

1<sup>st</sup> Floor, 12-A CBC Building, G-8 Markaz, Islamabad, Pakistan Tel: 051–8735923, 051–8735924

Date: June 6, 2022

Letter No: KOAK-483-2022

### **The Registrar**

National Electric Power Regulatory Authority (NEPRA) NEPRA Tower Attaturk Avenue (East) Sector G-5/1, Islamabad.

### SUBJECT: APPLICATION FOR GRANT OF GENERATION LICENSE

I, Yoon An Sang, Chief Executive Officer, being the duly authorized representative of KOAK Power Limited (hereinafter "KOAK") by virtue of Board Resolution dated June 1, 2022 hereby apply to the National Electric Power Regulatory Authority for the grant of Generation License to the KOAK Power Limited pursuant to section 14B of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

1.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedure Regulations, 2021, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in, the attached documents-in-support is true and correct to the best of my knowledge and no material omission has been made.

A Pay Order No. 15421588 in the sum of Rupees 1,698,912/- (One million Six Hundred Ninety Eight Thousand Nine Hundred and Twelve Only), being the license application fee calculated in accordance with schedule II to the National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedure Regulations, 2021, is also attached herewith.

Warm Regards

148AM Yoon An Sang **Chief Executive Officer** Я **KOAK Power Limited** 



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### The Registrar

National Electric Power Regulatory Authority (NEPRA) NEPRA Tower Attaturk Avenue (East) Sector G-5/1, Islamabad.

# Subject:Application for Grant of Generation License for KOAK Power Limited for 229MWAsrit Kedam Hydropower Project located at Swat River Khyber Pakhtunkhwa

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Dear Sir,

Korea South East Power Co., Ltd. (KOEN) is a premier state owned generation company of Republic of Korea with generation capacity of 10,376MW worldwide and asset based of \$9.9 Billion. KOEN has successfully developed 102MW Gulpur Hydropower Project in district Kotli of Azad Jammu & Kashmir which has achieved its Commercial Operations in March 2020.

The Letter of Intent (LOI) for 229MW Asrit Kedam Hydropower Project (The Project) was issued to KOEN on June 23, 2021 under KPK Hydropower Polity 2016. The Project is being implemented through KOAK Power Limited which is currently a wholly owned subsidiary of KOEN. The LOI requires the company to get Generation License and Feasibility Stage Tariff from NEPRA within the stipulated timeline followed by issuance of tripartite Letter of Support by Private Power & Infrastructure Board (PPIB) under the Federal Government's Power Generation policy 2015.

The Updated Feasibility Study of the Project was approved by Pakhtunkhwa Energy Development Organization (PEDO) on May 31, 2022 after rigorous deliberation of Panel of Experts (POE). The POE was comprised of representatives of PPIB, National Transmission & Despatch Company (NTDC), Central Power Purchasing Agency Guarantee Limited (CPPAG), PEDO, KPK Environmental Protection Agency (KPK EPA), Irrigation Department Khyber Pakhtunkhwa, and Peshawar Electric Supply Company (PESCO).

The Grid Interconnection Study (GIS) of the Project was conducted by Power Planners International and submitted to NTDC on February 3, 2022. The NTDC responded that the subject HPP is part of the integrated study for evacuation of power from hydropower projects in Swat valley at which is presently under progress by the PEDO's consultant and has not been completed yet therefore, NTDC shall give its approval on the subject GIS report after completion of integrated study. Upon the instruction of NTDC the GIS was also shared with PEDO and PESCO on February 14<sup>,2</sup> 2022. The GIS is under review of PESCO and comments shall be submitted once the aforesaid integrated study is completed. Since the Company has completed all its requirements relating to GIS and it is pending with NTDC for the



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reasons explained above therefore, the Company requests the waiver of the approval of such Study as part of Generation License. We undertake that the subject study shall be approved before the Financial Closure of the Project. (The relevant correspondence is attached)

No Objection Certificate from the KPK Environmental Protection Agency was issued vide letter No. EPA/EIA/Asrit-Kedam/238 dated 27/04/2012. The said NOC is valid however, being a prudent employer and to satisfy the Lender's concern the company has decided to update the Environmental Impact Assessment (EIA) and to get the renewed NOC in due course which is under process.

KOAK Power Limited hereby applies for the issuance of Generation License pursuant to the provisions of National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedure Regulations, 2021. The Checklist and relevant documents are attached herewith this application.

Keeping in view the forgoing, the Authority is requested to kindly process our application for grant of Generation License for subject Project as per applicable laws.

Warm Regards

Yoon An Sang Chief Executive Officer

Chief Executive Officer KOAK Power Limited



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Name of Applicant	:	KOAK Power Limited
Project Name	:	Asrit Kedam Hydropower Project
Capacity (Gross)	:	229MW

**Check List for Generation License** New Generation Facility (Hydropower) - License Application Regulation Information / Document-in-Support Attachment Reference Reference<sup>1</sup> Prescribe Application for grant of license along with Pay Attached with covering letter of this application 3(1) Order No. 15421588 of amounting 1,698,912/-KOAK Power Limited is seeking generation license only 3 (2) for the 229MW Asrit Kedam Hydropower Project located at Swat River. 3 (3) Three sets of application are provided Application is submitted in 1 original & 2 copies Details as required in Schedule III are attached 3 (4) (a) separately D1 3 (4) (b) **Prospectus and Sponsor Profile** Certified Copy of Certificate of Incorporation D2 3 (4) (c) (i) Certified Copy of Memorandum and Articles of D3 3 (4) (c) (i) Association 3 (4) (c) (i) Certified Copy of Annual Report of the company 3 (4) (c) (ii) Annual Report to SECP on Form A D4 3 (4) (c) (iii) Details of Authorized, Issued, and paid-up capital KOAK Power Limited is the wholly owned subsidiary of 3 (4) (c) (iv) Korea South-East Power Company. 3 (4) (d) (i) Cash Balance and Bank Certificate D5 The Company has provided a Performance Guarantee amounting to USD 215,000 to PEDO Details of charge or encumbrances attached to any under the issued Letter of Intent. This guarantee 3 (4) (d) (ii) asset is backed by (100% cash margin) balance held in USD Bank account. Latest Audited Financial Statements D6 3 (4) (d) (iii) The company intends to arrange financing from International Finance Corporation (IFC), Asian Expression of Interest to provide credit and financing 3 (4) (d) (iv) Development Bank (ADB) and Korea Exportalong with sources Import Bank (K-EXIM). EOI from ADB and IFC is attached as D7

<sup>&</sup>lt;sup>1</sup> National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedures Regulation, 2021



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3 (4) (d) (v)	Net Worth and Ratio	The Net worth and ratios are explained in Latest Audited Financial Statements as attached D6 to this application.	
3 (4) (d) (vi)	CV of Senior Management		
3 (4) (d) (vii)	Personnel details (PD & TD) - CVs	D8	
3 (4) (d) (viii)	Any contractor & sub-contractor has been selected	No contractor or sub-contractor has been selected by the Company. The company intends to appoint EPC Contractor based on International Competitive Bidding and in accordance with the guidelines of NEPRA for the same purpose.	
3 (4) (d) (ix)	Experience of the Applicant	The detail profile of the main sponsor (KOEN) is attached as D1 to this application	
3 (4) (e)	Technical and Financial proposal for Operation, Maintenance, Planning and Development	D9	
3 (4) (f)	Detailed Feasibility Study as approved by Panel of Experts (POE) of Pakhtunkhwa Energy Development Board (PEDO)	D10	
3 (4) (g)	Whether the applicant has been granted any other license under the Act.	No generation application related to Asrit Kedam Hydropower Project has ever been submitted to	
3 (4) (h)	Any generation application has been refused or not	D11	
3 (6)	Board of Directors Resolution authorizing to submit Generation License	D12	
3 (7)	Affidavit with regard correctness, authenticity, and Accuracy	D13	
Schedule III of Regulation <sup>2</sup>			
1.	Environmental and Social Impact Assessment Study	The study is attached as Appendix E to the Detailed Feasibility Study as attached D10 to this application	
2&3	Interconnection Study including load flow, short circuit, stability study	The study is attached as Appendix D to the Detailed Feasibility Study as attached D10 to this application	
4 (i)	Location	D14	
4 (ii)	Plant Type	Run of the river	
	Generation Voltage:	220kV	
A (!!!)	Power Factor:	0.95 leading & 0.9 lagging	
4 (11)	Frequency:	50 Hz	
	Control Metering & Instruments	SCADA	
4 (iv)	Head (gross, net head)	207.4 meters, 195.2 meters	

<sup>2</sup> National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedures Regulation, 2021

**Clean and Sustainable Power Company** 

KOAK	

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		Head loss 12.2 meters
4 (v)	Technology	Vertical Francis (4 Units) 3 x 67.4MW 1 x 27.2MW
4 (vi)	Tunnel (length, diameter)	10.291 Kilometers 7.4 Me=]'/ers
4 (vii)	Resettlement Issues	Land resettlement issues are addressed in ESIA as attached Appendix E to the Detailed Feasibility Study
4 (viii)	Consents	<ul> <li>D15 - Consents</li> <li>1. Letter of Intent issued by PEDO</li> <li>2. NOC from EPA KPK along with correspondence related to updated EIA.</li> <li>3. PEDO approval of Project Feasibility Study</li> <li>4. Correspondence related to Grid Integration Study with NTDC, PESCO and PEDO</li> </ul>
4 (ix)	Infrastructure Development	Details are provided in Project Feasibility Study as attached D10. The development/construction of any infrastructure shall be started after the start of construction works.
4 (x)	Project Schedule and Expected Life	The Project is expected to achieve Financial Close in March 2024 and as provided in Feasibility Study; the project shall be constructed in 60 months' time. The construction life of the Project is expected to be 100 years. However, after the expiry of concession period of 30 years from COD the Project shall be transferred to GOKPK.
4 (xi)	Peaking/base load operation	Base load operation
4 (xii)	Training and development	The company intends to implement an extensive training and development program as provided in ESIA as attached Appendix E to the Detailed Feasibility Study to this application.
4 (xiii)	Efficiency Parameters	Turbine: 94.5% Generator: 98.2% Plant Factor: 47.48%

# D1 Prospectus and Sponsor Profile KOAK POWER LIMIED

Asrit Kedam Hydropower Project

\* Clean and sustainable Power Company

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# ASRIT KEDAM HYDRO POWER PROJECT





KOAK Asrit Kedam Hydropower Project

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PROJECT STATUS	PROJECT	<ul> <li>Pakistan Asrit Kedam Hydropower</li> </ul>
The performance of the second se		Project
Asrit Kedam Rs KUNLUN SHAN	LOCATION	<ul> <li>Pakistan KPK, Mingora District(Swat River)</li> </ul>
		<ul> <li>375km northwest from Islamabad</li> </ul>
	CAPACITY	229MW 3 × 67.4, 1 × 27.2
37,5Km	Project Cost	<ul> <li>491.299 Mil. USD</li> </ul>
TRANSFORD	Ratio	Debt/Equity: 80% / 20%
O Gulpur Project Area	SPONSOR	• KOEN
	LENDERS	<ul> <li>IFC, ADB, K-EXIM</li> </ul>
	CONSTRUCTION	• 60 Months (2024. 03 ~ 2029. 03)
	OPERATION	<ul> <li>30 Years (2029 ~ 2059)</li> </ul>

# PROJECT PROGRESS

- ✓ 2018. 01 : Notice to Proceed issued by Government of KPK
- ✓ 2018.10 : Korean Government approved KOEN to develop AK Project
- ✓ 2019.12 : KOEN transferred equity(13.5 Mil.USD) to Pakistan
- ✓ 2021.06 : Letter of Intent Issued to KOAK Power Limited
- ✓ 2021. 12 : Updated EIA Submitted
- ✓ 2022. 01 : GIS Submitted
- ✓ 2022. 05 : Approval of Updated Feasibility Study

# **Development Plan**



KOAK Asrit Kedam Hydropower Project

# **PROJECT STRUCTURE**

# Sponsors: KOEN (100%)



EPC Contractor : TBD

O&M Contractor : KOEN

# FINANCIAL & TECHNICAL FEASIBILITY

Item	Contents	Item	Contents
Operation	30 Years	Generation/Yr	970.7 GWh
EPC Cost	373 Mil.USD	Total Cost	491.299 Mil.USD
Equity	98.26 Mil.USD	Debt	393.04 Mil.USD
ROE	17%	O&M Cost	7.4 Mil.USD/Year

WEIR SITE	ADIT #1 ADIT #2 L=625m L=950m POWER TUNNE L=9.958m	ADIT #3 L=596m	Powerhouse Site Surge Tank
Weir	W27.5×H27×L71.4m	Powerhouse	Underground (W20×H39×L88m)
Desander	W12×D14.4×L130m	HRT	D7.4m×10.29Km
Turbine Type	Vertical Francis	Vertical Pressure Tunnel	D7.4m×162.97m

KOAK Asrit Kedam Hydropower Project

# **INTRODUCTION OF KOEN (As of 2020.12)**

KEPCO	KOEN is the subsidiary of KEPCO (a Fortune Global 500 company), which owns and operates more than 70,000 MW of capacity worldwide.
	KEPCO has planned more than 3 billion dollars of investment in Pakistan, out of which 400 million dollars is already spent.
Only in KOEN	<ul> <li>Lowest power generation cost in Korea</li> <li>800 MW-grade flaming coal power plant in Korea</li> </ul>
Assets / Revenue	10,342 / 3,912 Mil. USD

## KOEN takes 9.4% of Generation capacity in KOREA

## KOEN'S POWER PROJECTS IN PAKISTAN

### GULPUR HYDROPOWER PROJECT (In Operation)



- IPP Project (Main Sponsor, OE, O&M)
- Installed Capacity : 102MW (51×2)
- Joint Sponsors : KOEN, Daelim, Lotte
- Total Project Cost : 317.64 Mil. USD
- First Overseas project of KOEN

## KALAM ASRIT HYDROPOWER PROJECT (Development Stage)



- IPP Project (Main Sponsor, OE, O&M)
- Installed Capacity : 238MW
- Joint Sponsors : KOEN, KIND, EPC Co.
- Total Project Cost : 477 Mil.USD
- Waiting for approval of F/S study

### Others

Distributed Solar PV power plant project in Chile and hydropower project in Nepal, as well as a PV power plant project in Bulgaria and Commissioning project in Indonesia.



# PROJECT PROSPECTUS

### 1. PROJECT COMPANY

### 1.1. INCORPORATION DETAILS

KOAK Power Limited is a Special Purpose Company incorporated on December 11, 2019 with Securities and Exchange Commission of Pakistan to design, construct, own, operate and maintain 229MW Asrit Kedam Hydropower Plant under KPK Hydropower Policy 2016 and Government of Pakistan's Power Generation Policy 2015. KOAK Power Limited is a wholly owned subsidiary of Korea South East Power Co. Ltd. The word KOAK is the acronym of Korea Asrit Kedam.

### 1.2. INTRODUCTION TO SHAREHOLDERS

### 1.2.1. KOREA SOUTH EAST POWER COMPANY

KOEN is a leading state owned generation company of South Korea and owns 11.4% of total Korea's generation capacity amounting to 10,342 MW. Total asset base of KOEN is USD 10.34 billion. KOEN is the wholly owned subsidiary of Korea Electric Power Company (KEPCO). KOEN has successfully implemented 102MW Gulpur Hydropower Project in Pakistan which is in its 2nd year of operation.

### 1.2.2. KOREA ELECTRIC POWER COMPANY

KEPCO is the largest electric utility company in South Korea and responsible for the generation, transmission and distribution of electricity and the development of electric power projects including those in nuclear, wind and coal. KEPCO have more than 70,000MW generation capacity worldwide with asset base of about \$150 billion.

### 1.2.3. OTHER SHAREHOLDERS

KOAK intends to add other shareholders having proper expertise and financial strengths at more advanced stage of the development. Currently, KOAK is solely owned by KOEN.

### 2. PROJECT INTRODUCTION

Project was first identified by GTZ during a hydropower potential study conducted between

1990-1995 under a Program of Pakistan German Cooperation.

In June 2006 Mirza Associates Engineering services (PVT) Ltd. submitted a cascade study on the development of the hydropower potential in the Swat River. Four potential sites were identified by consultant in this study. One of identified site was Asrit Kedam hydropower with a potential of 209 MW estimated by consultant.

