

Financing Options, Managing Cost & Tariff to make R&M Commercially Viable

**BCK Mishra,
Director (Operations),
UJVN Limited, Dehardun
Uttarakhand**

Agenda

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About Uttarakhand

- Uttarakhand, a hilly state, came into existence on 9th of November 2000.
- Uttarakhand has a large network of rivers, rivulets, and canals which make it rich in water resources and provide immense scope for development of hydropower.
- One of the first few hydro-power stations in India was commissioned at Galogi (Mussoorie) in 1907 in Uttarakhand.
- More power stations were subsequently developed in Uttarakhand in **sixties and seventies** in state sector.

About UJVNL

- UJVNL Limited was formed on 9th of November 2001 to operate and maintain existing hydropower stations and further projects in state sector.
- **As on date, UJVNL operates hydropower plants ranging in capacity from 2.25 MW to 304 MW, totalling up to 1284.85 MW.**
- At the time of formation of the state UJVNL was able to meet demand of the state.
- As on date the state is having power deficit as many new hydropower projects could not come up to meet the power requirement due to various reasons.

Background

- A National Committee was constituted by GOI in 1987 to identify the hydropower plants in the country needing R&M.
- Committee formulated a national strategy on renovation and modernization of hydropower plants which became an integral part of the National Policy.
- Based on the recommendations of the National Committee and subsequent reviews, 55 nos. of hydroelectric schemes with an aggregate capacity of 9,653 MW were identified for RMU work.

Background

- Out of these 55 schemes, RM&U work on 31 hydropower schemes with an aggregate installed capacity of 5,642.70 MW (Phase-I) and 591.4 MW (Phase-II) were completed during 8th and 9th plan.
- Government of India in its policy on Hydro Power Development, declared in 1998, laid stress on the need for renovation and modernization of hydro power plants in the country and accorded priority to the R&M programme.

Background

- Standing Committee comprising members from CEA, NHPC, PFC, BBMB, KPCL, KSEB, UPJVNL, TNEB & BHEL was constituted by Ministry of Power to identify new Hydro RM&U schemes for execution under Phase II.
- Standing Committee recommended 67 RMU schemes involving 214 generating units at 59 Hydro Power Stations with aggregate installed capacity of 10,318 MW for implementation of RMU work under Phase II programme.
- With the implementation of this programme, it was expected that a benefit of 3,684.91 MW shall accrue through uprating and life extension and total annual generation of 11,335 MU through RMU and life extension.

Initiatives by UJVNL for RMU of Old Hydropower Stations

UJVNL recognized that

- Most of its power stations have already outlived their normal useful life.
- Inefficient / old design / obsolete turbines and generators.
- Old and obsolete governors.
- Old and obsolete excitation system.
- Defunct automation system, takes more time to start / stop the units.
- Most of the controls are under manual operation.

Initiatives by UJVNL for RMU of Old Hydropower Stations

- Erratic functioning of Hydro Mechanical equipment;
- Erratic functioning of switchyard equipment;
- Old, damaged and non-functional control & protection equipment;
- Excessive wear/ tear/ erosion / damages of under water parts had taken place;
- Non-availability of spare parts of outdated systems and equipment;
- Deterioration/damages are leading to inefficient operation of the power plants.

Initiatives by UJVNL

- Capacity and generation enhancement through RMU of old power stations is an effective, environment friendly and riskless proposition;
- Economy in cost and time in RMU shall essentially result from utilization of the existing infrastructure, selective replacement of critical components;
- RMU will lead to increase in efficiency, peak power and energy availability apart from giving a new lease of life to the power plant/ equipment;
- The reliability of a power plant shall improve by use of modern equipment;
- UJVNL started planning for RMU.

Projects under RMU

Sl. No.	Name of Hydro Power Station	Commissioning Year	River	Installed Capacity (MW)	Type of Runner	Number of Unit
1.	Chibro	1975	Tons	240	Francis	4
2.	Khodri	1984	Tons	120	Francis	4
3.	Dhakrani	1965	Yamuna	33.75	Kaplan	3
4.	Dhalipur	1965	Yamuna	51	Kaplan	3
5.	Kulhal	1975	Yamuna	30	Kaplan	3
6.	Tiloth	1984	Bhagirithi	90	Francis	3
7.	Chilla	1980	Ganga	144	Kaplan	4
8.	Ramganga	1975	Ramganga	198	Francis	3
9.	Khatima	1955	Sharda	41.4	Kaplan	3
10.	Pathri	1955	Ganga	20.4	Kaplan	3
11.	Mohammapur	1952	Ganga	9.3	Kaplan	3

