Executive Summary

Arkari Gol Hydropower Project

The optimized maximum power station output is 99 MW corresponding to a maximum design discharge of 36 m^3/sec at a mean gross head of 335 meters achieved from a horizontal conduit length of 5600 meters.

The optimized project will produce 378 GWh/year out of which 139 GWh will be available during 4 hours of daily peaking period. The firm capacity available during these four hours for the duration of the whole year is 79 MW.

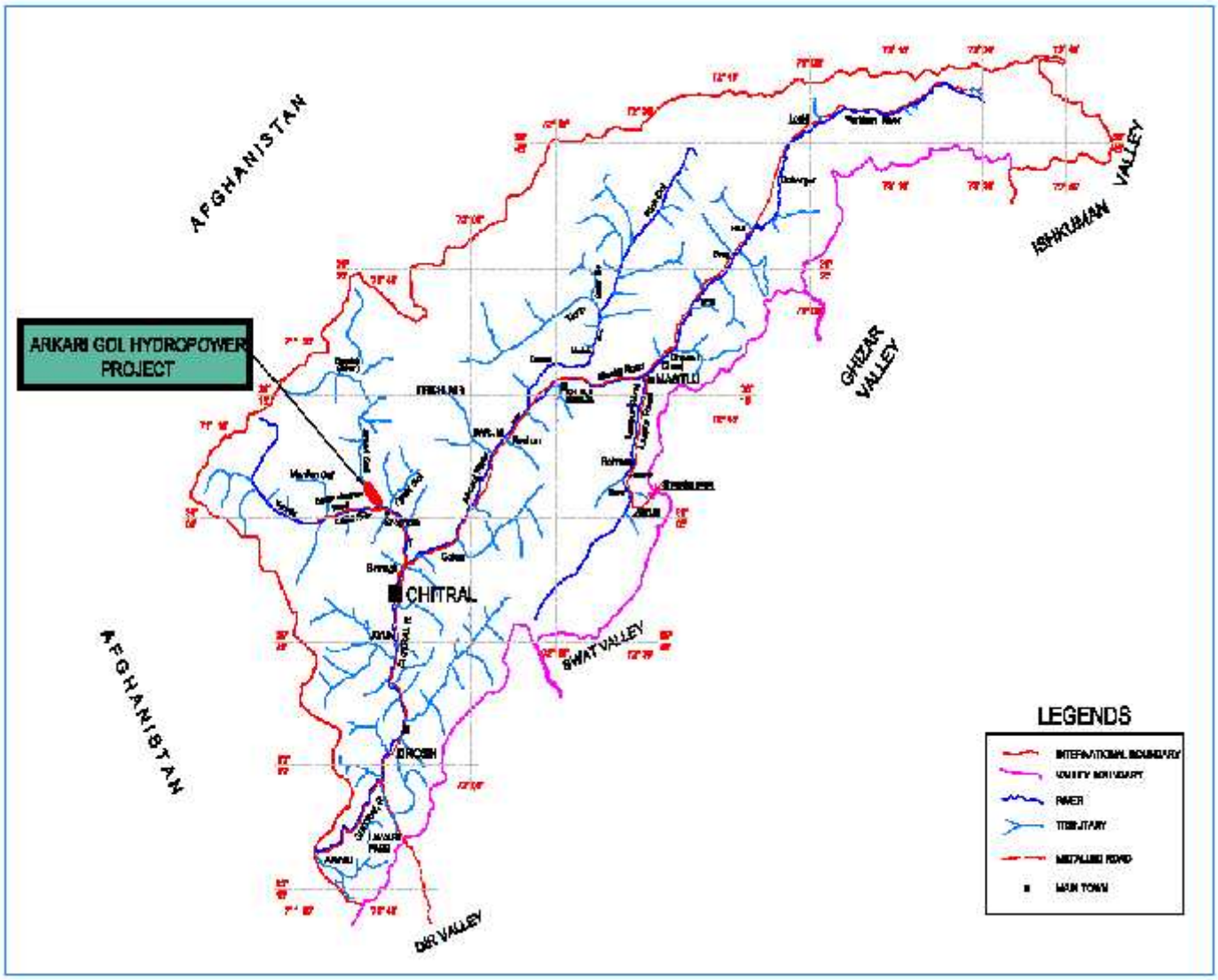
The total project cost is 179 Million USD or 1800 USD / kW installed. The total construction time is 48 months. The site, after completion of Lowari tunnel will be accessible around the year on existing road system. Before completion of this tunnel access on surface will be only from middle of May until end November.