Project was advertised by PPIB in 2007, as raw site for competitive bidding and was awarded to Younas Brothers Group ("YBG") on BOOT (Build-Own-Operate-Transfer) basis. The feasibility study of the Project was performed by RSW International (RSWI) of Montreal Canada, and it was approved in Nov. 2008. Estimated potential of the site was increased to 215 MW in this feasibility study.

The LOI issued to YBG was cancelled by PPIB due to various reasons and the Project was handed over to Government of Khyber Pakhtunkhwa ('GoKPK") for further development. GoKPK signed a memorandum of understanding ("MOU") with Korea South-East Power Co. Ltd. ("KOEN") for development of Project.

A Letter of Intent ("LOI") was issued to KOEN by GoKPK through Pakhtunkhwa Energy Development Board ("PEDO") in June 2021. PEDO is one window facilitation agency for private sector investment in the province.

Before issuance of LOI, KOEN conducted the technical due diligence of the feasibility study. Technical due diligence and site investigations were conducted by SAMAN engineering of Korea ("SAMAN") & were reviewed by Mott MacDonald of UK.

Feasibility Study update approved by panel of experts of PEDO on May 31, 2022. SAMAN



engineering of South Korea conducted the update of study.

As per findings of the Feasibility update, the potential installed capacity of the Project has increased to 229 MW.

### 3. PROJECT LOCATION

The project is located in the Khyber Pakhtunkhwa Province on the Swat River in the reach between the Asrit and the Kedam Villages. The Swat River is formed by the junction of the Gabral and the Ushu Rivers at the Kalam. The river flows southward and then flows westward until joined by the Panjkora River. After the confluence, the river enters the Peshawar Valley and meets with the Kabul River.

The total length of the Swat River is about 225 km and its catchment basin in the intake site of Asrit-Kedam project covers an area of 2,213 km<sup>2</sup>. A hydrometric station has been in operation since 1960 at the Kalam, located around 12 km upstream of the intake of the Asrit-Kedam project. Average annual flow at the intake site of the project is estimated to be about 96.4 m<sup>3</sup>/s.

### 4. PROJECT CLIMATE

The project area falls in sub-humid and sub-tropical zone of district swat with moderate summer and extreme cold winter. The hottest month is June with mean maximum and minimum temperature of 33°C and 16°C respectively, and the coldest month is January with mean maximum and minimum temperature of 11°C and -2°C, while the annual precipitation averages 866 mm (34.1 in).

Air temperature is decreased by 0.6°C ~ 1.0°C per every 100 m increase in the elevation. Snowfall occurs from EL. 5,000. Considering the elevation of the catchment area and temperature, it is supposed that snow accumulation plays a major role in the hydrological cycle.

Major precipitation events are concentrated from January to May and maximum precipitation is in March and April. It is supposed that the precipitation from March to April is falling as snow and rainfall by air temperature and elevation. 1<sup>st</sup> Floor, 12-A CBC Building, G-8 Markaz, Islamabad, Pakistan Tel: 051–8735923, 051–8735924

### 5. PROJECT IMPLEMENTATION PLAN

The Project will be implemented through a carefully designed ownership structure, project structure, risk structure, and financial structure and will be tied together in the Project's legal structure which, in turn, will form a foundation for funding the project on a limited recourse basis.

### 5.1. OWNERSHIP STRUCTURE

The ownership structure is how the special purpose company (SPC) is organized. KOAK is registered as limited liability company in Pakistan under local laws and regulations. KOEN is the major shareholder of the company and other shareholders will be invited to participate in the Project at later stages of the development.

### 5.2. LEGAL STRUCTURE

The Project's legal structure is the web of contracts and agreements negotiated to make financing possible. The project contract structure requires the weaving of enforceable contracts and agreements to make the project bankable and provide adequate protection of shareholder interests. In cases where a host government authority participates in the project, the implementation or ceding agreements are a key part of the legal framework.

Government of Pakistan and its departments have developed the capacity to handle these large infrastructure projects during last 30 years. The power market is mature, and all departments understand their role in development of these kind of projects. Standard agreements are available to define the roles and responsibilities of all stakeholders. These agreements involve decisions in every area they cover and when negotiated.

### 5.3. FINANCIAL STRUCTURE

Financial structure refers to the mix of financing used to fund a project, which includes equity, shortand long-term loans, bonds, trade credits, etc. and the cash flows to equity providers and the lenders. At this stage of Project, it is estimated that 80% of total cost will be financed through debt financing through multilateral development banks. Contacts with leading banks have been developed and LOIs have been received from some banks in this regard.



KOEN as main sponsor of the Project will be responsible to contribute the equity required for the successful commissioning.

### 6. PROJECT COSTS

### 6.1. CAPITAL COSTS

The cost estimates, presented below, are established based on the feasibility level design of the Project, and approved by POE. The consultants have utilized their skills, experience, and international best practices in context of similar hydropower projects in Pakistan to surmise all the cost components of the proposed hydropower scheme.

COST HEAD	AMOUNT (US\$)
EPC Costs	373,392,630
Non-EPC Cost	80,207,427
Base Project Cost	453,600,057
Interest During Construction	37,698,727
Total Project Cost	491,298,783
Table 1: Summary of Project Costs	

### 6.2. EPC COSTS

The EPC Cost of the Project will be finalized after reception of firm bids from local and international EPC Contractors through international competitive bidding at later stage. The EPC Contract will be awarded on the base of quality and cost rankings as per guidelines provided by NEPRA for this purpose.

COST HEAD	AMOUNT (US\$)
Civil works	210,552,807
Electrical and Mechanical	109,459,449
Preliminary Works	53,380,374
Total Construction Cost	373,392,630
Table 2: Summary of Construction Costs	

### 6.3. NON-EPC COSTS

Non-EPC Costs are the non-construction capital costs and comprise all the overheads, already incurred and expected to be incurred during project development and construction phases, for developing the Project efficiently and complete it positively in timely and prudent manner. The development costs include all non-construction costs and have been computed warily by the

consultants keeping in view the international and local best practices. While calculating these costs NEPRA's tariff guidelines are observed and explanations are provided where required.

The breakup of non-EPC cost is as follows,

COST HEAD	AMOUNT (US\$)
Owner Administration/ Overheads	16,491,642
Engineering and Supervision	21,261,429
Insurance during Construction	7,467,853
Financing/ Lender Fees	8,894,119
Duties & Taxes	9,551,754
Owner's Advisors	2,165,642
Land Acquisition and Resettlement	3,614,143
Environment & Ecology	2,027,851
O&M Mobilization	2,600,000
Government Fee & Charges	1,331,273
Lenders Advisors & Agents	4,801,722
Total - Non-EPC	80,207,427

Table 3: Breakup of Non-EPC Cost

These cost estimates are based on prevailing rates and may need revision based on conditions prevailing on EPC stage tariff of the Project.





Korea South-East Power Co. 32, Sadeul-ro 123beon-gil, Jinju-si, Gyeongsangnam-do, Republic of Korea (Chungmugong-dong) Tel 070-8898-1000 Fax 050-5027-1001 Homepage www.koenergy.kr



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There is power to move the world with uncommon passion. There is light to brighten the future with ceaseless innovation.

KOEN Korea South-East Power Recognized for its Global Competitiveness with its World-class Technology and Capability for Operation of Facilities

KOEN has been striving to be a healthy and constantly growing company with changing and innovative minds and creates the future values for the better world.



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Asrit Kedam Hydropower Project

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

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CERTIFICATE OF INCORPORATION

[Under section 16 of the Companies Act, 2017 (XIX of 2017)]

Corporate Universal Identification No. 0143765

I hereby certify that <u>KOAK POWER LIMITED</u> is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is <u>limited by</u> <u>shares.</u>

Given under my hend at Islamabad this Eleventh day of December, Two Thousand and Nineteen

Incorporation 10/06/07/590.9/= only

(Syed Jamal Ahmed Zaidi) Additional Joint Registrar

Islamabad

NO. ADI

CERTIFIED TO BE TRUE COPY

Joint Registrar of Companies Company Registration Office Islamabac



Asrit Kedam Hydropower Project

# THE COMPANIES ACT, 2017 (XIX of 2017)

# (COMPANY LIMITED BY SHARES)

# **ARTICLES OF ASSOCIATION**

# OF

# KOAK POWER LIMITED



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## PRELIMINARY

### PUBLIC COMPANY

The Regulations contained in Table 'A' to the First Schedule to the Companies. 1. Act, 2017 (the "Act") shall be the regulations of KOAK POWER LIMITED (the "Company") so far as these are applicable to a private company.

The Company is a "Public Company" within the meaning of Section 2(1)(52) of the Act : 2. and accordingly:

The number of the members of the Company (exclusive of persons in the employment of the Company), shall not be limited, provided that for the purpose of this provision. Where two or more persons hold one or more shares in the company jointly, they shall be treated as single member, and

The right to transfer shares of the Company shall not be restricted in the manner and to the extent herein appearing.

The authorized capital of the company is Rs1,000,000 (Rupees One Million Only) divided · 3. into 10,000 (Ten Thousand) Ordinary Shares of Rs.100/- (Rupees Hundred Only) each with powers to increase and reduce the Capital of the Company and to divide the shares in the Capital for the time being into several classes in accordance with the provisions of Companies Act, 2017.

4 The minimum subscription upon which the directors may proceed to make the first allotment has been fixed as Rs.515 (Rupees Five Hundred and Fifteen Only).

5. (1) In these regulations-

1. In these Articles, unless the context or the subject matter otherwise requires:

- 2.

a) --the Company means KOAK POWER LIMITED.
 b) --the office means the registered office for the time being of the company.

c) -the directors mean the directors for the time being of the company.

d) -the seal means the common seal or official seal of the company as the case may be.

- e) -the Act means the Companies Act, 2017.
- g) -the registrar means the registrar of companies as defined in the Companies Act. 2017.
- h) -the register means the register of the members to be kept in pursuant to section 119 of the Act.
- j) -secretary means the company secretary of the company.
- k) -memorandum means the memorandum of association of the company.
- I) -person includes an individual, company, corporation and body corporate.
- m) -articles means the articles of association of the company.
- n) --- board means the board of directors of the company.

o) --year used in the context of financial matters shall mean financial year of the

### Page 2 of 18

company.

. . . . .

- p) Expressions referring to writing shall be construed as including references to typewriting, printing, lithography, photography and other modes of representing or reproducing words in visible form.
- q) Words importing the singular number include the plural number and vice versa and words importing the masculine gender include the feminine gender.
- r) Unless the context otherwise requires words or expressions contained in these Articles shall be of the same meaning as in the Act or any statutory modification thereof in force at the date at which these Articles become binding on the company.
- s) Interpretations
  - 1) Affiliate means any entity (including any person, firm, corporation, association or partnership) which (a) is owned and controlled, directly or beneficially, singly or collectively, by one or more Initial Shareholders, (b) owns and controls, directly or beneficially, one or more Initial Shareholders, or (c) is under common ownership and control, directly or beneficially, one or more Initial Shareholders, or (c) is under common ownership and control, directly or beneficially, one or more Initial Shareholders, or (c) is under common ownership and control, directly or beneficially, by an entity which owns and controls, directly or beneficially, one or more Initial Shareholders. For the purposes of this definition, "own and controls" by an entity or entitles or another entity shall mean direct or beneficial ownership of fifty one percent (51%) or more interest in, and management control over, such other entity;
  - 2) Commercial Operation Date means the meaning ascribed thereto in the Power Purchase Agreement;
  - 3) Complex means the meaning ascribed thereto in the Power Purchase Agreement;
  - 4) Common Terms Agreement means the Common Terms Agreement dated the Signing Date among the Company and the Finance Parties.
  - 5) Finance Parties bears the meaning ascribed thereto in Common Terms Agreement.
  - 6) Financiers bear the meaning ascribed thereto in Common Terms Agreement.
  - 7) GOP bear the meaning ascribed thereto in in the GOP Implementation Agreement.
  - 8) GOP implementation Agreement or GOP IA means the implementation Agreement dated the Signing Date by and between the GOP and the Company entered into in relation to the Project, as may be amended by the parties thereto from time to time.
  - 9) Initial Shareholders means (i)- M/s. Korea South-East Power Co. Ltd., a company incorporated under the laws of Republic of Korea with its principal office at 32, Sadeul-Ro, 123 Beon-Gil, Jinju-Si, Gyeongsangnam-Do, Republic of Korea, (ii) Mr. Hong Seokbin having Passport No. M74744749, (iii) Mr. Kim Youngkeun having Passport No. M74198693, (iv) Mr. Yoon Ansang having Passport No. M07037396 and all other shareholders as ascribed under the Sponsors' Support Agreement as well as under the Common Terms Agreement, with their permitted assigns; permitted transferee and successors;
  - 10) Main Sponsor means Korea South-East Power Co. Ltd., a company incorporated under the laws of Republic of Korea with its principal Southe at

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S2, Sadeul-Ro, 123 Beon-Gil, Jinju-Si, Gyeongsangnam-Do, Republic of Korea with permitted assigns, permitted transferees and successors;

11) Power Purchase Agreement means the Power Purchase Agreement entered into by and between the Power Purchaser and the Company, for the purchase and sale of electric generation capacity and electric power generated by the Complex, as may be amended by the parties thereto from time to time; and

12) Power Purchaser means the Central Power Purchasing Agency (CPPA-G) is a Company incorporated under the Companies Ordinance, 1984 and wholly owned by the Government of Pakistan (the "GOP"), with its principal office located at CPPA-G. Shaheen Plaza, Plot No. 73-West, Fazal-e-Haq Road, Blue Area, Islamabad., Pakistan or any successor or substitute board or agency that assumes the responsibilities of the Central Power Purchasing Agency.

13) PPIB means the Private Power & Infrastructure Board of, a body corporate established under the Ministry of Water and Power, Government of Pakistan PPIB Act; 2012, with the principal office at Ground & 2nd Floors, Emigration Tower, Plot No. 10, Mauve Area, Sector G-8/1, Islamabad-Pakistan or any successor or substitute board or agency that assumes the responsibilities of the Private Power & Infrastructure Board.

14) PEDO means Pakhtunkhwa Energy Development Organization is an autonomous body of the Government of Khyber Pakhtunkhwa under the Pakhtunkhwa Energy Development Organization (Amendment) Act, 2014, with the principal office at Plot # 38, Sect B-2, Phase-5, Hayatabad, District Khyber Pakhtunkhwa, Peshawar-Pakistan or any successor or substitute board of agency that assumes the responsibilities of the Pakhtunkhwa Energy Development Organization.

15) Project Completion Date bears the meaning ascribed thereto in Common Terms Agreement.

- 16) Release Date bears the meaning ascribed thereto in Common Terms Agreement.
- 17) Signing Date bears the meaning ascribed thereto:
  - a)-in Common Terms Agreement;
- b)-in GOP implementation Agreement or GOP IA; and
- c)-in Sponsors Support Agreement.
- 18) Sponsors Support Agreement means the Sponsors Support Agreement dated the Signing Date among the Company, Sponsors' of the Company and the Finance Parties.
- (2) Unless the context otherwise requires, words or expressions contained in these regulations shall have the same meaning as in this Act; and words importing the singular shall include the plural, and vice versa, and words importing the masculine gender shall include feminine, and words importing persons shall include bodies corporate.

### BUSINESS

The directors shall have regard to the restrictions on the commencement of business imposed by section 19 if, and so far as; those restrictions are binding upon the company.

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### SHARES

In case of shares in the physical form, every person whose name is entered as a member in the register of members shall, without payment, be entitled to receive, within thirty days after allotment or within fifteen days of the application for registration of transfer, a certificate under the seal specifying the share or shares held by him and the amount paid up thereon:

Provided that if the shares are in book entry form or in case of conversion of physical shares and other transferable securities into book-entry form, the company shall, within ten days after an application is made for the registration of the transfer of any shares or other securities to a central depository, register such transfer in the name of the central depository.

- 8. The company shall not be bound to issue more than one certificate in respect of a share or shares in the physical form, held jointly by several persons and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all.
- 9. If a share certificate in physical form is defaced, lost or destroyed, it may be renewed on payment of such fee, if any, not exceeding one hundred rupses, and on such terms, if any, as to evidence and indemnity and payment of expenses incurred by the company in investigating title as the directors think fit. 6. Except to the extent and in the manner allowed by section '86, no part of the funds of the company shall be employed in the purchase of, or in loans upon the security of, the company's shares.

