shaft: 2 nos., Restricted Orifice type, 16 m dia. 89.3 m high
- Pressure Shaft: 4 nos., 151 m for 5.4 m dia. & 30.5 m for 4.5 m dia
- Penstocks: 4 nos. 4.5 m dia., 30.5 m each, circular shaped
- Powerhouse: Underground, 142.75m (L) x 18.5m (W) x 52.44m (H), 4 units of 125 MW each.
- Tail Race Tunnels: 4 nos., D-Shaped, 8.5m(W) x 7.5m(H), Average Length 247 m (approx.)

PERCENTAGE COMPLETION OF EACH COMPONENT

Project Component	% Completion
Barrage	70%
Desilting Structure (Including Desilting Inlet and Chambers)	26%
Head Race Tunnel (Heading Excavation)	39%
Surge Shaft	70%
Pressure Shaft	70%
Power House (Civil Works)	78%
E&M Works	50%
HM Works	53%
Total Project Completion	51%

COMMISSIONING OF THE PROJECT



The anticipated commissioning of the project is 2023-24 (March 2024).



However, it has been observed that civil works awarded under Lot I & Lot II are scheduled to be completed by 2024-25. Therefore, it is felt that in most scenarios, the project would be commissioned by 2024-25.

SITE PHOTOGRAPHS



MAIN ACCESS TUNNEL



VENTILATION TUNNEL



EOT CRANE



REINFORCEMENT WORKS AROUND STAY RING



TRANSFORMER CAVERN



POWERHOUSE CAVERN



SURGE SHAFT



PRESSURE SHAFT

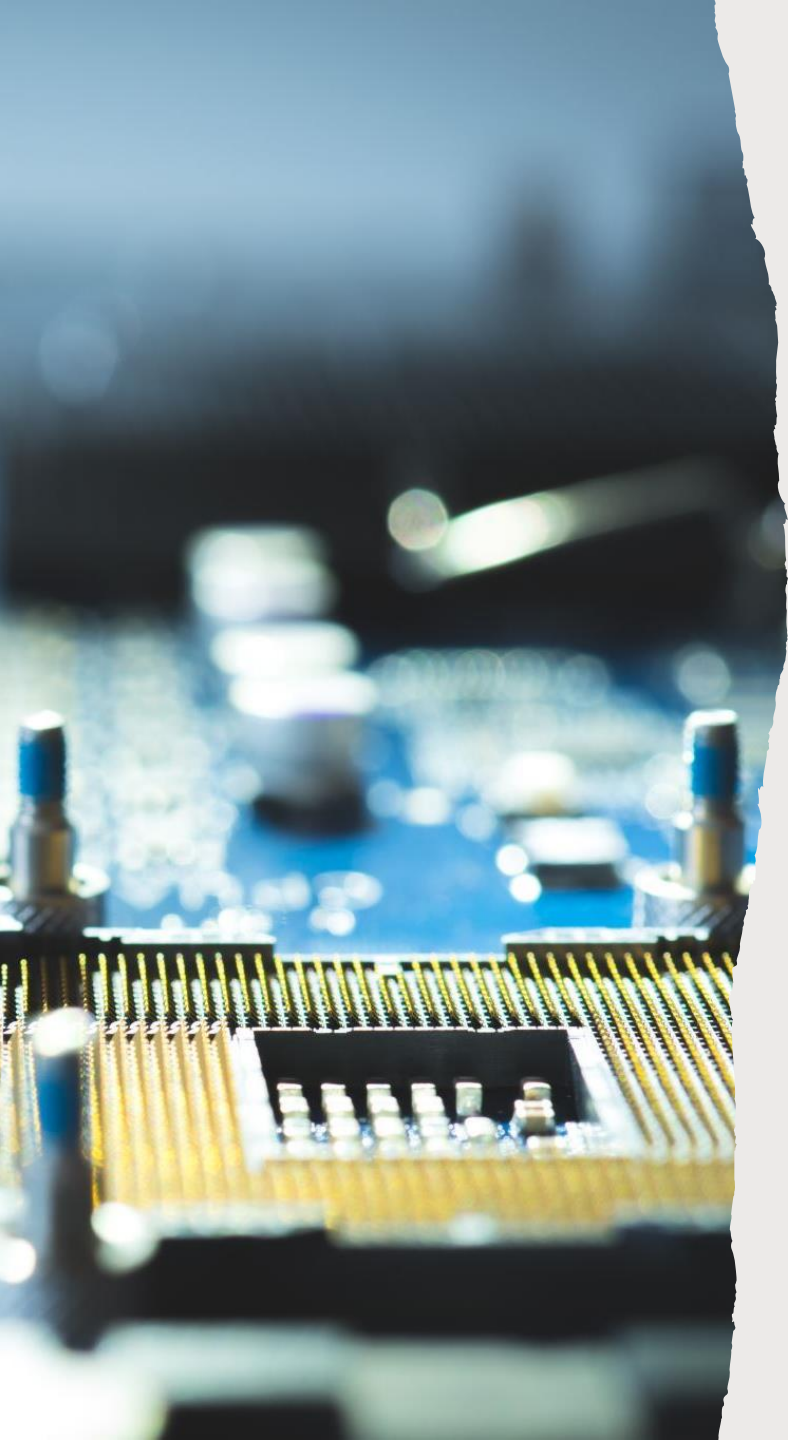
BARRAGE SITE



BAYS AND COFFER DYKE



DESILTING BASIN AND CUTOFF WALL



IMPLEMENTATION OF ICT AND AUTOMATION

- **SCADA (Supervisory Control and Data Acquisition) System:** The SCADA system is used to monitor and control the power generation process in the Teesta VI Project. The system provides real-time information about the plant's operating conditions, including water flow, generator voltage, and current. This information is used to optimize the performance of the plant and ensure its safe and efficient operation.
- **Remote Monitoring:** The Teesta VI Project uses remote monitoring to keep track of the power plant's performance from a remote location. This is done using sensors and cameras that are placed at different points of the plant. With the help of remote monitoring, the plant's operators can detect potential problems, take corrective actions, and prevent major breakdowns.