Introduction

The project is located in Khyber Pakhtunkhwa (KP) province of Pakistan on Arkari River in Chitral District. The Arkari River is a left tributary of Lutkho River. The project area is accessible by road and is at a distance of 460 km from Islamabad, the capital of Pakistan, and 370 km from Peshawar, the capital of Khyber Pakhtunkhwa province.

Comprehensive inventory studies for identification of hydropower potential in the mountainous areas of KP have been carried out by the Government of KP, represented by Pakhtunkhwa Hydel Development Organization (PHYDO) for the Chitral Valley supported by Ministry of Water and Power, Government of Pakistan, both in collaboration with the German Agency for Technical Cooperation (GTZ). Project site for the Arkari Gol Hydropower Project constitutes part of the inventory of hydropower projects identified during the identification studies. This document has been prepared for the Executive Summary of the Feasibility Study of the Arkari Gol Hydropower project.

Location of the Arkari Gol Hydropower Project has been presented in the project location map on the following page.



Project Location Map

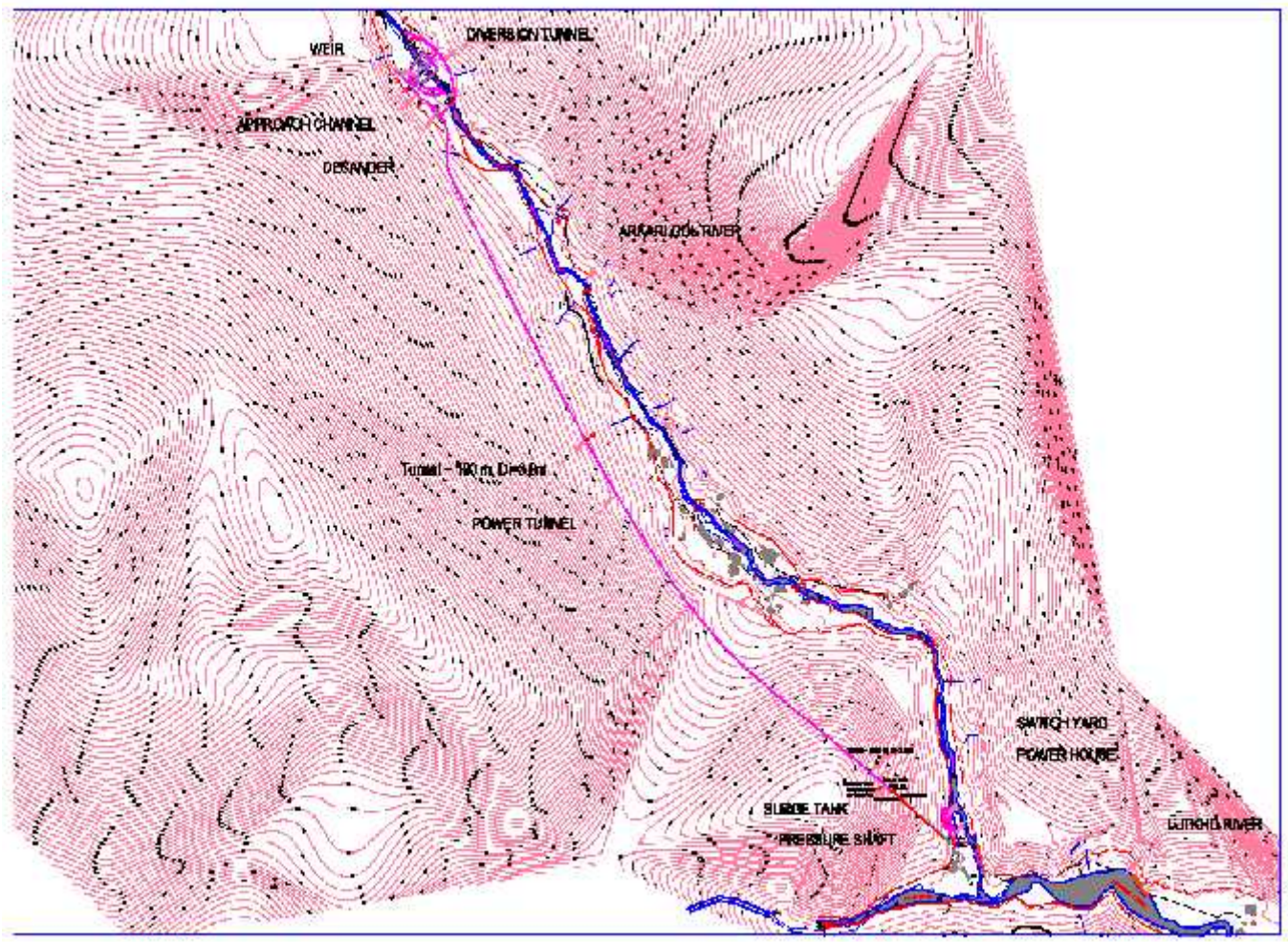
Extensive field reconnaissance including topographical surveys, hydrological and geological investigations and environmental assessments were carried out. Subsequently, the size of the project was optimized and design criteria determined, followed by engineering studies and feasibility design.