### TRANSFER AND TRANSMISSION OF SHARES

- 10. The instrument of transfer of any share in physical form in the company shall be executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register of members in respect thereof, provided that the following provisions/conditions apply to all shares issued by the Company:
  - (a) The transfer of such shares to persons of a nationality that is specifically prescribed by the laws of Pakistan shall not be registered by the Company.
  - (b) The Company shall have the right and power to investigate the declaration of nationality stated on any application for registration or transfer of such shares if, as a result of such transfer, the transferee would hold five percent (5%) or more of Ordinary Share Capital of the Company.
  - (c) The Company cannot issue any such shares and Initial Shareholder cannot transfer any such shares owned directly or beneficially by it at any time prior to the Commercial Operations Date or for a period of six (6) years after the Commercial Operations Date, if following such issuance or such transfer the Initial Shareholder will own directly, indirectly or beneficially less than fifty-one percent (51%) of the outstanding Ordinary Share Capital, except for a transfer of shares:
    - (i) to another Initial Shareholder
    - (ii) subject to national security interests of Pakistan as such interests shall be determined in the sole but reasonable discretion of the GOP, to an Affiliate of any Initial Shareholder;
    - (III) required by any law(s) of Pakistan or by the operation of the

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Pakistan or by order of a court, tribunal, or governmental authority or agency with appropriate jurisdiction;

resulting from the creation or enforcement of a security interest in or over any such shares in accordance with the financing documents entered into by the Company in relation to its power generation complex; or

(v) to which the Government of Pakistan (including any of its relevant authority or agency) has given its prior written approval. ູສເ

(d) The Main Sponsor shall own directly or beneficially at all times prior to the Commercial Operations Date and for a period of six (6) years after the Commercial Operations Date, not less than twenty percent (20%) of the then outstanding Ordinary Share Capital, except where the reduction of ownership of Ordinary Share Capital below twenty percent (20%) by the Main Sponsor results from a transfer of Ordinary Share Capital:

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. (1) required by any laws of Pakistan or by the operation of the laws of Pakistan or by order of a court, tribunal, or governmental authority or agency with appropriate jurisdiction;

**(II)** resulting from the creation or enforcement of a security interest in or over any Ordinary Share Capital in accordance with the financing documents entered into by the Company in relation to its power generation complex: or

the Government of Pakistan (including any of its relevant authority or (111) agency) has given its prior written approval.

(e) The restrictions set out in Articles 6(c) and 6(d) above shall be noted on all share ceitificates by affixing thereon a prominent legend as follows: "Subject in all respects to the restrictions on transfers of these shares set out in Articles 6(c), and 6(d) of the Company's Articles of Association". After the completion of the time period, provided in Articles 6(c) and 6(d), any share certificates to which the legend set out in Article 6(e) is still affixed may be returned to the Company and exchanged for a new certificate in accordance with Article 5.

Shares in physical form in the company shall be transferred in the following form, or in any usual or common form which the directors shall approve:---

Form for Transfer of Shares

### (First Schedule to the Companies Act, 2017)

light the transferor) in the transferor in the t said transferee ......the share (or shares) with distinctive numbers from inclusive, in the KOAK POWER LIMITED, to hold unto the said transferee, his executors, administrators and assigns, subject to the several conditions on which I held the same at the time of the execution hereof, and I, the said transferee, do 

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(2) If the directors refuse to register a transfer of shares, they shall within fifteen days after the date on which the transfer deed was lodged with the company send to the transferee and the transferor notice of the refusal indicating the defect or invalidity to the transferee, who shall, after removal of such defect or invalidity be entitled to re-

lodge the transfer deed with the company. Provided that the company shall, where the transferee is a central depository the

refusal shall be conveyed within five days from the date on which the instrument of transfer was lodged with it notify the defect or invalidity to the transferee who shall, after the removal of such defect or invalidity, be entitled to re-lodge the transfer deed with the company.

### TRANSMISSION OF SHARES

- 13. The executors, administrators, heirs, or nominees, as the case may be, of a deceased, sole holder of a share shall be the only persons recognized by the company to deal with the share in accordance with the law. In the case of a share registered in the names of two or more holders, the survivors or survivor, or the executors or administrators of the deceased survivor, shall be the only persons recognized by the company to deal with the share in accordance with the law.
  - 4. The shares or other securities of a deceased member shall be transferred on application duly supported by succession certificate or by lawful award, as the case may be, in favour of the successors to the extent of their interests and their names shall be entered to the register of members:
- 15. A person may on acquiring interest in a company as member, represented by shares, at any time after acquisition of such interest deposit with the company a nomination conferring on a person, being the relatives of the member, namely, a spouse, father, mother, brother, sister and son or daughter, the right to protect the interest of the legal heirs in the shares of the deceased in the event of his death, as a trustee and to facilitate the transfer of shares to the legal heirs of the deceased subject to succession to be determined under the Islamic law of inheritance and in case of non-Muslim members, as per their respective law.
- 16. The person nominated under regulation 12 shall, after the death of the member, be deemed as a member of company till the shares are transferred to the legal heirs and if the deceased was a director of the company, not being a listed company, the nominee shall also act as director of the company to protect the interest of the legal heirs.
- 17. A person to be deemed as a member under regulation 11, 12 and 13 to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he were the registered holder of the share and exercise any right conferred by membership in relation to meetings of the company.

### ALTERATION OF CAPITAL

18. Subject to the provisions of Article 6(c) and 6(d), the company may, by special resolution-

(a) -increase its authorized capital by such amount as it thinks expedient;

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(b) consolidate and divide the whole or any part of its share capital into shares of larger amount than its existing shares;

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hereby agree to take the said share (or shares) subject to the conditions aforesaid.

As witness our hands this...... day of..... day of..... Signature ..... Signature ..... Transferee Full Name, Transferor Full Name, Father's / Husband's Father's / Husband's Name Name CNIC Number (in case of **CNIC Number (in case** toreigner, Passport Number) of foreigner, Passport Nationality Number) ۰. Occupation Nationality **Usual Residential Address** Occupation and **Usual Residential** Address Cell number Landline number, If any Email address

Bank Account Details of Transferee for Payment of Cash Dividend (Mandatory in case of a listed company or optional for any other company)

It is requested that all my cash dividend amounts declared by the company, may be credited into the following bank account:

	Tile of Bank Account	
	Bank Account Number	
	Bank's Name	
ĺ	Branch Name and Address	

It is stated that the above mentioned information is correct and that I will intimate the changes in the above-mentioned information to the company and the concerned Share Registrar as soon as these occur.

Ol-anti-instation Transformer(a)

Signature of the Transferee(s)

- 12. (1) Subject to the restrictions contained in regulation 10 and 11, the directors shall not refuse to transfer any share unless the transfer deed is defective or invalid. The directors may also suspend the registration of transfers during the ten days immediately preceding a general meeting or prior to the determination of entitlement or rights of the shareholders by giving seven days' previous notice in the manner provided in the Act. The directors may, in case of shares in physical form, decline to recognize any instrument of transfer unless.
  - (a) a fee not exceeding fifty rupees as may be determined by the directors is paid to the company in respect thereof; and
  - (b) the duly stamped instrument of transfer is accompanied by the certificate of the shares to which it relates, and such other evidence as the directors may reasonably require to show the right of the transferor to make the transfer.

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27. The company may provide video-link facility to its members for attending general meeting at places other than the town in which general meeting is taking place after considering the geographical dispersal of its members:

Provided that in case of listed companies if the members holding ten percent of the total paid up capital or such other percentage of the paid up capital as may be specified, are resident in any other city, the company shall provide the facility of video-link to such members for attending annual general meeting of the company, if so required by such members in writing to the company at least seven days before the date of the meeting.

NOTICE AND PROCEEDINGS OF GENERAL MEETINGS

28. Twenty-one days' notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of meeting and, in case of special business, the general nature of that business, shall be given in manner provided by the Act for the general meeting, to such persons as are, under the Act or the regulations of the company, entitled to receive such notice from the company, but the accidental omission to give notice to, or the non-receipt of notice by, any member shall not invalidate the proceedings at any general meeting.

- 29. All the business transacted at a general meeting shall be deemed special other than the business stated in sub-section (2) of section 134 namely; the consideration of financial statements and the reports of the board and auditors, the declaration of any dividend, the election and appointment of directors in place of those retiring, and the appointment of the auditors and fixing of their remuneration.
- 30. No business shall be transacted at any general meeting unless a quorum of members is present at that time when the meeting proceeds to business. The quorum of the general meeting shall be-

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(a) in the case of a public listed company, not less than ten members present personally, or through video-link who represent not less than twenty-five per cent of the total voting power, either of their own account or as proxies;

(b) in the case of any other company having share capital, two members present personally, or through video-link who represent not less than twenty-five per cent of the total voting power, either of their own account or as proxies.

31. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting, if called upon the requisition of members, shall be dissolved; in any other case, it shall stand adjourned to the same day in the next week at the same time and place, and, if at the adjourned meeting a quorum is not present within half an hour from the time appointed for the meeting, the members present, being not less than two, shall be a auorum.

32. The chairman of the board of directors, if any, shall preside as chairman at every general meeting of the company, but if there is no such chairman, or if at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as chairman, any one of the directors present may be elected to be chairman, and if none of the directors is present, or willing to act as chairman, the members present shall choose one of their number to be chairman.

33. The chairman may, with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time but no business shall be transacted at any adjourned meeting other than the business left unfinished at the 

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(c) -sub-divide its shares, or any of them, into shares of smaller amount than is fixed by the memorandum;

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(d) -cancel shares which, at the date of the passing of the resolution in that behalf, have not been taken or agreed to be taken by any person, and diminish the amount of its share capital by the amount of the share so cancelled.

19 Subject to the provisions of the Act, all new shares shall at the first instance be offered to such persons as at the date of the offer are entitled to such issue in proportion, as nearly as the circumstances admit, to the amount of the existing shares to which they are entitled. The offer shall be made by letter of offer specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will deem to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the directors may dispose of the same in such manner as they think most beneficial to the company. The directors may likewise so dispose of any new shares which (by reason of the ratio which the new shares bear to shares held by persons entitled to an offer of new shares) cannot, in the opinion of the directors, be conveniently offered under this regulation.

20. The new shares shall be subject to the same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

21. The company may, by special resolution-

- (a) consolidate and divide its share capital into shares of larger amount than its existing shares:
- (b) sub-divide its existing shares or any of them into shares of smaller amount than is fixed by the memorandum of association, subject, nevertheless, to the provisions of section 85;
- (c) cancel any shares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.
- 22. The company may, by special resolution, reduce its share capital in any manner and with, and subject to confirmation by the Court and any incident authorized and consent required, by law.

### GENERAL MEETINGS

- 23. The statutory general meeting of the company shall be held within the period required by section 131.
- 24. A general meeting, to be called annual general meeting, shall be held, in accordance with the provisions of section 132, within sixteen months from the date of incorporation of the company and thereafter once at least in every year within a period of one hundred and twenty days following the close of its financial year.
- 25. All general meetings of a company other than the statutory meeting or an annual general meeting mentioned in sections 131 and 132 respectively shall be called extraordinary general meetings.
- 26. The directors may, whenever they think fit, call an extra-ordinary general meeting, and extra-ordinary general meetings shall also be called on such requisition, or in default, may be called by such requisitionists, as provided by section 133. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the company may call an extra-ordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the directors.

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or of his attorney duly authorized in writing.

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(2)-The instrument appointing a proxy and the power-of-attorney or other authority (if any) under which it is signed, or a notarially certified copy of that power or authority, shall be deposited at the registered office of the company not less than forty-eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote and in default the instrument of proxy shall not be treated as valid.

45. An instrument appointing a proxy may be in the following form, or a form as near thereto as may be:

#### INSTRUMENT OF PROXY KOAK POWER LIMITED • .\*

vote on my behalf at the (statutory, annual, extra-ordinary, as the case may be) general meeting of the company to be held on the .... day of ...., 2... and at any adjournment , thereof.

46. A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the proxy or of the authority under which the proxy was executed, or the transfer of the share in respect of which the proxy is given, provided that no intimation in writing of such death, insanily, revocation or transfer as aforesaid shall have been received by the company at the office before the commencement of the meeting or adjourned meeting at which the proxy is used.

### DIRECTORS

- The following subscribers of the memorandum of association shall be the first directors of 47. the company, so, however, that the number of directors shall not in any case be less than that specified in section 154 and they shall hold office until the election of directors in the first annual general meeting:
  - 1 MR. HONG SEOKBIN

2 MR. KIM YOUNGKEUN

3 MR. YOON ANSANG

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#### (PASSPORT NO. M74744749) (PASSPORT NO. M74198693) (PASSPORT NO. M07037396)

48. The remuneration of the directors shall from time to time be determined by the company in general meeting subject to the provisions of the Act. 

49. Save as provided in section 153, no person shall be appointed as a director unless he is a member of the company.

### POWERS AND DUTIES OF DIRECTORS

The business of the company shall be managed by the directors, who may pay all expenses incurred in promoting and registering the company, and may exercise all such. powers of the company as are not by the Act or any statutory modification thereof for the time being in force, or by these regulations, required to be exercised by the company in general meeting, subject nevertheless to the provisions of the Act or to any of these regulations, and such regulations being not inconsistent with the aforesaid provisions, as may be prescribed by the company in general meeting but no regulation made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.

51... The directors shall appoint a chief executive in accordance with the provisions of sections

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meeting from which the adjournment took place. When a meeting is adjourned for fifteen days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment: or of the business to be transacted at an adjourned meeting.

- 34. (1) At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands unless a poll is (before or on the declaration of the result of the show of hands) demanded. Unless a poll is so demanded, a declaration by the chairman that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, and an entry to that effect in the book of the proceedings of the company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, that resolution.
  - (2)-At any general meeting, the company shall transact such businesses as may be notified by the Commission, only through postal ballot.
- 35. A poll may be demanded only in accordance with the provisions of section 143.
- 36. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in sections 144 and 145 and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.
- 37. A poll demanded on the election of chairman or on a question of adjournment shall be taken at once.
- 38. In the case of an equality of votes, whether on a show of hands or on a poll, the chairman of the meeting at which the show of hands takes place, or at which the poll is demanded, shall have and exercise a second or casting vote.
- 39. Except for the businesses specified under sub-section (2) of section 134 to be conducted in the annual general meeting, the members of a private company or a public unlisted company (having not more than fifty members), may pass a resolution (ordinary or special) by circulation signed by all the members for the time being entitled to receive notice of a meeting. The resolution by circulation shall be deemed to be passed on the date of signing by the last of the signatory member to such resolution.

### **VOTES OF MEMBERS**

- 40. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have one vote except/ for election of directors in which case the provisions of section 159 shall apply. On a poll every member shall have voting rights as laid down in section 134.
- 41. In case of joint-holders, the vote of the senior who tenders a vote, whether in person or by
- proxy or through video-link shall be accepted to the exclusion of the votes of the other joint-holders; and for this purpose seniority shall be determined by the order in which the names stand in the register of members.
- 42. A member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy, may vote, whether on show of hands or on a poll or through video link, by his committee or other legal guardian, and any such committee or guardian may, on a poll, vote by proxy.
- 43. On a poll votes may be given either personally or through video link, by proxy or through postal ballot:

Provided that nobody corporate shall vote by proxy as long as a resolution of its directors in accordance with the provisions of section 138 is in force.

44. (1)-The instrument appointing a proxy shall be in writing under the hand of the appointer

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52. The amount for the time being remaining un-discharged of moneys borrowed or raised by the directors for the purposes of the company (otherwise than by the issue of share capital) shall not at any time, without the sanction of the company in general meeting, exceed the issued share capital of the company.

53. The directors shall duly comply with the provisions of the Act, or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgages, charges and pledge affecting the property of the company or created by it, to the keeping of a register of the directors, and to the sending to the registrar of an annual list of members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or sub-division of shares, and copies of special resolutions and a copy of the register of directors and notifications of any changes therein.

### MINUTE BOOKS

54. The directors shall cause records to be kept and minutes to be made in book or books . with regard to-

- (a) all resolutions and proceedings of general meeting(s) and the meeting(s) of directors and Committee(s) of directors, and every member present at any general meeting and every director present at any meeting of directors or Committee of directors shall put his signature in a book to be kept for that purpose;
- (b) recording the names of the persons present at each meeting of the directors and of any committee of the directors, and the general meeting; and
- (c) all orders made by the directors and Committee(s) of directors:

Provided that all records related to proceedings through video-link shall be maintained in accordance with the relevant regulations specified by the Commission which shall be appropriately rendered into writing as part of the minute books according to the said regulations.

