M.Sc. THESIS



# MAXIMIZING THE ENERGY OUTPUT OF HPP: A CASE STUDY OF NASIRABAD HYDROPOWER PROJECT


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## ABSTRACT

Pakistan is facing severe electricity crisis over a decade. Electricity demand is being met through expensive energy resources like thermal energy instead of renewable resources like hydropower. Every year sufficient amount of water is flowing into sea without being effectively utilized. Along with this, a lot of potential sites are available where flows are available in abundance. Need of time is that to harness more and more hydropower sites. Special measures should be taken for conserving water which will be helpful not only for electricity generation but for other purposes also. By utilizing all available water resources in an optimized manner, electricity crisis can be managed to some extent at low price as compared to electricity produced by other expensive energy resources.

WAPDA has identified a lot of hydropower projects in northern areas. Nasirabad hydropower project is one of them. It has been identified in Gilgit Baltistan. WAPDA has identified this project as a run of river project with installed capacity of 15 MW utilizing two number of turbines. This study was carried out to make Nasirabad hydropower project most feasible in terms of power and energy as well as cost effective generating more revenue. For this purpose, two alternatives of peaking and continuous operation were selected. Nasirabad Hydropower Project was assumed to run as a peaking (for 4 peak hours operation and 20 off-peak hours operation) as well as a continuous (for 24 hours operation) run of river plant to get optimum results. Energy output was found out by SIMAHPP and by developing spreadsheet model for both alternatives.

Annual energy output 235.15 GWh for peaking and continuous operation was same using SIMAHPP. But revenue generated for peaking operation is 1120.91 Million rupees which is more than the revenue generated for continuous operation i.e. 1034.69 Million rupees. Revenue was computed by introducing cost per KWh for peak and off-peak hours. SIMAHPP simulates only for one turbine. Project working as a continuous operation dropped off on the basis of less revenue generated.

Computation of energy using spreadsheet model for one turbine was also carried out. Annual energy computed for both alternatives is almost same. But breakdown of total annual energy into peak and off-peak energy showed that peak energy produced in peaking operation is more than the peak energy produced in continuous operation (by providing some storage upstream to store flows to be utilized in peak hours). On this basis, annual revenue computed is 1106 Million rupees for peaking operation which is more than the revenue computed for continuous operation i.e. 1086.20 Million rupees. In this method, continuous operation was dropped off due to less revenue generated as compared to revenue generated in peaking operation.

Comparison of both studies considering only the peaking plant operation was carried out which showed same results for both studies. To increase the output of project, it was decided to increase design discharge with increased number of turbines. The purpose behind this was to utilize sufficient available flows throughout the year. SIMAHPP gives results for only one turbine. But in spreadsheet model, computations can be made for number of turbines.

Finally, project was optimized with increased design discharge working as a peaking plant for 4 peak hours operation in combination with continuous plant

working for 20 off-peak hours. In this case, energy output was 645.80 GWh with installed capacity of 119 MW generating additional 117.50 Million rupees revenue than continuous system operation with same number of turbines. For peaking system, 2.84 million $m^3$ amount of storage was required to store extra flows which will be utilized in peak hours. Required storage of reservoir was calculated using the area-elevation-volume relationship at elevation 2046 meters. Plan and sections of proposed reservoir area were drawn with the help of contour map of Nasirabad Hydropower Project by using Auto-Cad.