Project Description

General Layout

The intake with the dam is located on Arkari River 8 km upstream of its junction into Lutkho River near the village of Uchhatur. From there, the water is transferred through a desander basin, horizontal low pressure tunnel , surge chamber system and vertical pressure shaft with horizontal pressure tunnel to the surface-type powerhouse situated on right bank of

Arkari River near its junction with Lutkho River near the village of Andakht. Project Layout is presented in the figure below.



Layout Plan

The 20 m high concrete faced rockfill dam creates a reservoir of about 1.06 million cubic meters total capacity out of which 0.489 million cubic meters are used as live-storage for four-hour daily peak operation during dry season.

From the intake structure, a concrete lined 290 meter long open canal to a desander basin of 70 m length connected to a 5600 m meter long headrace tunnel with a net diameter of 4.15 m meters will transfer the 36 m^3/sec design discharge to the surge tank. From there, a 296 m vertical pressure shaft and a 494 m long horizontal pressure tunnel, will lead the water to the powerhouse.

The gross head will be 335 m.

The powerhouse is open surface type 46.7 m long, 24.2 m wide and 13.5 m high. It houses three vertical shaft Pelton type turbine-generator sets of 33 MW each.

Trail Race and Outlet Structure will discharge the water into Arkari River.

The annual production in total will be 378 GWh out of which 139 GWh will be peak energy. The firm capacity is 79 MW. Firm Capacity and peak energy refer to four hours daily at 90% availability.

An open 132 kV switchyard is located adjacent to powerhouse and will be connected with the National Grid following the grid system development in the area.

Grid interconnection will be arranged to the requirements of NTDC for systematic coordination of evacuation of hydropower production in District to the National Grid.
It is proposed to evacuate the entire energy of the District from a Central Grid Station near Chitral Town through a 220 kV, at later stages combined with 500 kV System via Lowari top, through Panjkoora Valley to Mardan.

The production of Arkari hydropower project is planned to be transmitted to this Central Grid Station through a 132 kV transmission system, collecting energy production from all hydropower stations along Lutkho River, namely Arkari Gol Powerhouse at Andakht village, Mujigram – Shogo and Shogo-Sin.

Cost Estimates and Economic Analysis

Detailed cost estimates and BOQ are available in Feasibility Report which may be used as a basis for development of tender documents.

The total construction cost works out to about US$ 179 million, with a specific capacity cost of 1800 US$/kW. The economic analysis establishes that the project forms part of the least cost generation expansion program of WAPDA and therefore will be economically feasible. The project has also been also demonstrated to be technically feasible and financially viable.

The economic analysis has established the project to be attractive with NPV (at 12% discount rate) to be about 260 million US$, the project EIRR works out to be 22%. The

project is therefore economically attractive.