#### THE SEAL

55. The directors shall provide for the safe custody of the seal and the seal shall not be affixed to any instrument except by the authority of a resolution of the board of directors or by a committee of directors authorized in that behalf by the directors and in the presence of at least two directors and of the secretary or such other person as the directors may appoint for the purpose; and those two directors and secretary or other person as aforesaid shall sign every instrument to which the seal of the company is so affixed in their presence.

### DISQUALIFICATION OF DIRECTORS

56. No person shall become the director of a company if he suffers from any of the disabilities or disqualifications mentioned in section 153 or disqualified or debarred from holding such office under any of the provisions of the Act as the case may be and, if already a director, shall cease to hold such office from the date he so becomes disqualified or disabled:

Provided, however, that no director shall vacate his office by reason only of his being a

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member of any company which has entered into contracts with, or done any work for, the company of which he is director, but such director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted. 1. .

### PROCEEDINGS OF DIRECTORS

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57. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. A director may, and the secretary on the requisition of a director shall, at any time, summon a meeting of directors. Notice sent to a director through email whether such director is in Pakistan or outside Pakistan shall be a valid notice:

- 58. The directors may elect a chairman of their meetings and determine the period for which he is to hold office; but, if no such chairman is elected, or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the directors present may choose one of their number to be chairman of the meeting.
- 59. At least one-third (1/3rd) of the total number of directors or two (2) directors whichever is higher, for the time being of the company, present personally or through video-link, shall constitute a quorum.
- 60. Save as otherwise expressly provided in the Act, every question at meetings of the board shall be determined by a majority of votes of the directors present in person or through video-link, each director having one vote. In case of an equality of votes or tie, the chairman shall have a casting vote in addition to his original vote as a director.
- 61. The directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit; any committee so formed shall, in the exercise of the powers so delegated, conform to any restrictions that may be imposed on them by the directors.
- 62. (1)-A committee may elect a chairman of its meetings; but, if no such chairman is elected. or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the members present may choose one of their number to be chairman of the meeting,
  - (2) A committee may meet and adjourn as it thinks proper. Questions ansing at any meeting shall be determined by a majority of votes of the members present. In case of an equality of votes, the chairman shall have and exercise a second or casting vote.

63. All acts done by any meeting of the directors or of a committee of directors, or by any person acting as a director, shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such person had been duly appointed and was qualified to be a director.

64. A copy of the draft minutes of meeting of the board of directors shall be furnished to every director within seven working days of the date of meeting.

65. A resolution in writing signed by all the directors for the time being entitled to receive notice of a meeting of the directors shall be as valid and effectual as if it had been passed at a meeting of the directors duly convened and held.

### **FILLING OF VACANCIES**

66. At the first annual general meeting of the company, all the directors shall stand retired from office, and directors shall be elected in their place in accordance with section 169 for a term of three years.

Page 14 of 18

1 - .

67. A retiring director shall be eligible for re-election.

- 68. The directors shall comply with the provisions of sections 154 to 159 and sections 161, 162 and 167 relating to the election of directors and matters ancillary thereto.
- 69. Any casual vacancy occurring on the board of directors may be filled up by the directors, but the person so chosen shall be subject to retirement at the same time as if he had become a director on the day on which the director in whose place he is chosen was last elected as director.
- 70. The company may remove a director but only in accordance with the provisions of the Act. DIVIDENDS AND RESERVE
- 71. The company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the directors.
- 72. The directors may from time to time pay to the members such interim dividends as appear to the directors to be justified by the profits of the company.
- 73. Any dividend may be paid by a company either in cash or in kind only out of its profits. The payment of dividend in kind shall only be in the shape of shares of listed company held by the distributing company.
- 74. Dividend shall not be paid out of unrealized gain on investment property credited to profit and loss account.
- 75. Subject to the rights of persons (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according to the amounts paid on the shares.
- 76. (1)-The directors may, before recommending any dividend, set aside out of the profits of the company such sums as they think proper as a reserve or reserves which shall, at the discretion of the directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of company or be invested in such investments (other than shares of the company) as the directors may, subject to the provisions of the Act, from time to time think fit.
  - (2)-The directors may carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve.
- 77. If several persons are registered as joint-holders of any share, any one of them may give effectual receipt for any dividend payable on the share.
- 78. (1)-Notice of any dividend that may have been declared shall be given in manner hereinafter mentioned to the persons entitled to share therein but, in the case of a public company, the company may give such notice by advertisement in a newspaper circulating in the Province in which the registered office of the company is situate.
  - (2)-Any dividend declared by the company shall be paid to its registered shareholders or to their order. The dividend payable in cash may be paid by cheque or warrant or in any electronic mode to the shareholders entitled to the payment of the dividend, as per their direction.
- (3) In case of a listed company, any dividend payable in cash shall only be paid through electronic mode directly into the bank account designated by the entitled shareholders.
   79. The dividend shall be paid within the period laid down under the Act.

### ACCOUNTS

Page 15 of 18

80. The directors shall cause to be kept proper books of account as required under section 220.

81.

85.

The books of account shall be kept at the registered office of the company or at such other place as the directors shall think fit and shall be open to inspection by the directors during business hours.

82. The directors shall from time to time determine whether and to what extent and at what time and places and under what conditions or regulations the accounts and books or papers of the company or any of them shall be open to the inspection of members not being directors, and no member (not being a director) shall have any right of inspecting any account and book or papers of the company except as conferred by law or authorized by the directors or by the company in general meeting.

83. The directors shall as required by sections 223 and 226 cause to be prepared and to be laid before the company in general meeting the financial statements duly audited and reports as are referred to in those sections.

84. The financial statements and other reports referred to in regulation 80 shall be made out in every year and laid before the company in the annual general meeting in accordance with sections 132 and 223.

A copy of the financial statements and reports of directors and auditors shall, at least twenty-one days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder.

86. The directors shall in all respect comply with the provisions of sections 220 to 227.

87: Auditors shall be appointed and their duties regulated in accordance with sections 246 to 249

### NOTICES

88. (1) A notice may be given by the company to any member to his registered address or if he has no registered address in Pakistan to the address, if any, supplied by him to the company for the giving of notices to him against an acknowledgement or by post or courier service or through electronic means or in any other manner as may be specified by the Commission.

(2)-Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice and, unless the contrary is proved, to have been effected at the time at which the letter will be delivered in the ordinary course of post,

89. A notice may be given by the company to the joint-holders of a share by giving the notice to the joint-holder named first in the register in respect of the share.

90. A notice may be given by the company to the person entitled to a share in consequence of the death or insolvency of a member in the manner provided under regulation 85 addressed to them by name, or by the title or representatives of the deceased, or assignees of the insolvent, or by any like description, at the address, supplied for the purpose by the person claiming to be so entitled.

91: Notice of every general meeting shall be given in the manner hereinbefore authorized to (a) every member of the company and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting, and (c) to the auditors of the company for the time being and every person who is entitled to receive notice of general meetings.

Page 16 of 18

S

### WINDING UP

67. A retiring director shall be eligible for re-election.

- 68. The directors shall comply with the provisions of sections 154 to 159 and sections 161, 162 and 167 relating to the election of directors and matters ancillary thereto.
- 69. Any casual vacancy occurring on the board of directors may be filled up by the directors, but the person so chosen shall be subject to retirement at the same time as if he had, become a director on the day on which the director in whose place he is chosen was last
- elected as director. 70. The company may remove a director but only in accordance with the provisions of the Act DIVIDENDS AND RESERVE
- 71. The company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the directors.
- 72. The directors may from time to time pay to the members such interim dividends as appear to the directors to be justified by the profits of the company.
- 73. Any dividend may be paid by a company either in cash or in kind only out of its profits. The payment of dividend in kind shall only be in the shape of shares of listed company held by the distributing company.
- 74. Dividend shall not be paid out of unrealized gain on investment property credited to profit and loss account:
- 75. Subject to the rights of persons (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according to the amounts paid on the shares.
- 76. (1) The directors may, before recommending any dividend, set aside out of the profits of the company such sums as they think proper as a reserve or reserves which shall, at the discretion of the directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of company or be invested in such investments (other than shares of the company) as the directors may, subject to the provisions of the Act, from time to time think fit.
  - (2)-The directors may carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve.
- 77. If several persons are registered as joint-holders of any share, any one of them may give effectual receipt for any dividend payable on the share.
- 78. (1) Notice of any dividend that may have been declared shall be given in manner hereinafter mentioned to the persons entitled to share therein but, in the case of a public company, the company may give such notice by advertisement in a newspaper circulating in the Province in which the registered office of the company is situate.
  - (2)-Any dividend declared by the company shall be paid to its registered shareholders or to their order. The dividend payable in cash may be paid by cheque or warrant or in any electronic mode to the shareholders entitled to the payment of the dividend, as per their direction.
- (3) In case of a listed company, any dividend payable in cash shall only be paid through electronic mode directly into the bank account designated by the entitled shareholders.
   79 The dividend shall be paid within the period laid down under the Act.

Page 15 of 18

ACCOUNTS
- 92. (1) In the case of members' voluntary winding up, with the sanction of a special resolution of the company, and, in the case of creditors' voluntary winding up, of a meeting of the creditors, the liquidator shall exercise any of the powers given by sub-section (1) of section 337 of the Act to a liquidator in a winding up by the Court including inter-alia divide amongst the members, in specie or kind, the whole or any part of the assets of the company, whether they consist of property of the same kind or not.
  - (2) For the purpose aforesaid, the liquidator may set such value as he deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the members or different classes of members.
  - (3)-The liquidator may, with the like sanction, vest the whole or any part of such assets in trustees upon such trusts for the benefit of the contributories as the liquidator, with the like sanction, thinks fit, but so that no member shall be compelled to accept any shares or other securities whereon there is any liability.

#### INDEMNITY

93. Every officer or agent for the time being of the company may be indemnified out of the assets of the company against any liability incurred by him in defending any proceedings, whether civil or criminal, arising out of his dealings in relation to the affairs of the company, except those brought by the company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under section 492 in which relief is granted to him by the Court.

Page 17 of 18.

5 We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of this Articles of Association, and we respectively agree to take the number of shares in the capital of the company as set opposite our respective names:

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	Name and surname (present & former) In full (in Block Letters)	NtC No. (in case of foreigner, Passport No.) Father's	Father's/ Husband's Name in full	National Ity(ies) with any former National ity	Occupation	Usual residential of shares address in full or the taken by a registered/ principal each subscriber other than natural person figures and words)
	KOREA SOUTH-EAST POWER CO., LTD.	Reg. No. 120-86-19151	NA	KOREA (SOUTH)	<i>и</i>	IN KOREA 32, SADEUL-RO, 123 BEON-GIL, JINJU-SI, GYEONGSANGNAM- DO; KOREA
	<b>THROUGH</b> KIM ÝOUNGKEUN	M74198693	HYEONG TAE, KIM	KOREA (SOUTH)	BUSINES	IN KOREA 7723-6 SOGYEO-DONG, CHANGWON CITY, GYEONGSANGNAMDO, REPUBLIC OF KOREA
						IN PAKISTAN 1204, CENTAURS, TOWER B, F- 5, ISLAMABAD
	HONG.SEOKBIN	M74744749	WONKI HONG	KOREA. (SOUTH)	SERVICE	IN KOREA SEWANG 101-2202, GUIDONG KWANGJIN-GU, SEOUL, REPUBLIC OF KOREA IN PAKISTAN 11 <sup>-11</sup> SQUARE PLAZA, 1 <sup>37</sup> FLOOR, STREET 1, MPCHS, E- 11/1, ISLAMABAD
	KIM YQUNGKEUN	M74198693	HYEONG TAE	KOREA (SOUTH)	SERVICE	IN KOREA 723-6 SOGYEO-DONG CHANGWON CITY, GYEONGSANGNAMDO, REPUBLIC OF KOREA 1004, CENTAURS, TOWER B, F-
	YÖÖN ANSANG	M07037396	YOUNGKYUN YOQN	KOREA (SOUTH)	SERVICE	6, ISLAWABAD INKOREA DMC RAEMAN-E PYUNHANSAESANG 112-2201, SUSAEKRO-100, SEODAEMUN- GU, SEOUL, REPUBLIC OF KOREA IN FAKISTAN 1) <sup>11</sup> SQUARE PLAZA, 1 <sup>81</sup> FLOOR, STREET 1, MPCHS, E- 11/1 ISLAMABAD - CTIFIED TO BE TRUE
L	Dated the 21 <sup>st</sup> day	otal number	of shares ta	ken (Five	Hund	dred and Fifteen Only 515
	Witness to above sign	<u>atures:</u> (For	r the document	s submitted	in ph	ivsical form) Interview
	Signature Full Name (in Block Letters), Father's' Husband's, name Nationality Occupation					Joint Registrar of Company Company Registration Office
	NIC No. Usiual residential address					<b>v</b>
		Company Regis	TO BE TRUE I Tariq Rast Att Registraf attrilon Office Isl	COPY Teed Page 18 of 1	8	

# THE COMPANIES ACT, 2017 (XIX of 2017)

(COMPANY LIMITED BY SHARES)

MEMORANDUM

OF

ASSOCIATION

OF



KOAK POWER LIMITED



# (COMPANY LIMITED BY SHARES)

## MEMORANDUM OF ASSOCIATION

# OF

## KOAK POWER LIMITED

The name of the company is KOAK POWER LIMITED.

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(1)

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(111)

The registered office of the Company will be situated in Islamabad Capital Territory.

The principal line of business of the company shall be to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution, and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain thermal power plants, coal flied power plants, hydal power plants, wind mills, power grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops and necessary devices; showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

Except for the businesses mentioned in sub-clause (iii) hereunder, the company may engage in all the lawful businesses and shall be authorized to take all necessary steps and actions in connection therewith and ancillary thereto.

Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust management company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, Modaraba management company, Stock Brokerage business, forex, managing agency, business of providing the services of security guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.

It is hereby undertaken that the company shall not:

(a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation:

Page 1 of 4

- launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other (b) related activities/businesses or any lottery business;
- (c) engage in any of the permissible business unless the requisite approval, permission, consent or licence is obtained from competent authority as may be required under any law for the time being in force.

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## The liability of the members is limited. 4.

5. The authorized capital of the company is Rs1,000,000 (Rupees One Million Only) divided into 10,000 (Ten Thousand) Ordinary Shares of Rs.100/- (Rupees Hundred Only) each with powers to increase and reduce the Capital of the Company and to divide the shares in the Capital for the time being into several classes in accordance with the provisions of Companies Act, 2017.