Enhancement in Generation (in MU)

S. No.	Name of Project	Capacity (MW)	Present Generation	Generation after RMU	Enhancement (MU)	Completion Schedule
1	Galogi	3.00	3	8	5	2013-14 (Completed) One more unit is under installation
2	Pathri	20.40	90	155	65	2013-14 (Completed)
3	Mohd.pur	9.30	40	65	25	2013-14 (Completed)
4	Khatima	41.40	149	235	86	2016-17 (Completed)
5	Tiloth	90.00	446	484	38	2020-21
6	Ramganga	198.00	283	450	167	2020-21
7	Kulhal	30.00	145	183	38	2020-21
8	Dhakrani	33.75	161	184	23	2020-21
9	Dhalipur	51.00	240	276	36	2020-21
10	Chilla	144.00	805	1029	224	2020-21
11	Khodri	120.00	406	444	38	2023-24
12	Chibro	240.00	865	942	77	2023-24
	Total	980.85	3633	4455	822	

Anticipated enhancement in generation: 22.6%

Expected Expenditure on RMU

S. No.	Power Station	Capacity (MW)	Estimated Cost (Without IDC) (Rs. Cr.)	Estimated Investment (Rs. Cr.) With IDC	Financing Organization
1	CHIBRO	240	180.61	184.88	To be decided
2	KHODRI	120	165.85	169.63	To be decided
3	DHAKRANI	33.75	113.18	116.41	To be decided
4	DHALIPUR	51	113.71	116.81	To be decided
5	KULHAL	30	115.44	118.72	To be decided
6	TILOTH	90	327.89	384.66	REC
7	CHILLA	144	359.70	490.56	PFC
8	PATHRI	20.4	99.05	113.25	PNB/MNRE Grant
9	MOHD. PUR	9.3	67.38	76.54	NABARD/MNRE Grant
10	RAMGANGA	198	351.26	455.22	To be decided
11	KHATIMA	41.4	215.83	256.77	PFC
Total		977.85	2109.9	2483.45	

Major Scope of RMU Works

- Refurbishment of turbines and associated accessories with the provision of new runner/runner blade of improved design having higher efficiency.
- Provision of new sets of guide vane and replacement of grease lubricated bearings by self lubricated bushes.
- Refurbishment of governor system with provision of new digital governor heads for Dhakrani, Dhalipur, Kulhal & Tiloth power stations and complete replacement for Pathri, Mohammadpur, Khatima, Chilla & Ramganga.
- Refurbishment of generator with provision of new stator core and class-F insulated stator and rotor windings, cooling water system, CO₂ system and common auxiliaries for Khodri, Dhakrani, Dhalipur, Kulhal, Tiloth, Pathri, Mohammadpur, Chilla, Ramganga & Khatima power stations.

- Provision of new static excitation system for Dhakrani, Dhalipur, Kulhal, Pathri, Mohammadpur, Chilla, Ramganga, Khatima & Tiloth power stations.
- Installation of monitoring system for turbine and generator.
- Replacement of Control, Protection and Instrumentation System by state-of-art technology.
- Refurbishment of Generator transformers, refurbishment/replacement of MV/LV transformers.
- Refurbishment of generator with provision of new class F insulated rotor windings ,cooling water system, CO2 system and common auxiliaries for Chibro power station.
- Replacement of 220 KV oil filled cable by Refurbishment of MedVolt/LowVolt installations of Dams, Barrages and Power Stations.
- Provision of UPS system for safe AC supply to Automatic Control System and related peripheral equipment XLPE cable for Chibro power station.

- Refurbishment/ Replacement of DC system, Refurbishment/Replacement of DG sets with necessary arrangements for auto start.
- Replacement/Renovation of switchyard equipment.
- Civil works of Power Station, Dams, Barrages, Power Channel and Tunnels.
- Repairing with replacement of damaged parts of various gates and hoists of dams, barrages and power stations. Painting of gates, hoists and pressure shafts. Major overhauling of EOT cranes of power houses.
- Refurbishment/replacement of trash rack and provision of new trash rack cleaning machine.
- Measurement system for Measurement of Hydraulic Quantities

Phasing of RMU Schemes

- UJVNL has taken initiative for extensive RM&U of its old power stations;
- In the first phase following two plants have been taken for RMU in year 2010:
 - ✓ Pathri (3 X 6.8 MW)
 - ✓ Mohammadpur (3 X 3.1 MW)
 - ✓ RMU of these projects has been completed.
- In Second Phase following plants have been taken:
 - ✓ Khatima (3X13.4 MW) completed in 2016-17
 - ✓ Kulhal (3 X 10 MW), contract awarded but in dispute as scope reduced by Regulator.