PROJECT COST ESTIMATE		
S.No	**Description**	**Total Cost in 1000 US$**
A	Preliminary works	16702.187
B	Civil works	89326.25
C	Hydraulic steel works	393.257
D	Hydro-mechanical & Electrical equipment	39905.683
E	Transmission system	309.6
F	Engineering and administration	7.44951858
G	Other charges (Bank charges insurance, customs duty, income tax etc.	32539.9125
	Total project cost price level 2013 (105 Rupees/ US$)	**179184.339**

Environmental and Social Impact Assessment

The demography, the ethnic composition of the people, their socio-economic conditions, health and sanitation, land and water use, agriculture, irrigation, forestry, fisheries, flora and fauna, impact on land, water and air and the socio economic activities have been thoroughly examined. Although the negative impact of the project on the ecology and the inhabitants will be negligible, yet a mitigation plan has been prepared to overcome the problem of perceptible nature.

A significant positive effect is that emission of green-house gases is avoided by replacement of fossil-fired plant capacity by environment friendly and renewable hydropower.

Field investigations and engineering studies have led to the conclusion that the project is technically feasible, financially sound, economically useful and environmentally safe. Arkari Gol hydropower project ranks as one of the most promising sites and should be undertaken as soon as possible, whether in the public or private sector.

Design Features and Project Schedule

Principal design features and project schedule have been presented in the pages that follow.

PRINCIPAL DESIGN FEATURES

Hydrology (Design Flows)	
Design Discharge	36 m^3/s
Design Flood at dam site	562 m^3/s (1000 year flood)
Design Flood at powerhouse site	571 m^3/s (1000 year flood)
Reservoir	
Reservoir Length	1.30 km
Reservoir Area	0.121 km^2
Max. Reservoir Operating Level	2190 m.a.s.l.
Min. Reservoir Operating Level	2186 m.a.s.l.
Reservoir Capacity (Live Storage)	0.489 m.c.m.
Dam Structure	
Type of Structure	CFRD
Dam Height (above river bed)	20 m
Dam Crest Level	2192 m.a.s.l.
Type of Spillway	
Spillway with under sluices	4
No. of Gates (under sluices)	4
Gate Type	Roller Gates
Gate Size (WXH)	6m x 6m
Discharge Capacity	1436 m^3/s
Minimum Net Head	315 m
Rated Net head	318 m
Plant Design Discharge	36 m^3/s
Installed Plant Capacity	99
Turbine Type	
No. of Units	3
Turbine Center Line Level	1854.70 m.a.s.l.
Generator	3 x 38.82 MVA
Design Annual Energy	378 GWh
Plant Factor	43.60%
Powerhouse Type	Surface External
Size of Powerhouse (LxWxH)	46.71m x 24.20m x 13.46 m
Tailrace Channel	
Length of Tailrace Channel	100 m

Intake	
Type	Lateral Intake
No. of Gates	2
Gate Size (WxH)	3m x 4m
Deck Elevation	2185 m.a.s.l.
Intake Sill Level	2181 m.a.s.l.
Connecting Channel	
Size(W x H)	6m x 4m
Length	290 m
Desander (Surface)	
No. of Chambers	4
Size of Chamber	70m x 6m
Low Pressure Headrace Tunnel	
Inside shape and dimension	Horse Shoe
Dimensions	4.15 m x 2.68 m
Length	5600 m
Surge Tank	
Surge Shaft	
Diameter (inner)	4.50 m
Height	71 m
No. of Surge Chambers	3
Lengths	96m, 96m, 74.5m
Pressure Shaft	
Diameter	3.10 m
Length	296 m
Pressure Tunnel	
Diameter	3 m
Length	494 m
Power Generation	
Gross head (HWL-Turbine centre line)	335 m
Head Loss	17 m
Max. Net head	318 m

PROJECT SCHEDULE

ID	ACTIVITY	0				1				2				3				4				5
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	PRELIMINARY WORKS - Land Acquisition - Tenders, Bidding, Contracts																					
2	PREPARATORY WORKS - Camps and Roads																					
3	DAM STRUCTURE - River Diversion, Excavation - Concreting, Grout Curtain																					
4	CONDUIT SYSTEM - Tunnels and Shaft - Surge Structures																					
5	POWERHOUSE CIVIL WORKS - Excavation & Concreting - Internal Works, Tail Race																					
6	POWERHOUSE EQUIPMENT - Fabrication, delivery & assembly of Turbines, Generators, Transformer																					
7	SWITCH YARD & TRANSMISSION																					
8	ADDITIONAL WORKS - Residential Buildings, Stores - Workshops																					
9	COMMISSIONING & OPERATION																					