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Page 1 of 4

. We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of this Memorandum of Association, and we respectively agree to take the number of shares in the capital of the company as set opposite our respective names:

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respective fidities.						
Name and sumame (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No:) Father's	Father's/ Husband's Nàme in full	National ity(ies) with any former National ity	Occupation	Usual residential address in full or the registered/ principal office address for a subscriber other than natural person	Number of shares taken by each subscrib er (in figures and words)
KOREA SOUTH-EAST POWER CO., LTD. THROUGH KIM YOUNGKEUN	Reg. No. 120-86-19151 M74198693	NA HYEONG TAE KIM	KOREA (SOUTH) KOREA (SOUTH)	BUSINESS	IN KOREA 32, SADEUL-RO, 123 BEON-GIL, JINJU-SI, GYEONGSANGNAM- DO, KOREA 723-5 SOGYEO-DONG, CHANGWON CITY, GYEONGSANGNAMDO, REPUBLIC OF KOREA	500
HONG SEOKBIN	M74744749	WONKI HONG	KOREA (SOUTH)	SERVICE	IN PAKISTAN 1204, CENTAURS, TOWER B, F- 8, ISLAMABAD IN KOREA SEWANG 101-2202, GUIDONG, KWANGJIN-GU, SEOUL, REPUBLIC OF KOREA IN PAKISTAN 11. <sup>M</sup> SQUARE PLAZA, 1 <sup>bT</sup> FLOOR, STREET 1, MPCHS, E- 114, 161 AMABAD	5
KIŃ YOUNGKE JN	M74198693	HYEONG TAE KIM	KOREA (SOUTH)	SERVICE	IN KOREA 733-9 SOGYEO-DONG, CHANGWON CITY, GYEONGSANGNAMDO, REPUBLIC OF KOREA IN PAKISTAN 1204, CENTAURS, TOWER B, F- 8: ISLAMABAD	5.,
YOON ANSANG	M07037398	YOUNGKYUN YOON	KOREA (SOUTH)	SERVICE	NKOREA DMG RAEMIAN-E PYUNHANSAESANG 112-2201, SUSAEKRO-100, SEODAEMUN- GU, SEOUL, REPUBLIC OF KOREA IN PAKISITAN 11 <sup>TH</sup> SQUARE PLAZA, 1 <sup>ST</sup> FLOOR, STREET 1, MPCHS, E- 11/1 ISLAMABAD	5
T	otal number	of shares ta	ken (Five	Hund	dred and Fifteen Only)	515
Dated the 21 <sup>st</sup> day of Witness to above sign	o <b>f Novembe</b> atures: (For	r, 2019. the document	s submitted	in ph	ysical form) ERTIFIED	TO BE TRUE UO:
Full Name (in Block Letters) Father's Husband's name Nationality Occupation						Intaway
NIC No. Usual residential address					Joint Regis Company Regis	strar of Companie
<u>៣ធល្លាទេគ្រហ</u> ។(	T LE TRUE (	COPY		r.		Entra Alexandre



Asrit Kedam Hydropower Project

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Form A THE COMPANIES ACT, 2017 THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018 [3ection 130(1) and Regulation 4] ANNUAL RETURN OF COMPANY HAVING SHARE CAPITAL

PART-

(Please complete in typescript or in bo	ld block capitals)			
1.1 CUIN ( Registration Number)	0143765			
1.2 Name of the Company	KOAK POWER LIMITED			
1.3 Fee payment details	1.3.1 Chalan No E-2021-83	1.3.2. Amount	680.0	
1.4 Form A made upto	dd mm yyyy 28/10/2021			
1.5 Date of AGM	28/10/2021			
Section A	PART -	<u>n</u>		
2.1 Registered Office Address	PLOT NO 7-C, G-8 MARKAZ, Islamabed Capital Territory (I.C.	ISLAMABAD ISLAMABAD IS	lamabad	
2 2 Email Address	lariq@koakpower.com			
2.3 Office Tel. No.	0092518735923			
2.4 Office Fax No.	0092518735924			
2.5 Principle line of business	HYDEL			
2 6 Mobile No. of Authorized officer (Chief Executive/Director/ Company Secretary/ Chief Financial Officer)	03181545945		_	
2.7 Authorized Share Capital				
Classes and kinds of Shares	No. of Shares	Amount	Face Value	
Ordinary Shares		2,500,000,000 00		
2.8 Paid up Share Capital			l	· · · · · · · · · · · · · · · · · · ·
Classes and kinds of Shares	No. of Shares	Amount	Face Value	
Ordinary Shares		2,091,739,900.00		
2.9 Particulars of the holding /sub	baidiary company, if any			
Name of Company		Holding/Subsidiary	% Shares Held	
KOREA SOUTH-EAST POWER CO	LTD	128619151	100	
2.10 Chief Executive				
Address	GWAN AK DREAMTOWN 13	7-1901, SUNGHYUNRO-80,	GWAN AK-GU,	
NIC No	M63997854	<u></u>		]
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2.11 Chief Financiał Officer	
Name	IOHO OOWIL
Address	DAEBANG NOBLELAND APARTMENT 101-102, SADEUL RO 61, JINJUSI, GYEONGSANG
NIC No	M93574956
2.12 Secretary	
Name	
Address	HOUSE 5, STREET 49, JINNIAH GARDEN, ISLAMABAD
NIC No	3740593260197
2.13 Legal Advisor	
Name	RIAA BARKER GILLETTE
Address	191-A, CAVALRY GROUND, SHAMI ROAD, LAHORE CANTT. PAKISTAN.
NIC No	
2.14 Particulars of Auditors	
Name	GRANT THRONTON ANJUM REHMAN
Address	302B, 3rd Floor, Evacuee Trust Complex, Sir Aga Khan Road, F-5/1, Islamabad, Pakistan
2.15 Particulars of Shares Registrar (if	applicable)
Name	
Address	
Email	

#### Section-B

#### 2.16 List of Directors on the date Annual return is made

S#	Name of Director	Residential Address	Nationality	NIC (Passport No. if foreigner)	Date of appointment /election	Name of Member/Creditors nominating/appointing
1	YOON ANSANG	DMC RAEMIAN-E PYUNHANSAESANG 112-2201, SUSAEKPO 100, SEODAEMUN CH	Korea South	M07037396	28/12/2020	
		SEOUL, REPUBLIC OF KOREA SEOUL N/A Korea South NA				
2		DAEBANG NOBLELAND APARTMENT 101-102, SADEUL RO 61, JINJUSI. GYEONGSANGNAMDO, REPUBLIC OF KOREA	Korea South	M93574956	28/12/2020	
3	KYUNG SIK KIM	GWAN AK DREAMTOWN 137-1901, SUNGHYUNRO-80, GWAN AK-GU,	Korea South	M63997854	28/12/2020	

#### 2.17 List of members & debenture holders on the date upto which this Form is made

S#	Folio#	Name *	Address	Nationality	No of shares	Percentage	NIC No(Passport if foreigner)
Mem	bers						
1	1	KOREA SOUTH EAST POWER CO .	32, SADEUL-RO, 123 BEON-GIL, JINJU-SI,	Korea South	20917384		999999999999
2	2	KIM KYUNG SIK	GWAN AK DREAMTOWN 137-1901, SUNG	Korea South	5	]	M63997854
3	3	YOON ANSANG	DMC RAEMIAN-E PYUNHANSAESANG 112	Korea South	5	]	M07037396
4	4	CHOI JIWOO	DAEBANG NOBLE LAND APARTMENT 101	Korea South	5	]	M93574956
Debe	nture Ho	lders					
	1						

\* In case the member or debenture holder is holding shares or debentures on behalf of other person(s), the name of such other person(s) shall be mentioned in parantheses alongwith the name of the member or debenture holder





2.18 Transfer of shares (debentures) since last Form A was made

S#	Name of Transferor	Name of Transferee	No of Shares Transferred	Date of Registration of transfer
Membe	15			
1	KIM YOUNG KEUN	KIM KYUNG SIK	5	07/02/2020
2	HONG SEOK BIN		5	07/02/2020
Debent	ure Holders	]/~··		

PART-3

#### 3.1 Declaration:

 1 deviation.
 1 do hereby solemnly, and sincerely declare that the information provided in the form is:
 (i) true and correct to the best of my knowledge, in consonance with the record as maintained by the Company and nothing has been concealed; and
 (ii) hereby reported after complying with and fulfilling all requirements under the relevant provisions of law, rules, regulations, directives, circulars and estimations which were in an introduction. notifications whichever is applicable.

3.2 Name of Authorized Officer with designation/ Authorized Intermediary		Secretary
3.3 Signatures	Electronically signed by T.	
3.4 Registration No of Authorized Intermediary, if applicable		
		Day Month Year
3.5 Date		26/11/2021
Perio	No.Por	CERTIFIED TO BE TRUE COPY Joint Registrar of Companies Company Registration Office Islamabac
1058	2 2	

Server.



FORM 29

#### THE COMPANIES ACT, 2017 THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018 [Section 197 and Regulations 4 and 20] PARTICULARS OF DIRECTORS AND OFFICERS, INCLUDING THE CHIEF EXECUTIVE, SECRETARY, CHIEF FINANCIAL OFFICER, AUDITORS AND LEGAL ADVISER OR OF ANY CHANGE THEREIN

PART-I

PART-II

1.3.2 Amount

1.1 CUIN (Incorporation Number)	0143765
1 2 Name of Company	KOAK POWER LIMITED
1.3 Fee Payment Details	

3300.0

2. Particulars\*:

1.3.1 Challan Number

Contractor and States and Hardes

E-2022-920644

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation** * (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)	Nature of directorship (nominee/indepe ndent/additional other) (j)
YOON ANSANG	M07037396	YOUNGKYUN YOON	DMC RAEMIAN-E PYUNHANSAESAN G 112-2201, SUSAEKRO-100, SEODAEMUN-GU,	Director	Korea South	BUSINESS	28/12/2020	Appointed /	
MIN BYEONG SOO	M03699409	MIN CHOUNG SIK	26, Jeongwangsingil- ro 49beon-gil, Siheung-si, Gyeonggi-do, Republic of Korea	Director	Korea South	SERVICE	02/12/2021	Appointed /	Nominee
CHOI HOON TAE	M96807349	CHOI KYU SIK	Apartment No. 605/1203, Chungheung apartment. Jinjusi, Gyungsangnamdo,	Director	Korea South S	SERVICE	02/12/2021	Appointed /	Nominee
CHOI HOON TAE	M96807349	CHOI KYU SIK	Apartment No. 605/1203, Chungheung apartment, Jinjusi, Gyungsangnamdo,	Chief Accountant/C FO	Korea South	SERVICE	02/12/2021	Appointed /:	
YOON ANSANG	M07037396	YOUNGKYUN YOON	DMC RAEMIAN-E PYUNHANSAESAN G 112-2201, SUSAEKRO-100, SEODAEMUN-GU,	Chief Executive	Korea South	SERVICE	02/12/2021	Appointed /	

P	resent Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation** * (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)	Nature of directorship (nominee/indepe ndent/additional/ other) (j)
K	YUNG SIK KIM	M63997854	YOUNG SON KIM	GWAN AK DREAMTOWN 137- 1901, SUNGHYUNRO-80, GWAN AK-GU,	Chief Executive	Korea South		04/01/2021	Resigned /	
]]	WOO CHOI	M93574956	BYEONG JUNE CHOI	DAEBANG NOBLELAND APARTMENT 101- 102, SADEUL RO 61, JINJUSI,	Chief Accountant/C FO	Korea South		10/02/2020	Resigned /	
K	VING SIK KIM	M63007854	VOUNG SON	CWAN AK	Director	Kama Cauth	DINENECC	20H 20020	Decisionad /	

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## PAGE1

KYUNG SIK KIM	M63997854	YOUNG SON KIM	GWAN AK DREAMTOV 1901, SUNGHYUN GWAN AK-0	VN 137- IRO-80, 3U,	Director	Korea South	BUSINESS	28/12/2020	Resigned /	
JIWOO CHOI	M93574956	BYEONG JUNE CHOI	DAEBANG NOBLELAN APARTMEN 102, SADEL 61, JINJUSI,	D † 101- JL RO	Director	Korea South	BUSINESS	28/12/2020	Resigned /	
.3. Any other change in	particulars relating	to columns (a) to	(g) above	-						
Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Resi Addre (d)	dential ss	Designation (e)	Nationality** (f)	Business Occupation* ** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)	Nature of directorship (nominee/indepen dent/additional/oth er)
* In the case of a firm, th ** In case the nationality *** Also provide particula **** In case of resignatio ***** in case of a directo	e full name, addre is not the nationa ars of other director n of a director, the r nominated by a n	ss and above meni lity of origin, provic ships or offices hel resignation letter a ember or creditor	ioned particu le the nations d, if any." Ind in case of the name of s	lars of ea ality of ori removal such nom	ch pariner, and gin as well of a director, mi inating or appoi	the date on wh amber's resoluti nting body shal	ich each becar on be attached I also be menti	ne a partner.	(j), and a copy of	t résolution from
the nominating or appoir	nting body be attac	hed.								ا ويې د او د مېره و مېره
3.1 Declaration:					PART-III					
I do hereby solemnly, an (i) true and correct to (ii) hereby reported afte applicable	id sincerely declare the best of my kno er complying with a	that the information wledge, in consoni nd fulfilling all requ	on provided in ance with the irements und	the form record a ler the rel	is: s maintained by evant provisions	the Company : of law, rules, re	and nothing ha	is been concea ctives, circular	aled and and notifications	whichever is
3.2 Name of Authorized	Officer with design	ation/ Authorized I	ntermediary	TARIQ	DOOMHAN	··	Secretar	<u>у</u>	· · · ·	]]]] >/
3.3 Signature				Electron	ically signed by	TARIQ MAHM	000			معقمية الأولية المولية الم
3.4 Date (DD/MM/YYY)	<b>`</b> )			01/02/20	)22				· **** .	
3.5 Registration No of A	uthorized Intermed	iary, if applicable								
							CERTI	FIED TO	) BE TRU	ECOPY

have 302 05 20

Joint Registrar of Companies Company Registration Office Islamabad





Asrit Kedam Hydropower Project



HABIBMETRO



11-May-2022

#### TO WHOM IT MAY CONCERN

This is to certify that M/s. KOAK POWER LIMITED of 11th SQUARE PLAZA 1st FLOOR STREET # 01 SEC # E-11/1 MPCHS, Islamabad, Pakistan is/are maintaining Account under Demand Deposit - IBB Number 6-99-2-29301-333-122638 having IBAN PK02MPBL9902173330122638 with us since 13-Dec-2019 and having a balance of USD 2,206,735.19 (Two Million Two Hundred Six Thousand Seven Hundred Thirty Five USD and Nineteen cents ) on 10-May-2022.

This certificate is being issued at the specific request of our customer and without any risk and responsibility on the part of this bank or any of its officers.

For Habib Metropolitan Bank Limited

Authorised Signatory



Comparison Comparison (Comparison of Here) (Comparison Comparison Com Comparison Comp

Habib Metropolitan Bank Ltd. (Subsidiary of Habib Bank AG Zurich) Islamic Banking Branch - Islamabad: Shop No. 7 & 8, Hill View Plaza, Near Fresco Sweets, Jinnah Avenue, Blue Area, Islamabad, Pakistan. Tel: 92 51 2605 971-77 Fax: 92 51 2605 970



HABIBMETRO



11-May-2022

#### TO WHOM IT MAY CONCERN

This is to certify that M/s. KOAK POWER LIMITED of 1ST FLOOR, 11TH SQUARE PLAZA, STREET# 1, E-11/1, MPCHS, Islamabad, Pakistan is/are maintaining Account under Demand Deposit - IBB Number 6-99-2-29301-714-122638 having IBAN PK10MPBL9902177140122638 with us since 13-Dec-2019 and having a balance of PKR 105,684,842.49 (One Hundred Five Million Six Hundred Eighty Four Thousand Eight Hundred Forty Two PKR and Forty Nine paisa ) on 10-May-2022.

This certificate is being issued at the specific request of our customer and without any risk and responsibility on the part of this bank or any of its officers.

For Habib Metropolitan Bank Limited

**Authorised Signatory** 



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Habib Metropolitan Bank Ltd. (Subsidiary of Habib Bank AG Zurich) Islamic Banking Branch - Islamabad: Shop No. 7 & 8, Hill View Plaza, Near Fresco Sweets, Jinnah Avenue, Blue Area, Islamabad, Pakistan. Tel: 92 51 2605 971-77 Fax: 92 51 2605 970

# D6 Audited Financial Statements KOAK POWER LIMIED

Asrit Kedam Hydropower Project

# KOAK POWER LIMITED FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 2021



# DIRECTORS' REPORT

The Directors of your Company are pleased to present the Annual Audited Report of the Company along with its audited financial statements for the year ended June 30, 2021, in accordance with the Section 226 and 227 of the Companies Act 2017

## State of the Company's Affairs and Fair Review of its Business

KOAK Power Limited ("the Company"), was registered in Pakistan on December 11, 2019 as a public unlisted company with the Securities and Exchange Commission of Pakistan against incorporation no. 0143765 with its registered office plot no 7-C, G/8 Markaz, Islamabad.

The Company was established by Korea South-East Power Co. Ltd., (the "Holding Company"/KOEN) by owning the 100% shares of the Company.

Initially, the letter of intent (LOI) of the Project was issued in favor of Y.B Pakistan Limited (YBL) by the Private Power Infrastructure Board (PPIB) which later on terminated on May 4, 2017. Subsequent to above termination of LOI, a MoU dated May 15, 2017 was signed between the Pakhtunkhwa Energy Development Organization (PEDO) and KOEN to develop the Project. The feasibility study for the Project was conducted by YBL which was approved by PPIB on December 29, 2008. On termination of LOI, YBL moved an appeal in Honorable Sindh High Court (SHC) and entered into litigation against termination of its LOI. The honorable SHC issued an order in favor of PPIB. YBL challenged the award of the Project by PEDO to KOEN before the Honorable Peshawar High Court (PHC) which was decided in favor of YBL on November 7, 2018. The PHC Judgement was appealed before the Honorable Supreme Court of Pakistan (SCP) by the KOEN.

