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POWER POTENTIAL STUDIES – A CASE STUDY OF KULSI MUTLTIPURPOSE PROJECT

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The project proposal at a glance

The river Kulsi, known as Khri in the upper catchments in Meghalaya, is a south bank tributary of the river Brahmaputra. The river originates from the Khasi hill range of Meghalaya and outflows into the River Brahmaputra. The total length of Kulsi River from its source to outfall is about 220 km out of which 100km is in Meghalaya and rest 120 km is in Assam.

The Kulsi Multipurpose Project envisages construction of an earthen dam across the river Kulsi at about 1.5 km down stream of Ukium village in Assam. Three saddle dams at Chikadonga, Mejengabari and Doledonga have been proposed for full utilization of the potential of the project. The reservoir so created will provide storage for multipurpose benefits of flood control, irrigation and power generation. A map showing the tentative project proposal is shown in Map -1.

1 Power Potential study

The Power potential study has been undertaken to evaluate the project parameters so that the three-pronged benefit can be derived optimally. Following considerations are made while evaluating the parameters like FRL, MDDL, and installed capacity (IC):

1.1 *Identification of full reservoir level (FRL):*

One of the purposes of this study is to identify the FRL at which all the benefits of the project are optimum.

In the present study the dam height has been restricted to 67 m at El. 125.0 m (FRL 120.0 m), as studies have revealed that any further increase in dam height leads to

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disproportionate increase in the project cost compared to the incremental benefits. It is seen from the trial simulation runs that if the dam height of the project is kept below 42.0 m at El. 100.0 m (FRL 95.0 m), power generation from the project decrease considerably and not commensurate with the water availability and storage availability at the site. It is also observed that irrigation demand for the command area proposed for the project can be met from the power releases required to meet the firm power targets. However, if the FRL is lowered further from El. 95.0m, power releases are not sufficient to meet the irrigation demand and additional conservation storage for irrigation has to be provided, which adversely affects the cost economics of the project. *In view of these, the FRL of the project is proposed to be optimized between EL 95.0 M and EL 120.0 M.*

2.2 *Selection of Minimum Draw Down Level (MDDL):*

Another purpose of this study is to select the MDDL for each of the trial FRLs so that 90% dependable energy and the firm power from the project are optimised.

1.2 *Optimisation of Installed Capacity (IC):*

Depending on the optimum combination of FRL and MDDL for the project, a decision has to be arrived at on the installed capacity. Therefore, optimization of the installed capacity is also one of the purposes of this study.

As indicated above, irrigation demands for the proposed command area are to be met from the power releases. A continuous firm release has, therefore, to be maintained from the power house for the purpose. Simultaneously installed capacity should be such that the power house can be operated as peaking station to meet the peak energy demand.

To meet the above conflicting demands without any downstream regulating structure, *installed capacity of the project has been proposed to be fixed as follows.*

Installed Capacity = 3 MW + 5 x (Firm Power – 3 MW)

The unit with 3 MW generating capacity shall be operated to meet the irrigation demand. This has been proposed in consideration of the fact that power releases corresponding to generation of 3 MW of power is sufficient to meet the irrigation demands during the months of Jan, Feb, Jun, Nov as well as December. During these five months,

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the other units of the power house can be operated at 20% load factor, which however may increase during the remaining months as per the need of meeting the additional irrigation demand.

2 THE ACRES RESERVOIR SIMULATION MODEL

Acres Reservoir Simulation Program (ARSP) developed by Acres International Ltd., Canada The has been used to simulate the Kulsi reservoir.

ARSP is a general, multi-purpose, multi-reservoir simulation program that can be used to represent water resources systems incorporating the physical processes like inflows, losses, storage & release of water etc. The ARSP is capable of simulating a wide range of operating policies governing the allocation of water in a multipurpose, multi-reservoir system.

3 SIMULATION INPUT DATA :

The simulation study has been carried out with the input data as indicated below:

3.1 HYDROLOGIC DATA:

Following hydrological data are required for the study of Kulsi Multipurpose Project:

3.1.1 INFLOW SERIES AT MONTHLY TIME STEP:

The Hydrology (NE) Directorate of the Central Water Commission recommended a runoff series (1964-2000) submitted by Brahmaputra Board, for preliminary planning purposes of the Kulsi Multipurpose Project. That series has been extended to 2003 by incorporating additional data and adopted for this power potential study.

3.1.2 MEAN MONTHLYRESERVOIR EVAPORATION DATA:

The reservoir evaporation coefficient reflects the average depth of water lost in evaporation from the surface area of reservoir on monthly basis. The quantity of water that evaporates from the reservoir surface is calculated by multiplying the surface area by evaporation coefficient.

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3.1.3 IRRIGATION DEMAND:

Gross command area of Kulsi Project has been estimated to be 37908 ha.

An area of 23882 ha (Net Irrigable Area) is to be irrigated using the water of Kulsi reservoir. The irrigation demand has been assessed accordingly.

3.1.4 AREA CAPACITY CHARACTERISTIC OF THE RESERVOIR:

The elevation area capacity values have been worked out from reservoir area maps developed by the project authority.

3.1.5 TAIL WATER LEVEL:

A tail water-rating curve at the tail race release location has been developed and has been used for the study.

3.1.6 INITIAL RESERVOIR LEVEL:

Simulation studies have been carried out hydrological year wise i.e. May to April. The initial reservoir water level at the beginning of the simulation (May 1964) has been assumed to be at EL 100.00 M or at MDDL whichever is higher. For FRLs 95.0 m and 100.0 m, the initial reservoir levels have been taken at El.80.0m.

3.1.7 HEAD LOSS:

A constant head loss of 1.0 m in the water conductor system has been assumed in the study.