- In third phase following projects shall be taken:
 - ✓ Dhakrani (3 X 11.25 MW) under tendering for award.
 - ✓ Dhalipur (3 X 17 MW) under award process.
- In fourth phase following projects shall be taken:
 - ✓ Tiloth (3 X 30 MW) awarded.
 - ✓ Chilla (4 X 36 MW) under tendering for award.
 - ✓ Ramganga (3 X 66 MW) under tendering/ investment approval.
- In fifth phase following plants shall be taken:
 - ✓ Chibro (4 X 60 MW)
 - ✓ Khodri (4 X 30 MW)

Reasons for Phasing

- To reduce energy loss due to closure of the units in one go;
- To have sufficient cash flows from generation;
- To avoid excessive burden of loan;
- To check the success of the planning and implementation and further refine the processes;
- To gain experience of execution and avoid the time loss in other projects;
- To utilize the experienced manpower effectively.

Benefits from Proposed RMU

- UJVNL shall enhance generation by more than 800 MU which will be equivalent to installing a new plant of about 160 MW capacity;
- Life extension of about 30-35 years;
- Better efficiency of plant & machines;
- Better availability of machines;
- Centralized monitoring of all the plants.

Problems During Execution

- RMU of Mohammadpur, Pathri and Khatima Power Stations have been completed.
- Various issues which came up in the course of implementation are:
 - Scope got exceeded due to replacement of the items which were to be repaired as per scope.
 - ✓ Reason being non-accessibility of items during RLA & LE studies, which is the basis for scope preparation;
 - ✓ Changes in the scope lead to time and overrun

- In the scope of work of RMU of Pathri Power Station, repair/refurbishment of Shaft, Top Cover, Rotor Pole Body were included.
- During reverse engineering it was felt essential to replace these items.
- Metallurgy of these items were not suitable for repair/refurbishment.
- Also, as per Contract the executing firm is bounded by the performance guarantee, but due to non-reparability of these items these, order for supply of new item had to be placed for better performance of the machines.

- Since these items were long lead items, the order affected the schedule adversely.
- Due to these unforeseen changes in scope the cost of the Project has increased.
- Similar condition was encountered in execution of RMU work of Mohammadpur Power Station. One major component, Pivot Ring, was found to be in very bad condition after opening of the machine.
- Metallurgy of Pivot Ring did not allow repair.
- Change order was issued for replacement of Pivot Ring which affected the cost and schedule .

Issues & Challenges

- Due to gap in demand and supply, it is difficult to undertake the RMU of plants as it needs shut down of machines;
- Not much of expertise is available in the Indian market for Scope determination of RMU Project.
- It is not possible to engage any manufacturer for RLA & LE studies, since such action shall debar him from participation in tender for execution.
- Absence of good consultancy firms/agency for conducting tests required in RLA & LE studies.

- Cost is always an issue which is calculated in general based on thumb rule (1.5-2.5Crore/MW), without considering the scope and size of the units.
- Owner of the plant does not give the unit for complete dismantling, which results in wrong assessment of scope.
- No standard benchmark for such projects;
- Non-availability of initial documents of the Projects;
- Issues related to copy right of the original manufacturer;
- Employees reluctance to accept the change;

Financing Options

- In year 2001, Government approved a new scheme on Accelerated Power Development Programme (APDP)
- The amount provided in the Budget was to be released as additional Central Plan Assistance to the State Governments
- The scheme was continued till the end of 11th Plan i.e. 2012
- **Funding Mechanism** for the Scheme:
 - In the case of special category States (Jammu & Kashmir, Himachal Pradesh, constituent States of the North Eastern Region including Sikkim) entire cost of the project was to be met in the form of 90% grant and 10% loan.
 - In case of non-special States, 50% of the project cost be met from APDP out of which half will be in the form of grant and half as loan. The remaining 50% of the cost of project can be met by the utility from their internal resources or loans from PFC/REC/FIs/Suppliers' credit.