After above, the parties agreed to resolve their disputes through out of court settlement. Accordingly, on April 1, 2020 KOEN and YBL entered into a 'Settlement, Project & Feasibility Rights Purchase Agreement' and, thereafter, on April 6, 2020 KOEN, YBL and PEDO entered into a 'Feasibility Rights Purchase Agreement'. To guarantee the due performance of payment obligations under above agreements, the Company on June 26, 2020, has issued a bank guarantee of USD 5,625,000 in favor of YBL, which on March 31, 2021 extended till September 30, 2021 with mutual understanding. In line with the above mentioned agreements both parties had taken actions for withdrawal and ceasing of litigations. On October 1, 2020, the honorable SCP has given its order that since the consensus has been arrived at by and between the parties, the impugned judgment of the honorable PHC is set aside and the matter was remanded back to PHC to decide the matter under intimation to parties. On June 21, 2021, the honorable PHC settled down the matter by giving orders, in favor of the Company and the Project.

## **Statement of Compliance**

This Annual Audited Financial Report has been prepared in accordance with the accounting and reporting standards as applicable in Pakistan. The accounting and reporting standards applicable in Pakistan comprise of International Financial Reporting Standards (IFRS Standards) issued by the International Accounting Standards Board (IASB) as notified under the Companies Act, 2017 and provisions of and directives issued under the Companies Act, 2017. Where provisions of and directives issued under the



Companies Act, 2017 differ from the IFRS Standards, the provisions of and directives issued under the Companies Act, 2017 have been followed.

Directors are pleased to state that:

- **a.** The financial statements have been drawn up in conformity with the requirements of the Companies Act, 2017 and present fairly state of its affairs, operating results, cash flow and changes in equity
- **b.** The financial statements, prepared by the management, present fairly the Company's state of affairs, the result of its operations, cash flows and changes in equity;
- c. Proper books of accounts have been maintained;
- **d.** Appropriate accounting policies have been consistently applied in preparation of financial statements and accounting estimates are based on reasonable and prudent judgment;
- e. International Financial Reporting Standards as applicable in Pakistan, have been followed in preparation of financial statements;
- **f.** The system of internal financial controls, which is in place, is being continuously reviewed internally. The process will continue and any weakness in controls will be removed.

There are no significant doubts about the Company's ability to continue as a going concern.

## Appropriations

During the year under review, Project is in development phase hence no recommendations for Dividend, Reserve Fund, General Reserve or Reserve Account have been made during the year.

# Members of the Board of Directors and any Change during the Year

No change in the members of the Board of Directors and Chief Executive Officer was occurred since last Annual General Meeting of the Company. The Current Board of Directors of the Company consists of:

1- Mr. Kim, Kyungsik	Chairman/ Chief Executive Officer (Appointed
2- Mr. Yoon, Ansang	Director
3- Mr. Choi, Jiwoo	Director

# The principal activities and the development and performance of the company's business

The Company was established on December 11, 2019 for the development of Asrit-Kedam Hydropower Project (the Project) with estimated installed capacity of 215MW (run of river type), administratively located in district Swat, Khyber Pakhtunkhwa (KPK) on the Swat River.

As disclosed above, on June 23, 2021, the Company has been granted LOI for the Project by PEDO under Khyber Pakhtunkhwa Hydropower Policy 2016, on submission of prequalification documents and irrevocable, unconditional, on demand bank guarantee of USD 215,000 which is valid up to June 20, 2024 in favor of PEDO.



Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

## **Principal risks and Uncertainties**

Hence, company is in its initial development phase and committed to achieve all milestones given in LOI. However, to mitigate all the risks and uncertainties that are faced by every business, the Company shall implement a vigilant and prudent rationale. The Company shall emphasize on recognizing all long-term and short-term risks, to overcome and mitigate them.

During the year there was no principal risks and uncertainties other than as described under note 19 of these financial statements for the year ended June 30, 2021

## Any Other Changes During the Financial Year

These are no changes occurred during the financial year 2020-2021, except those as disclosed in Note 1 of the Annual Audited Report.

## Contents of modification in the auditors' report

No content in the auditors' report is modified for the Annual Audited Accounts for the year ended June 30, 2021.

## **Pattern of Shareholding**

A statement of the pattern of shareholding of the shareholders as at June 30, 2021, whose disclosure is required under the reporting framework, is included in the annexed shareholders' information.

## **Related Party Transactions**

Board reviewed the related party transactions. These transactions were in line with the requirements of International Financial Reporting Standards (IFRS) and the Companies Act, 2017. The Company maintains a thorough and complete record of all such transactions. Please see note 21 of these Annual Audited Accounts for the year ended June 30, 2021.

## **Holding Company**

Korea South-East Power Co., Ltd. ("KOEN"), the main shareholder of the Company, was established on April 20th 2001 and incorporated in South Korea as an autonomous power company after having been spun off from Korea Electric Power Co. ("KEPCO") in a bid of the Korea Government's organizational restructuring of the power industry. Currently, KEPCO owns 100% of KOEN's ownership.

KOEN, being beneficial owner, is the holding Company of KOAK POWER LIMITED. Presently KOEN holds 100% of the total share capital of the Company.

## Earnings per share

The project is in its development phase and no recognition of revenues is recoded, hence no earnings per share is given in this Annual Audited Report.

## Reasons for loss during the year and prospects of profit

The project of the Company is in development phase. After achieving successful Financial Closing of the project, the construction phase will start with its full strength. Thereafter, on completion of the project and achieving of Commercial Operation Date (COD), Company shall be in profits on sale of electricity to the national grid.



Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

## Defaults in payment of debts and reasons thereof

Hence, there is no any debt obligations on the Company during the year and there is no defaults of debt in this year.

## Adequacy of internal financial controls

For the effective and adequate financial controls, the Board of Directors and Senior Management ensure that:

- 1. Proper systems and procedures are at place for internal financial controls at various departments;
- 2. Assessments are made encompassing functioning of various compliances under various statues, rules & regulations framed there under;
- **3.** Adequate systems and procedures are at place for physical verification of fixed and other assets;
- 4. Proper books of accounts, vouchers along with supporting documents are maintained;
- 5. Confirmation of balances from the parties are obtained;
- 6. There are adequate checks and balances for protection of funds and securities, operating systems, management information systems, management reporting, front and back office operations, contingency planning and disaster recovery;
- 7. It is ensured that activities are integrated into the risk management system in a timely and appropriate manner;
- 8. Physical verification of cash and all fixed assets are permitted at reasonable intervals;

## Material changes and commitments

Between the end of the financial year of the company to which the financial statement relates and the date of the report, followings are the material changes and commitments to meet.

During the year, on June 23, 2021, the Company has been granted Letter of Intent (LOI) for the Project by the Pakhtunkhwa Energy Development Organization (PEDO), after submission of pre-qualification documents and irrevocable, unconditional, on demand bank guarantee of USD215,000 which is valid up to June 20, 2024 in favor of PEDO. The management of the Company is confident to achieve the milestones on the timelines indicated in LOI.

Subsequently on September 27, 2021, the Company, in compliance with the 'Settlement, Project & Feasibility Rights Purchase Agreement' with Y.B. Pakistan Limited (YBL), has fully settled the purchase consideration of USD5.625 million. Hence, the disputes with YBL are fully settled now and the underlying bank guarantee of USD5.625 million has been released and cancelled.

## Any other information

## **Material Achievements**

1- On June 23, 2021, LOI was granted to the Company by PEDO, on submission of irrevocable, unconditional, on demand bank guarantee of USD 215,000 in favor of PEDO.



Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

- 2- In compliance with the 'Settlement, Project & Feasibility Rights Purchase Agreement with YBL, on September 27, 2021, the Company has fully settled the purchase consideration of USD5.625 million; and hence the disputes with YBL are now fully settled.
- 3- The irrevocable, unconditional, on demand bank guarantee of USD5.625 million in favor of YBL is released and cancelled.
- 4- An internationally renowned company "Saman Corporation" has been engaged to update the Project's feasibility study and in this respect the "Inception Report" has been submitted to PEDO on 16th Aug 2021.
- 5- The appointment of Panel of Experts (POE) by PEDO is in progress, for monitoring the conduct and progress of feasibility study.

## **Annual General Meeting**

The Board of Directors recommend to members of the Company to hold the 2<sup>nd</sup> Annual General Meeting of the Company, accordingly.

## Auditors

The retiring auditors Messer Grant Thornton Anjum Rahman, Chartered Accountants, Islamabad being eligible offer themselves for re-appointment. The Board of Directors of the Company has endorsed their re-appointment for shareholders consideration in the forthcoming Annual General Meeting.

#### **Registered Office**

The registered office of the Company is situated in "Islamabad Capital Territory" at Plot 7-C, G-8 Markaz, Islamabad.

## Acknowledgement

The Board recognizes and intensifies the valued Sponsor, the Korea South East Power Co., Ltd. for their continued confidence and support given to the Company.

We also extend our appreciation to the Government of Pakistan, Government of Khyber Pakhtunkhwa, Pakhtunkhwa Energy Development Organization (PEDO) and all regulatory bodies for their sustained support.

We appreciate to all management and employees of KOAK POWER LIMITED for their carefulness and dedication with the Company.

## Date of the report

The date of this Directors' Report is October 6<sup>th</sup>, 2021 as the date of the Board meeting.

## For and on behalf of the Board of Directors

KIM, KYUNGSIK Chief Executive Officer

Islamabad October  $6^{th}$ , 2021





Grant Thornton Anjum Rahman

302 B, 3rd Floor, Evacuee Trust Complex, Aga Khan Road, F-5/1, Islamabad, Pakistan.

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#### INDEPENDENT AUDITOR'S REPORT

To the members of KOAK Power Limited

Report on the Audit of the Financial Statements

#### Opinion

We have audited the annexed financial statements of **KOAK Power Limited**, which comprise the statement of financial position as at June 30, 2021, and the statement of profit or loss, statement of comprehensive income, the statement of changes in equity, the statement of cash flows for the year then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information, and we state that we have obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purposes of the audit.

In our opinion and to the best of our information and according to the explanations given to us, the statement of financial position, the statement of profit or loss, the statement of comprehensive income, the statement of changes in equity and the statement of cash flows together with the notes forming part thereof conform with the accounting and reporting standards as applicable in Pakistan and give the information required by the Companies Act, 2017 (XIX of 2017), in the manner so required and respectively give a true and fair view of the state of the Company's affairs as at June 30, 2021 and of the loss and comprehensive loss, the changes in equity and its cash flows for the year then ended.

#### **Basis for Opinion**

We conducted our audit in accordance with International Standards on Auditing (ISAs) as applicable in Pakistan. Our responsibilities under those standards are further described in the *Auditor's* Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Company in accordance with the International Ethics Standards Board for Accountants' Code of Ethics for Professional Accountants as adopted by the Institute of Chartered Accountants of Pakistan (the Code) and we have fulfilled our other ethical responsibilities in accordance with the Code. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of Management and Board of Directors for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with the accounting and reporting standards as applicable in Pakistan and the requirements of Companies Act, 2017(XIX of 2017) and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

Chartered Accountants



In preparing the financial statements, management is responsible for assessing the Company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Company or to cease operations, or has no realistic alternative but to do so.

Board of directors are responsible for overseeing the Company's financial reporting process.

#### Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with ISAs as applicable in Pakistan will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with ISAs as applicable in Pakistan, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Company's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Company to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with the board of directors regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.



#### **Report on Other Legal and Regulatory Requirements**

Based on our audit, we further report that in our opinion:

- a) proper books of account have been kept by the Company as required by the Companies Act, 2017 (XIX of 2017);
- b) the statement of financial position, the statement of profit or loss, the statement of comprehensive income, the statement of changes in equity and the statement of cash flows together with the notes thereon have been drawn up in conformity with the Companies Act, 2017 (XIX of 2017) and are in agreement with the books of account and returns;
- c) investments made, expenditure incurred and guarantees extended during the year were for the purpose of the Company's business; and
- d) In our opinion, no zakat was deductible at source under the Zakat and Usher Ordinance, (XVIII of 1980).

The engagement partner on the audit resulting in this independent auditor's report is Hassaan Riaz.

Grant Horalou Augin Reln. Grant Thornton Anjum Rehman Chartered Accountants

Islamabad October 06, 2021

## KOAK POWER LIMITED STATEMENT OF FINANCIAL POSITION AS AT JUNE 30, 2021

		2021	2020
	Note	Rupees	Rupees
ASSETS			
Non - current assets			
Operating fixed assets	4	14,162,679	485,584
Right of use asset	5	52,238,889	62,033,682
Project development cost	6	1,248,549,280	113,089,950
Intangible asset	7	1,325,561	-
Long term security deposits against lease of building		2,273,702	2,010,702
Cash margin with bank against guarantee	10.2	34,034,500	-
		1,352,584,611	177,619,918
Current assets			
Advances, deposits and prepayments	8	3,392,150	7,752,058
Advance income tax - net	9	2,890	60,585
Cash and bank balances	10	1,837,196,975	2,178,540,033
		1,840,592,015	2,186,352,676
Total Assets		3,193,176,626	2,363,972,594
EQUITY AND LIABILITIES			
Share capital and reserves			
Share capital	11	2,091,739,900	2,091,739,900
Advance against equity		1,137	1,137
Accumulated (losses)/profits - revenue reserve		(25,841,968)	161,197,548
		2,065,899,069	2,252,938,585
Non - current liabilities			
Non current portion of lease liabilities	12	43,192,513	55,612,820
Deferred liabilities	13	2,722,172	-
Current liabilities			
Current portion of lease liabilities	12	10,748,621	6,925,480
Trade and other payables	14	1,070,614,251	48,495,709
		1,081,362,872	55,421,189
Total equity and liabilities		3,193,176,626	2,363,972,594
		<sup>**</sup>	y
CONTINGENCIES AND COMMITMENTS	15		

The annexed notes from 1 to 25 form an integral part of these financial statements.

CHIEF EXECUTIVE

anzier DIRECTOR

## KOAK POWER LIMITED STATEMENT OF PROFIT OR LOSS FOR THE YEAR ENDED JUNE 30, 2021

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	Notes	Year ended June 30, 2021 Rupees	From December 11, 2019 to June 30, 2020 Rupees
Revenue			
Cost of revenue		-	-
Gross profit/(loss)		-	-
Administrative expenses	16	(46,788,604)	(20,604,784)
Operating (loss) for the year/period		(46,788,604)	(20,604,784)
Finance cost	12	(8,802,834)	(1,892,655)
Other operating (loss)/income	17	(131,029,254)	183,694,987
(Loss)/profit before taxation		(186,620,692)	161,197,548
Taxation	18	(418,824)	-
(Loss)/profit after taxation		(187,039,516)	161,197,548
	:		

The annexed notes from 1 to 25 form an integral part of these financial statements.

CHIEF EXECUTIVE

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DIRECTOR

## KOAK POWER LIMITED STATEMENT OF COMPREHENSIVE INCOME FOR THE YEAR ENDED JUNE 30, 2021

	2021 Rupees	From	
		December 11,	
		2019 to June 30, 2020 Rupees	
(Loss)/profit after taxation	(187,039,516)	161,197,548	
Other comprehensive income	-	-	
Total comprehensive (loss)/income	(187,039,516)	161,197,548	
The annexed notes from 1 to 25 form an integral part of these financial statements.		y	

CHIEF EXECUTIVE

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DIRECTOR

## KOAK POWER LIMITED STATEMENT OF CHNAGES IN EQUITY FOR THE YEAR ENDED JUNE 30, 2021

	Share capital	Advance against equity	Accumulated (losses)/profit	Total
		]	Rupees	
Balance as at December 11, 2019		·	-	-
Issue of ordinary share capital	2,091,739,900	1,137	-	2,091,741,037
Total comprehensive income for the period				
Profit after tax	-	-	161,197,548	161,197,548
Other comprehensive income - net of tax	-	-	-	-
-	-		161,197,548	161,197,548
Balance at 30 June 2020	2,091,739,900	1,137	161,197,548	2,252,938,585
Balance as at July 01, 2020 Total comprehensive loss for the year	2,091,739,900	1,137	161,197,548	2,252,938,585
Loss after tax	-		(187,039,516)	(187,039,516)
Other comprehensive income - net of tax	-	-	-	-
			(187,039,516)	(187,039,516)
Balance at 30 June 2021	2,091,739,900	1,137	(25,841,968)	2,065,899,069
The annexed notes 1 to 25 form on integral part of th	ase financial statement	•		

The annexed notes 1 to 25 form an integral part of these financial statements.