IMPLEMENTATION OF ICT AND AUTOMATION

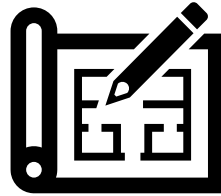
- **Automated Control Systems:** The Teesta VI Project uses automated control systems to optimize the operation of the plant. For example, automated control systems are used to adjust the water flow to the turbines based on the power demand, temperature, and other factors. This ensures that the plant operates at maximum efficiency and minimizes the risk of equipment failure.
- **Data Analytics:** The Teesta VI Project uses data analytics to analyze the data generated by the plant's sensors and control systems. This data is used to identify trends, detect anomalies, and optimize the performance of the plant. For example, data analytics can be used to predict the maintenance needs of the plant's equipment and schedule maintenance activities.

SCOPE OF IMPROVEMENT:

- Versatile use of Automation and ICT.



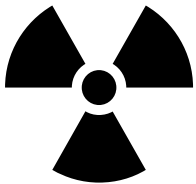
- Developing a comprehensive project plan.



- Monitoring And Updating.



- Management of project risks.



- Foster effective communication.



- Sustainability in the approach



CONCLUSIONS:



Exposure to on field project operation and management.



Hydroelectricity a sustainable form of energy.



Information about contract, technicalities and challenges.



In last, got opportunity to put in ideas.



References

1. Official concerned website of NHPC:
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2. Official website of Central Electricity Authority Government of India
 - <https://cea.nic.in/>
3. Wikipedia <https://en.wikipedia.org>
4. Teesta Stage III - Challenging generator transportation in India
5. <https://www.nsenergybusiness.com/projects/teesta-vi-hydropower-project-sikkim/>

THE END OF THE PRESENTATION IS REACHED.

THANK YOU!!