3.2 POWER GENERATION DATA:

3.2.1 GENERATING CAPACITY:

The installed capacity of the project has been varied depending on different combinations of FRL & MDDL. Installed capacity has been fixed on the basis of the firm power as indicated earlier.

3.2.2 TURBINE/GENERATOR EFFICIENCY:

For this study, a constant overall efficiency value of 92% for the turbine and generator has been used.

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4 RESERVOIR OPERATING POLICY

The reservoir of the Kulsi MP Project will have been operated in such a manner so as to provide optimum benefit of the three purposes described earlier. The policy adopted for this study along with the result obtained is as below:

4.1 *MDDL OPTIMISATION:*

The simulation model has been operated against a particular FRL and different MDDLs so that an optimum MDDL can be selected from the criteria of maximization of firm power within allowable failure limits. Assessment of the installed capacity has been made as indicated earlier. No flood cushion is provided at this stage of the study. The model has been operated for FRLs 95.0, 100.0, 105.0, 110.0 115.0 and 120.0 m.

It is observed that there is no irrigation failure in all the above cases and generation of average annual energy increases with the rise in the levels of MDDLs.

Table below shows the best combination of FRL & MDDL along with firm power produced, installed capacity and generation of annual average energy along with 90% dependable energy.

Table – RESULT OF MDDL OPTIMISATION

FRL (M)	MDDL (M)	INSTALLED CAPACITY (MW)	FIRM POWER (MWc)	AVERAGE ANNUAL ENERGY (GWh)	90% DEPENDABLE ENERGY (Gwh)
95	80	29	8.2	145.6	116.51
100	80	40	10.5	178.7	137.09
105	80	55	13.5	213.7	153.91
110	90	67	16.0	243.2	168.89
115	90	88	20.0	270.6	178.35
120	90	100	22.5	296.3	200.17

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5 COST OF THE PROJECT

It is essential to assess the cost of the project prior to cost benefit analysis. The estimation of the cost at four alternative heights of the dam e.g. 42 m, 52 m, 62 m and 72 m at top El.100.0 m, 110.0 m, 120.0 m & 130.0 m respectively have been carried out The Table below shows the unit wise cost of the project at these heights:

Table – Estimation of Project Cost

Dam Top El. (M)	FRL (M)	Cost of the Project (Rs. Crore)			
		UNIT - I	UNIT - II	UNIT - III	TOTAL
100	95	427	94	57	578
110	105	501	94	109	704
120	115	608	94	174	876
130	125	763	94	223	1080

Costs of the Unit-I of the project have been interpolated for dam heights at top El.s of 105.0 m, 115.0 m and 125.0 m. The cost of UNIT –II, being cost towards irrigation, will not change with the height of the dam and remains same. UNIT – III covers the cost of the power component. It is seen that unit cost under UNIT – III (including civil cost of power house) is nearly Rs.1.97 Crore/MW of installed capacity.

5.1 *COST OF GENERATION:*

The cost of generation has been evaluated on the basis of first year tariff and these have been summarised in the above Table.

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From the above table it is seen that the cost of energy generation is the lowest at FRL 95.0 M.

6 FLOOD MODERATION

As flood moderation is one of the purposes of the project, an attempt has been made to assess the possible flood absorption space in the reservoir.

6.1 *OPERATING POLICY:*

A filling schedule has been developed keeping the reservoir levels as low as possible during the monsoon months without compromising the generation of the firm power Simulation studies for maximization of flood control storage space have been carried out for FRLs 95.0 and 115.0 m. The objective of this study is to ascertain the availability of maximum possible flood space in the reservoir during the monsoon months without compromising the firm power generation. These values have been utilized for assessment of flood moderation benefits at these FRLs.

GENERATION COST - BASED ON FIRST YEAR TARRIF

Dam Top El.	FRL	IC	Project Cost	Cost allocated to Power	90% Depble Energy	Cost of Generation
(m)	(m)	(MW)	(Crore)	(Crore)	Gwh	Rs/Kwh
100	95	29	578	148	116.51	2.05
105	100	40	637	205	137.09	2.44
110	105	55	704	260	153.91	2.76
115	110	67	777	322	168.89	3.12
120	115	88	876	361	178.35	3.31
125	120	100	986	471	200.17	3.85

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6.2 *AVAILABILITY OF FLOOD SPACE:*

A month end reservoir levels is obtained after the simulation runs. The space available between a particular FRL and the month end reservoir levels is also indicated and this storage is termed as "Flood Storage

Flood frequency analysis has been carried out to estimate the 25-year return period flood at Ukium, which has been worked out to be 1755 cumecs. Reservoir routing indicates that a storage volume of about 91 MCm is required to absorb the 25-year flood hydrograph with releases restricted to safe release of 150 cumecs.

It is seen from the study that in case of FRL 115.0 m and also for FRL 95.0 m, availability of flood space is more or less sufficient to accommodate a 25-year flood during the months of May to August.

7 CONCLUSION

As brought out above, the primary objectives of the project were power generation, irrigation and flood moderation. It is also seen that irrigation demand in all the alternative combinations can be met up from releases required for power generation. As such power generation and flood moderation are the two criteria for the optimum project parameters. As flood moderation benefit is comparatively small compared to power benefit attractive project parameters from the point of view of cost of generation are as tabulated below:

FRL (m)	MDDL (m)	Firm Power (MW)	I.C. (MW)	Project Cost (Rs. Crs)	Average Annual Energy (GWh)	90% dependable Annual Energy (Gwh)	Cost of Generation (Rs./kwh)
95	80	8.2	29	578	145.7	116.51	2.05

Cost of generation at these project parameters appears to be reasonable while meeting the irrigation and flood moderation demands at benefit: cost ratios of 1.5:1 and 1:1 respectively.