CHIEF EXECUTIVE

DIRECTOR

## KOAK POWER LIMITED CASH FLOW STATEMENT FOR THE YEAR ENDED JUNE 30, 2021

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		From
	Year ended	December 11,
	June, 30	2019 to June 30,
	2021	2020
	Rupees	Rupees
CASH FLOW FROM OPERATING ACTIVITIES		
(Loss)/profit before taxation	(186,620,692)	161,197,548
Adjustments for:		
Depreciation	13,145,783	3,325,467
Amortization of intangible	583,339	-
Finance cost	8,802,834	1,892,655
Unrealized exchange loss/(gain) - net	131,211,909	(181,231,319)
Income related to Covid-19 concession in lease rental	-	(2,400,000)
Provision for gratuity	1,223,414	-
	154,967,279	(178,413,197)
Net cash used in operating activities before working capital changes	(31,653,413)	(17,215,649)
Changes in working capital		
Decrease //increase) in advances, deposite and prepayments	A 347 560	(7 752 058)
Increase in trade and other payables	1 022 118 542	48 495 709
Increase in provident fund liability	1,572,758	
Cash concerted from operations	006 295 456	22 528 002
Cash generated nom operations	770,303,430	23,328,002
Income tax withheld	- (74.000)	(00,585)
Gratuity paid	(74,000)	-
Tax paid	(301,129)	
iver cash generated from operating activities	995,950 <u>,</u> 927	25,407,417
CASH FLOW FROM INVESTING ACTIVITIES		
Operating fixed assets	(17,015,746)	(546,121)
Intangible asset	(1,908,900)	-
Right of use asset/lease liability - net	(17,400,000)	(2,252,967)
Project development cost	(1,135,459,330)	(113,089,950)
Long term security deposits against lease of building	(263,000)	(2,010,702)
Cash (used) in investing activities	(1,172,046,976)	(117,899,740)
CASH FLOW FROM FINANCING ACTIVITIES		
Issuance of share capital	-	2.091.739.900
Advance against equity	-	1.137
Cash margin with bank against guarantee	(34,034,500)	-
Net cash (used)/generated from financing activities	(34,034,500)	2,091,741,037
Nat degrapse in each and each activity lasts	/040 424 440\	
Reference for each and cash equivalents	(210,101,149)	-
Effect of exchange rate changes on cash and cash equivalents	(151,211,909)	181,231,319
Cash and cash equivalents at the beginning of the year/period	2,178,540,033	
Cash and cash equivalents at the end of the year/period	1,837,196,975	2,178,540,033
		yt.

CHIEF EXECUTIVE

DIRECTOR

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### KOAK POWER LIMITED NOTES TO THE FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 2021

#### 1 THE COMPANY AND ITS OPERATIONS

KOAK POWER LIMITED ("the Company"), was incorporated in Pakistan on December 11, 2019 as a public unlisted company with the Securities and Exchange Commission of Pakistan against incorporation no. 0143765. The principal activity of the Company is to Build, Own, Operate and Transfer (BOOT) basis a hydroelectric power complex of an estimated installed capacity of 215 MW named Asrit-Kedam Hydro Power Project (the Project). The Company is the subsidiary of Korea South-East Power Co Ltd (Parent Company/KOSEP/KOEN) which owns 100% (2020: 100%) shareholding in the Company. Korea South-East Power Co Ltd is incorporated in Korea having its registered office at 32, Sadeul-Ro, 123 Beon-Gil, Jinju-Si, Gyeongsangnam-Do, Republic of Korea.

Initially a letter of intent (LOI) of the Project was issued in favour of Y.B Pakistan (YB) by the Private Power Infrastructure Board (PPIB) which later on terminated on May 4, 2017. Subsequent to above termination of LOI, a MoU dated May 15, 2017 was signed between the Pakhtunkhwa Energy Development Organization (PEDO) and KOEN to develop the Project. The feasibility study for the Project was conducted by YB which was approved by PPIB on December 29, 2008. On termination of LOI, YB moved an appeal in Honorable Sindh High Court (SHC) against PPIB and entered into litigation against termination of its LOI. The honorable SHC issued an order in favor of PPIB challenged the award of the Project by PEDO to KOEN before the Honorable Peshawar High Court (PHC) which was decided in favour of YB on November 7, 2018. The PHC judgement was appealed before the Honorable Supreme Court of Pakistan (SCP) by the KOEN.

Subsequent to above, the parties agreed to resolve their disputes through out of court settlement. Accordingly, on April 1, 2020 KOEN and YB entered into a 'Settlement, Project & Feasibility Rights Purchase Agreement' and, thereafter, on April 6, 2020 KOEN, YB and PEDO entered into a 'Feasibility Rights Purchase Agreement'. To guarantee the due performance of payment obligations under above agreements, the Company on June 26, 2020, has issued a bank guarantee of USD 5,625,000 in favour of YB, which on March 31, 2021 extended till September 30, 2021 with mutual understanding. In line with the above mentioned agreements both the parties had taken actions for withdrawal and ceasing of litigations. On October 1, 2020, the honorable SCP has given its order that since the consensus has been arrived at by and between the parties, the impugned judgment of the honorable PHC is set aside and the matter was remanded back to PHC to decide the matter under intimation to parties. On December 17, 2020, the honorable PHC settled down the matter by giving orders, in favour of the Company and the Project.

Thereafter on June 23, 2021, the Company has been granted LOI for the Project by PEDO after submission of prequalification documents and irrevocable, unconditional, on demand bank guarantee of USD 215,000 which is valid upto June 20, 2024 in favour of PEDO.

Subsequently on September 27, 2021, the Company, in compliance with the above referred 'Settlement, Project & Feasibility Rights Purchase Agreement' with YBL, has fully settled the purchase consideration of USD5.625 million. Hence the disputes with YBL are fully settled now and the underlying bank guarantee has been released and cancelled.

The Company has already initiated the works as required in LOI targeting to achieve the timely issuance of Letter of Support (LOS). An internationally renowned company "Saman Corporation" has been engaged to update the Project's feasibility study and in this respect the "Inception Report" has been submitted to PEDO on 16th Aug 2021. Moreover, the appointment of panel of experts by PEDO for monitoring the conduct and progress of feasibility study is in progress. The management of the Company is confident to achieve the milestones on the timelines indicated in LOI.

#### HEAD OFFICE

The Company's registered office is situated at plot no 7-C, G-8 Markaz Islamabad.

#### SITE AREA

The site is located in Malakand Division, District Swat, Khyber Pakhtunkhwa (KPK) on the Swat River.

#### HOLDING COMPANY

Korea South-East Power Co. Ltd., (the "Holding Company"/KOEN) - by holding 100% shares of the Company. ASSOCIATES

Korea South-East Power Co. Ltd., Pakistan Branch

#### 2 BASIS OF PREPARATION

#### 2.1 Statement of compliance

These financial statements have been prepared in accordance with the accounting and reporting standards as applicable in Pakistan. The accounting and reporting standards applicable in Pakistan comprise of International Financial Reporting Standards (IFRS Standards) issued by the International Accounting Standards Board (IASB) as notified under the Companies Act, 2017 and provisions of and directives issued under the Companies Act, 2017. Where provisions of and directives issued under the Companies Act, 2017 differ from the IFRS Standards, the provisions of and directives issued under the Companies Act, 2017 have been followed.

### KOAK POWER LIMITED NOTES TO THE FINANCIAL STATEMENTS NOR THE YEAR ENDED JUNE 30, 2021

#### 2.2 Basis of measurement

These financial statements have been prepared under the historical cost convention.

#### 2.3 Significant accounting estimates

The preparation of financial statements in conformity with the accounting and reporting standards as applicable in Pakistan requires management to make judgments, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimate and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the results of which form the basis of making the judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates.

The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognized in the period in which the estimates are revised if the revision affects only that period, or in the period of revision and future periods.

Judgments made by management in the application of approved accounting standards that have significant effect on the financial statements and estimates with a significant risk of material adjustment in the next year are discussed in the ensuing paragraphs.

#### (a) Operating fixed assets

The Company reviews the useful lives of operating fixed assets on a regular basis. Any change in estimate in future years might affect the carrying amounts of the respective items of operating fixed assets with corresponding effect on depreciation charge and impairment.

#### (b) Impairment

The carrying amounts of the Company's assets are reviewed at each balance sheet date to determine whether there is any indication of impairment loss. Any change in estimates in future years might affect the carrying amounts of the respective assets with corresponding effect on depreciation charge and impairment.

#### (c) Taxation

The Company takes into account the current income tax law and decisions taken by appellate authorities. Instances where the Company's view differs from the view taken by the income tax department at the assessment stage and where the Company considers that its view on items of material nature is in accordance with law, the amounts are shown as contingent liabilities.

#### (d) Contingencies

The Company discloses significant contingent liabilities for the pending litigations and claims against the Company based on its judgment and the advice of the legal advisors for the estimated financial outcome. The actual outcome of these litigations and claims can have an effect on the carrying amounts of the liabilities recognized at the balance sheet date. However, based on the best judgment of the Company and its legal advisors, the likely outcome of these litigations and claims is remote and there is no need to recognize any liability at the reporting date.

#### 2.4 Functional and presentation currency

These financial statements are presented in Pakistan Rupee (PKR), which is the Company's functional currency. All financial information presented in PKR has been rounded off to the nearest of PKR, unless otherwise stated.

Standards, interpretations and amendments to accounting and reporting standards not yet effective

The following International Financial Reporting Standards (IFRS Standards) as notified under the Companies Act, 2017 and the amendments and interpretations thereto will be effective from the dates mentioned below:

Standard, 1	Interpretation or Amendment	Effective date (annual periods beginning on or after)
LAS 1	Presentation of Financial Statements - Amendments regarding the classification of liabilities and Amendments regarding the disclosure of accounting policies	January 1, 2023
IAS 12	Income Taxes - Amendments regarding deferred tax on leases and decommissioning obligations	January 1, 2023
IAS 8	Accounting Policies, Changes in Accounting Estimates and Errors - Amendments regarding the definition of accounting estimates	January 1, 2023
IAS 16	Property, Plant and Equipment - Amendments prohibiting a company from deducting from the cost of property, plant and equipment amounts received from selling items produced while the company is preparing the asset for its intended use	January 1, 2022

# Standard, Interpretation or Amendment

Standard, II	nterpretation or Amendment	Effective date (annual periods beginning on or after)
LAS 37	Provisions, Contingent Liabilities and Contingent Assets - Amendments	January 1, 2022
	regarding the costs to include then assessing whether a contract is onerous	
LAS 39	Financial Instruments: Recognition and Measurement - Amendments regarding replacement issues in the context of the IBOR reform	January 1, 2021
IFRS 7	Financial Instruments: Disclosures- Amendments regarding replacement issues in the context of the IBOR reform	January 1, 2021
IFRS 9	Financial Instruments - Amendments regarding replacement issues in the context of the IBOR reform	January 1, 2021
IFRS 9	Financial Instruments - Amendments resulting from Annual Improvements to IFRS Standards 2018–2020 (fees in the '10 per cent' test for derecognition of financial liabilities)	January 1, 2022
IFRS 16	Amendments regarding replacement issues in the context of the IBOR reform	January 1, 2021

The above standards and amendments are not expected to have any material impact on Company's financial statements in the period of initial application.

Following standard and interpretation has been issued by the International Accounting Standards Board (IASB), which are yet to be notified by the Securities and Exchange Commission of Pakistan (SECP), for the purpose of their applicability in Pakistan:

IFRS 1 First time Adoption of International Financial Reporting Standards

The following interpretation issued by IASB have been waived of by SECP:

Service concessions arrangements IFRIC 12

#### 3 SIGNIFICANT ACCOUNTING POLICIES

#### 3.1 **Operating fixed assets**

Operating fixed assets owned by the Company are stated at cost less accumulated depreciation and impairment loss, if any, except for capital work in progress, which is stated at cost less impairment loss, if any. Cost of operating fixed assets comprises of purchase price, borrowing cost on qualifying asset, non-refundable local taxes and other directly attributable cost.

Depreciation is charged on straight line method at rates given in note 4, after taking into account their respective residual values, if any, so as to write off the cost of assets over their estimated useful lives. Depreciation is charged from the day the asset is available for use till the date on which the asset is disposed off.

Renewals and replacements are recognized in the carrying amount of the operating fixed assets if it is probable that future embodied economic benefits will flow to the Company. Other repair and maintenance costs are charged to the profit and loss account. Gains and losses on disposals of assets, if any, are taken to the profit and loss account.

#### Capital work in progress

These are stated at cost less accumulated impairment losses, if any. All expenditure connected with specific assets incurred during installation and construction period are carried under this head. These are transferred to specific asset as and when the asset is available for its intended use.

#### Intangible assets 3.2

An intangible asset is recognized if it is probable that the future economic benefits that are attributable to the asset will flow to the Company and that cost of such asset can also be measured reliably. These are stated at cost less accumulated amortization and impairment loss, if any. Amortization is provided from the month when the asset becomes available for use, on straight line basis to write off the cost of an asset over its estimated useful life at the rate of 33.33% per annum. No amortization is charged in the month of disposal /retirement. There are no intangible assets of the Company having infinite useful lives.

## KOAK POWER LIMITED **JOTES TO THE FINANCIAL STATEMENTS** FOR THE YEAR ENDED JUNE 30, 2021

#### 3.3 Impairment

The carrying amount of the Company's assets are reviewed at each balance sheet date to determine whether there is any indication of impairment. If such indications exist, the asset's recoverable amount is estimated in order to determine the extent of the impairment loss, if any. Impairment loss is recognized as expense in the profit and loss account. An impairment loss is reversed only to the extent that the asset's carrying amount does not exceed the carrying amount that would have been determined, net of depreciation or amortization, if no impairment loss had been recognized. A reversal of the impairment loss is recognized in the profit and loss account.

#### 3.4 Staff retirement benefits

#### Gratuity (a)

The Company maintains a gratuity scheme (un-registered), for its eligible employees. Provision is made in these financial statements, on the basis of last drawn gross salary and length of service of eligible employees. The Company has not conducted actuarial valuation, of the gratuity fund, as it believes that such valuation will not result any material adjustment to these financial statements.

#### Provident fund (b)

The Company maintains a contributory provident scheme (un-registered) for all its eligible employees, within the books of accounts of the Company. Monthly contributions are made to the fund both by the Company and employees at the rate of 10% of basic pay. The Company's contributions are charged to the statement of profit or loss.

#### 3.5 Leases

The Company assesses at contract inception whether a contract is, or contains, a lease. That is, if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration.

#### **Right-of-use** asset

The Company recognizes a right-of-use asset and a lease liability at the lease commencement date. The right-of-use asset is initially measured at cost, which comprises the initial amount of the lease liability adjusted for any lease payments made at or before the commencement date, plus any initial direct costs incurred and an estimate of costs to dismantle and remove the underlying asset or to restore the underlying asset or the site on which it is located, less any lease incentives received. The right-of-use asset is subsequently depreciated using the straight-line method from the commencement date to the earlier of the end of the useful life of the right-of-use asset or the end of the lease term. The estimated useful lives of right-of-use assets are determined on the same basis as those of operating fixed assets. In addition, the right-of-use asset is periodically reduced by impairment losses, if any, and adjusted for certain remeasurement of the lease liability. Where the Company determines that the lease term of identified lease contracts is short term in nature i.e. with a lease term of twelve months or less at the commencement date, right of use assets is not recognized and payments made in respect of these leases are expensed in the statement of profit or loss.

#### Lease liabilities

The lease liability is initially measured at the present value of the lease payments that are not paid at the commencement date, discounted using the interest rate implicit in the lease or if that rate cannot be readily determined, the Company's incremental borrowing rate. Generally, the Company uses its incremental borrowing rate as the discount rate.

Lease payments in the measurement of the lease liability comprise the following:

a. fixed payments, including in-substance fixed payments;

b. variable lease payments that depend on an index or a rate, initially measured using the index or rate as at the commencement date;

c. amounts expected to be payable under a residual value guarantee; and

d. the exercise price under a purchase option that the Company is reasonably certain to exercise, lease payments in an optional renewal period if the Company is reasonably certain to exercise an extension option, and penalties for early termination of a lease unless the Company is reasonably certain not to terminate early.

The lease liability is measured at amortized cost using the effective interest method. It is remeasured when there is a change in future lease payments arising from a change in an index or rate, if there is a change in the Company's estimate of the amount expected to be payable under a residual value guarantee, or if the Company changes its assessment of whether it will exercise a purchase, extension or termination option. When the lease liability is remeasured in this way, a corresponding adjustment is made to the carrying amount of the right-of-use asset, or is recorded in profit or loss if the carrying amount of the right-of-use asset has been reduced to zero.
#### 3.6 Financial instruments

All financial assets and financial liabilities are recognized at the time when the Company becomes a party to the contractual provisions of the instrument. All the financial assets are derecognized at the time when the Company losses control of the contractual rights that comprise the financial assets. All financial liabilities are derecognized at the time when they are extinguished that is, when the obligation specified in the contract is discharged, cancelled, or expires. Any gains or losses on de-recognition of the financial assets and financial liabilities are taken to the statement of profit or loss.