Financing Options

- UJVNL has availed the benefits of APDP in the following Projects:
 - ✓ Chibro: Replacement of Machine Circuit Breakers, Governor & Excitation System
 - ✓ Khdori: Replacement of Machine Circuit Breakers, Governor & Excitation System
 - ✓ Chilla: Replacement of Governor & Excitation System

Financing Options

- UJVNL after completing the works under APDP has opted for Comprehensive RMU of its old Power Station.
- Following financial institutions and banks came forward to finance the RMU program of UJVNL:
 - NABARD
 - PFC
 - KfW
 - CCC
 - PNB
 - REC

Loan detail of various RMU Projects

Sl. No.	Financial Institution	Purpose of Loan	Interest Rate/ Appear as on date	Remark
1.	PNB Loan	RMU of Pathri HEP	10.85%	Grant from MNRE
		RMU of Galogi SHP		Grant from MNRE
		RMU of Pathri HEP (Addl. Loan)	10.85%	
2.	PFC Loan	RMU of Khatima	12.25%, 12.00%, 11.65%	Timely Rebate @ 0.25%
		RMU of Chilla	10%	
3.	NABARD Loan	RMU of Mohammdpur	Interest @ 6.5%	Grant from MNRE
4.	REC	RMU of Tiloht	10%	

EDC Line of Credit (CCC Chilla)

RMU of Chilla Power station was proposed to be financed under bilateral agreement between CCC & GoU under EDC(Export Development Canada) line of credit. The glimpse of the loan conditions were as under:

Tranche	Repayment in (semi annual installments)	Interest rate to borrower	Other cost
A	4-10	USD LIBOR + 133 bps	Commitment charges @ 0.2% p.a. of the portion of allocated amount Administration fee @ 0.2% of the Allocated amount
B	11-17	USD LIBOR + 206 bps	
C	18-20	USD LIBOR +210 bps	
D	21-24	USD LIBOR + 215 bps	

kfW Loan

The interest rate applicable on soft and commercial loan as per terms of on-lending proceeds from the KfW line of credit were:

	Commercial Loan	Soft Loan
KfW Interest Rate	EURIBOR* + 1.3%	0.75% (Fixed)
PFC Margin	1.00%	1.00%
Total Interest Rate (Payable Semi-Annually)	EURIBOR* + 2.3% (Floating)	1.75% (Fixed)

- The interest is payable semi-annually on standard dates i.e. 30th June and 30th December, every year from the date of first disbursement.
- Commitment charges: 0.25% on undisbursed loan amount for a period beginning three months from the date kfW approves in writing the re-financing of an individual sub-project.

Issues in Financing

- For financing of the RMU projects there had been no major problem.
- FIs were ready to finance the projects based on balance sheet of the organization and strength of the project
 - ✓ As no major implementation risk attached to the project.
 - ✓ Projects were planned in such a way that the plant continues to generate revenue which reduces the risk of financier.
 - ✓ It is a deviation from financing a new project where revenue is generated only in future.

Managing Cost

- In order to make RMU a beneficial proposition, the Cost of the Project should be managed appropriately.
- For **Cost management** process :
 - ✓ Identify each of the costs within the project,
 - ✓ Ensure that expenses are approved before procurement,
 - ✓ Keep a central record of all costs incurred,
 - ✓ Control the overall cost of your project

Identification of Cost

- Estimation of Cost for comprehensive RMU of any Hydro Power Project is a very complex phenomenon.
- The estimation depends on the mode to be adopted for tendering purpose
 - ✓ Turnkey Procurement
 - ✓ Or itemized procurement & coordination by Employer etc.
- UJVNL has adopted work on Turnkey basis.
- For Turnkey Job the estimation of complete Comprehensive RMU of Project is being done on the following basis:
 - ✓ Budgetary Offer from reputed manufacturers
 - ✓ Parametric estimation of the work based on the tendered cost of similar works

Estimation of Cost

Problems in Estimation by Budgetary Offers:

- The accurate costing depends on accurate 'Scope of Work'.
- For costing budgetary offer from reputed manufactures is to be obtained for which the manufacturers have to visit site and inspect the project.
- It may not be difficult for the manufacturer to provide cost details for the items which are to be replaced, but it is very difficult to estimate cost for the items which are to be repaired/ refurbished.

Estimation of Cost

- BHEL, VOITH, ANDRITZ and ALSTOM are the major manufacturers in hydropower sector.
- They are not able to depute their teams for proper estimation of the rates because of requirement of different experts for cost estimation of different components.
- Also there is cost involvement with the risk and uncertainty in the project take off.
- If somehow the manufacturer is convinced and sends his team there is likelihood of estimate is padded up to meet the risks/uncertainties of estimation and it becomes very difficult to get the accurate itemized rate of the components.

Estimate of Cost

Problems in Parametric Estimation :

Parametric Estimation is more scientific but hydropower stations are tailor made / unique and hence it is difficult to establish correlation between components of different hydropower stations

Capital Structure

- Different banks and FIs follow the following structure regarding debt & equity:
 - 70 : 30 (PNB, PFC)
 - 80 : 20 (KfW, CCC)
 - 90 : 10 (NABARD, ADB)
- However, the viability of the Project at DPR stage is calculated as per the norms of regulatory commissions.

Viability of RMU

Viability of Project at DPR stage is calculated on 'With Project' and 'Without Project' Scenario.

Without Project Scenario:

- Average generation data of last 10 years (or as per site conditions) has been considered for benefit of the on-going Project.
- Present Value of Cost and Benefits out of the Project is then calculated for assumed life of the Project (generally for 15 years with 1% deterioration rate per year)

Viability of RMU

With Project Scenario:

- Average generation data as per anticipated value after RMU of shall be considered for benefit.
- Present Value of Cost (including Project Cost) and Benefits out of the Project is then calculated for extended period of 35 years.
- Generation loss during the project implementation period is also included in the model.

Financial Parameters for Viability of Projects

- Following financial parameters are then calculated:
 - ✓ IRR (Internal Rate of Return)
 - ✓ NPV (Net Present Value)
 - ✓ BCR (Benefit Cost Ratio)
- Depending on the above values, the Project is said to be viable/unviable.

R&M Approval from Regulator

- The UERC Regulation 2015 specifies as below-

“The generating company for meeting expenditure on renovation and modernization (R&M) for the purpose of extension of life beyond the useful life of the generating station shall make an application before the Commission for in-principal approval of the proposal with a Detailed Project Report giving complete scope, justification, cost-benefit analysis, estimated life extension from a reference date, financial package, phasing of expenditure, schedule of completion, reference price level, estimated completion cost including foreign exchange component, if any, record of consultation with beneficiaries and any other information considered to be relevant by the generating company.”

R&M Approval from Regulator

- Where the Generating Company makes an application for the in-principle approval of its proposal for renovation and modernisation, the in-principle approval shall be granted after due consideration of reasonableness of the cost estimates, financing plan, schedule of completion, interest during construction, use of efficient technology, cost-benefit analysis, and such other factors as may be considered relevant by the commission.

R&M Approval from Regulator

- Any expenditure incurred or projected to be incurred and admitted by the Commission after prudence check based on the estimates of renovation and modernization expenditure and life extension, and after writing off the original amount of the replaced asset and deducting the accumulated depreciation including advance against depreciation already recovered from the Original project cost, shall form the basis for determination of Tariff.

R&M Expenditure as Additional Capitalization

- As per UERC Tariff regulations, 2015, any expenditure incurred or projected to be incurred on or after 1.4.2016 as may be admitted by the commission as renovation and modernisation expenditure for life extension shall be serviced in the manner specified in Regulation for Additional Capitalisation and De-capitalisation.

Determination of Tariff after R&M

- The tariff after R&M is determined by admitting the R&M expenditure as additional capitalization and accordingly the components of fixed cost i.e. Depreciation, interest on loan and Return on equity, Operation and maintenance Expenses and interest on working capital are determined.
- The design energy of the
- Only change in process of determination of tariff from old plant tariff is in the component of O&M expenditure.
- O&M expenditure consists of three sub-components i.e. Repair and Maintenance, Employee Cost and Administrative and General Expenses.
- The Repair and Maintenance is capped at 2% of the Capital expenditure for five years after R&M.

Recovery of Capital Cost after R&M

- The capital cost expenditure will be recovered in extended life period of the project.
- If capital cost approved by regulator is equal to the capital expenses in R&M, the capital cost incurred will be recovered in extended life period of the project and the R&M may be commercially viable if the plant achieves the performance parameters in the DPR.

Thank You