#### 3.6.1 Financial assets

The Company classifies its financial assets into following three categories:

- fair value through other comprehensive income (FVOCI);
- fair value through profit or loss (FVTPL); and
- measured at amortized cost.

The classification depends on the entity's business model for managing the financial assets and the contractual terms of the cash flows. A financial asset is initially measured at fair value plus, for an item not at FVTPL, transaction costs that are directly attributable to its acquisition.

#### (i) Amortized cost

Assets that are held for collection of contractual cash flows where those cash flow represents solely payments of principal and interest are measured at amortized cost. Interest income from these financial assets, impairment losses, foreign exchange gains and losses, and gain or loss arising on derecognition are recognized directly in profit or loss.

#### (ii) Fair value through other comprehensive income

Financial assets at fair value through other comprehensive income are held within a business model whose objective is achieved by both collecting contractual cash flows and selling financial assets and the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

#### (iii) Fair value through profit or loss

Assets that do not meet the criteria for amortized cost or fair value through other comprehensive income or assets that are designated at fair value through profit or loss using fair value option, are measured at fair value through profit or loss. A gain or loss on debt investment that is subsequently measured at fair value through profit or loss is recognized in profit or loss in the period in which it arises.

#### 3.6.2 Financial liabilities

The Company classifies its financial liabilities in the following categories:

- at fair value through profit or loss; and
- other financial liabilities

The Company determines the classification of its financial liabilities at initial recognition. All financial liabilities are recognized initially at fair value and, in the case of other financial liabilities, also include directly attributable transaction costs. The subsequent measurement of financial liabilities depends on their classification, as follows:

#### a) Fair value through profit or loss

Financial liabilities at fair value through profit or loss include financial liabilities held-for-trading and financial liabilities designated upon initial recognition as being at fair value through profit or loss. The Company has not designated any financial liability upon recognition as being at fair value through profit or loss.

#### b) Amortized cost

After initial recognition, other financial liabilities which are interest bearing are subsequently measured at amortized cost, using the effective interest rate method. Gain and losses are recognized in the statement of profit or loss, when the liabilities are derecognized as well as through effective interest rate amortization process.

#### Offsetting

A financial asset and financial liability is off-set and the net amount is reported in the statement of financial position when there is a legally enforceable right to set-off the transaction and also there is an intention to settle on a net basis or to realize the asset and settle the liability simultaneously.

#### 3.6.3 Impairment of financial assets:

The Company assesses on a forward looking basis the Expected Credit Losses (ECL) associated with its debt instruments carried at amortized cost and FVTOCI. The impairment methodology applied depends on whether there has been a significant increase in credit risk.

Following are financial instruments that are subject to the ECL model:

- Trade debts
- Cash and bank balances

#### General approach for loans, advances and deposits and cash and bank balances

The measurement of expected credit losses is a function of the probability of default, loss given default (i.e. the magnitude of the loss if there is a default) and the exposure at default. The assessment of the probability of default and loss given default is based on historical data adjusted by forward-looking information (adjusted for factors that are specific to the counterparty, general economic conditions and an assessment of both the current as well as the forecast direction of conditions at the reporting date, including time value of money where appropriate). As for the exposure at default for financial assets, this is represented by the assets' gross carrying amount at the reporting date. Loss allowances are forward-looking, based on 12 month expected credit losses where there has not been a significant increase in credit risk rating, otherwise allowances are based on lifetime expected losses.

Expected credit losses are a probability weighted estimate of credit losses. The probability is determined by the risk of default which is applied to the cash flow estimates. In the absence of a change in credit rating, allowances are recognized when there is reduction in the net present value of expected cash flows. On a significant increase in credit risk, allowances are recognized without a change in the expected cash flows, although typically expected cash flows do also change; and expected credit losses are rebased from 12 month to lifetime expectations.

#### Simplified approach for trade debts

The Company recognizes life time ECL on trade debts using the simplified approach. The measurement of ECL reflects: - an unbiased and probability-weighted amount that is determined by evaluating a range of possible outcomes.

- reasonable and supportable information that is available at the reporting date about past events, current conditions and forecasts of future economic conditions.

As the Company applies simplified approach in calculating ECLs for trade debts the Company does not track changes in credit risk, but instead recognized a loss allowance based on life time ECLs at each reporting date. ECLs on these financial assets are estimated using a provision matrix approach adjusted for forward looking factors specific to the debtors and economic environment.

The Company recognizes an impairment gain or loss in the statement of profit or loss for all financial instruments with a corresponding adjustment to their carrying amount through a loss allowance account, except for investments in debt instruments that are measured at FVTOCI, for which the loss allowance is recognized in other comprehensive income and accumulated in the investment revaluation reserve, and does not reduce the carrying amount of the financial asset in the statement of financial position.

#### 3.7 Fair value measurement

Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. The fair value measurement is based on the presumption that the transaction to sell the asset or transfer the liability takes place either:

i) In the principal market for the asset or liability; or

ii) In the absence of a principal market, in the most advantageous market for the asset or liability.

The principal or the most advantageous market must be accessible by the Company. The fair value of an asset or a liability is measured using the assumptions that market participants would use when pricing the asset or liability, assuming that market participants act in their economic best interest.

The Company uses valuation techniques that are appropriate in the circumstances and for which sufficient data are available to measure fair value, maximizing the use of relevant observable inputs and minimizing the use of unobservable Level 1 - Quoted (unadjusted) market prices in active markets for identical assets or liabilities;

Level 2 - Valuation techniques for which the lowest level input that is significant to the fair value measurement is directly or indirectly observable; and

Level 3 - Valuation techniques for which the lowest level input that is significant to the fair value measurement is unobservable.

For assets and liabilities that are recognized in the financial statements at fair value on a recurring basis, the Company determines whether transfers have occurred between levels in the hierarchy by re-assessing categorization (based on the lowest level input that is significant to the fair value measurement as a whole) at the end of each reporting period.

The Company's Senior Management determines the policies and procedures for both recurring fair value measurement and for non-recurring measurement. External valuers may be involved for valuation of significant assets and significant liabilities. For the purpose of fair value disclosures, Company determines classes of assets and liabilities on the basis of the nature, characteristics and risks of the asset or liability and the level of the fair value hierarchy, as explained above.

#### 3.8 Taxation

Income tax on profit or loss for the year comprises current and deferred taxation. Current and deferred tax is recognized in the profit and loss account except to the extent that it relates to items recognized directly in equity in which case it is recognized in equity.

#### (a) Current

The profits and gains of the company derived from electric power generation are exempt from tax in terms of clause 132 of Part I of the Second Schedule to the Income Tax Ordinance, 2001, subject to the conditions and limitations provided therein. The exempted income is also excluded from the purview of Alternate Corporate Tax, applicable otherwise at 17% of accounting profit, under section 113C of the Ordinance. Under clause 11A of Part IV of the Second Schedule to the Income Tax Ordinance, 2001, the company is also exempt from levy of minimum tax on 'turnover' under section 113 of the Ordinance. However, full provision is made in the profit and loss account on income from sources not covered under the above clauses at current rates of taxation after taking into account, tax credits and rebates available, if any.

#### (b) Deferred

Deferred tax is accounted for using the balance sheet liability method in respect of all temporary differences arising from differences between the carrying amount of assets and liabilities in the financial statements and the corresponding tax bases used in the computation of the taxable profit. However, the deferred tax is not accounted for if it arises from initial recognition of an asset or liability in a transaction other than a business combination that at the time of transaction

Deferred tax liabilities are generally recognized for all taxable temporary differences and deferred tax assets are recognized to the extent that it is probable that taxable profits will be available against which the deductible temporary differences, unused tax losses and tax credits can be utilized.

Deferred tax is calculated at the rates that are expected to apply to the period when the differences reverse based on tax rates that have been enacted or substantively enacted by the balance sheet date. Deferred tax is charged or credited in the profit and loss account, except in the case of items credited or charged to other comprehensive income or equity in which case it is included in other comprehensive income or equity.

Deferred tax has not been provided in these financial statements as the company's management believes that the temporary differences will not reverse in the foreseeable future due to the fact that the profits and gains of the Company derived from electric power generation are exempt from tax subject to the conditions and limitations provided for in terms of clause 132 of Part I of the Second Schedule to the Income Tax Ordinance, 2001.

#### 3.9 Cash and cash equivalents

Cash and cash equivalents comprise cash in hand, cash with banks on current, saving and deposit accounts. Other short term highly liquid investments that are readily convertible to known amount of cash and which are subject to an insignificant risk of exchange in value are included as a component of cash and cash equivalents for the purpose of the statement of cash flow statement.

#### **4 OPERATING FIXED ASSETS**

Particulars	Computer and Office Furniture, accessories equipment fixtures		Furniture, fittings and fixtures	Total	
		R	upees		
Cost					
Balance as at December 11, 2019	-	-	-	-	
Additions during the period	265,500	280,620	-	546,120	
Disposals during the period	-	-	-	-	
Balance as at June 30, 2020	265,500	280,620		546,120	
Balance as at July 1, 2020	265,500	280,620	-	546,120	
Additions during the year	868,839	8,042,789	8,164,118	17,075,746	
Disposals during the year	-	(60,000)	-	(60,000)	
Balance as at June 30, 2021	1,134,339	8,263,409	8,164,118	17,561,866	
Depreciation					
Balance as at December 11, 2019	-	-	-	-	
Charge for the period	26,644	33,892	-	60,536	
Disposals during the period	-	-	-	-	
Balance as at June 30, 2020	26,644	33,892	-	60,536	
Balance as at July 1, 2020	26,644	33,892	-	60,536	
Charge for the year	161,398	2,019,955	1,169,637	3,350,990	
Disposals during the year	-	(12,339)	•	(12,339)	
Balance as at June 30, 2021	188,042	2,041,508	1,169,637	3,399,187	
Carrying value as at June 30, 2020	238,856	246,728	<u> </u>	485,584	
Carrying value as at June 30, 2021	946,297	6,221,901	6,994,481	14,162,679	
Annual rate of depreciation	33%	33%	20%		
5 RIGHT OF USE ASSET	<u></u>				

This pertains to rental premises acquired under a contract for a period of 5 years. Details of right-of-use asset are given below and that of related lease liability are given in note 12.

	Note	2021 Rupees	2020 Rupees
Cost			- And -
Initial recognition		65,298,612	-
Addition/modification		-	65,298,612
Depreciation			
Opening balance		(3,264,930)	-
Charge for the year/period	16	(9,794,793)	(3,264,930)
Closing balance		(13,059,723)	(3,264,930)
Closing net book value		52,238,889	62,033,682
PROJECT DEVELOPMENT COST			
Management services support fee	14.1	202,799,784	48,792,864
Project legal and technical consultancy		10,735,078	3,994,450
Project acquisition and development	6.1	1,017,019,152	57,037,200
Guarantee commission		6,660,803	3,265,436
Site survey and investigation services		11,334,463	-
		1.248.549.280	113 089 950

6.1 This includes USD 5,625,000 equivalent to Rs. 890,437,500 (2020: Rs. Nil) payable to Y.B Pakistan secured against bank guarantee (note 15) under Settlement, Project and Feasibility Rights Purchase Agreement between Korea South-East Power Company Limited and Y.B Pakistan Limited.

			2021	2020
7	INTANGIBLE ASSET	Note	Rupees	Rupees
	Cost			
	Initial recognition		-	-
	Addition/(deletion)	7.1	1,908,900	-
	Amortization			
	Opening balance		-	-
	Charge for the year/period	16	(583,339)	-
			(583,339)	
	Closing net book value		1,325,561	-
	Annual rate of amortization		33.33%	-
7.1	Intangible asset represents an ERP software procured during	the year.	<u></u>	<u> </u>
8	ADVANCES, DEPOSITS AND PREPAYMENTS		ē. i	
	Advances to employees - secured		77,504	110,199
	Security deposits		1,913,171	1,337,999
	Prepayments	8.1	1,401,473	6,297,370
	Others		2	6,490
			3,392,150	7,752,058
8.1	This mainly include prepaid rent Rs.1,062,424 (2020: Rs. 6,29	7,370) and pr	epaid insurance Rs. 1	334,152 (2020: Rs.
	Nil).		-	
			2021	2020
9	ADVANCE TAX - NET	Note	Rupees	Rupees
	Tax refundable at beginning of the year/period		60,585	-
	Income tax paid/withheld during the year/period		361,129	60,585
	Provision for taxation	18	(418,824)	-
	Tax refundable at end of the year/period		2,890	60,585
10	CASH AND BANK BALANCES			
	Cash at bank:			
	Current accounts			
	PKR - Habib metropolitan-6-99-02-29301-714-122638		5,504,281	4,216,151
	USD - Habib metropolitan-6-99-02-29301-333-122638			
	(2021:USD 11,784,739 (2020: 12,884,739))	10.1	1,865,524,206	2,174,299,727
			1,871,028,487	2,178,515,878
	Cash margin with bank against guarantee	10.2	(34,034,500)	-
	Cash in hand		202,988	24,155
			1,837,196,975	2,178,540,033
10.1	The bank balance amounting to USD \$5,625,000 is under lie	n against outs	tanding letter of guar	rantee as disclosed
	in note 15.			
10.2	This represents a cash margin of USD 215,000 against a bank	guarantee as	disclosed in note 15.	
			2021	2020
11	SHARE CAPITAL	Note	Rupees	Rupees
	Authorized share capital			
	25,000,000 (2020: 25,000,000) ordinary shares of Rs.100			
	each.		2,500,000,000	2,500,000,000
	Issued, subscribed and paid up capital			
	20,917,399 (2020: 20,917,399) ordinary shares of Rs. 100			
	each fully paid in cash	11.1	2.091.739 900	2 091 739 900
11.1	Korea South East Power Company Limited (KOSEP)	the holding	company holds	2 0917 384 (2020)
	2,0917,384) ordinary shares in the Company. KOSEP is inco	proprated in S	outh Korea having r	epistered office at
	32, Sadeul-Ro, 123 Beon-Gil, Iinju-Si, Gveongsangnam-Do. H	Republic of K	orea.	-0
		4	ሞ	

				2021	2020
12	LEASE LIABILITY		Note	Rupees	Rupees
	Opening balance			62,538,300	-
	Additions/modifications during the year	/period	5	-	63,045,645
	Interest expense	-		8,802,834	1,892,655
	Lease rentals paid during the year/period	ł		(17,400,000)	-
	Income related to Covid-19 concession i	n lease rental		-	(2,400,000)
	As at June 30			53,941,134	62,538,300
	Less: Current portion			(10,748,621)	(6,925,480)
	-			43,192,513	55,612,820
	Maturity of lease liability is as follows	5:			
	For the year ended June 30, 2021	Minimum			Present value
	<b>,</b>	lease payments		Interest	of minimum lease
					раумена
		•••••	****	Rupees	
	Less than one year	16,500,000		5,751,379	10,748,621
	Between one and five years	49,977,840	·	6,785,327	43,192,513
		66,477,840		12,536,706	53,941,134
	For the year ended June 30, 2020				Present value
		Minimum lease		Interest	of minimum lease
		payments			payments
				Rupees	
	Less than one year	17,400,000		7,170,363	10,229,637
	Between one and five years	66,477,840		14,169,177	52,308,663
		83,877,840		21,339,540	62,538,300
				2021	2020
13	DEFERRED LIABILITIES		Note	Rupees	Rupees
	Gratuity		13.1	1,149,414	_
	Provident fund			1,572,758	-
				2,722,172	-
13.1	Provision at the beginning of the year/p	eriod		-	-
	Charge for the year/period			1,223,414	-
	Payments during the year/period			(74,000)	-
	Provision at the end of the year/period			1,149,414	-
14	TRADE AND OTHER PAYABLES				
	Due to related party		14.1	174,608,030	45,710,851
	Payable to suppliers			5,568,721	2,784,858
	Payable to Y.B Pakistan Limited		6.1	890,437,500	-
	-			1,070,614,251	48,495,709

14.1 This represents payable to the holding company on account of management and advisory services being rendered to the Company on account of development of the Project under services and management support agreement (SMSA) dated February 07, 2020 (Note 21.1). The referred agreement is for the period of three years, extendable by mutual understanding.

Share of rent from KOEN Pakistan Branch

18 TAXATION - For the year

- Prior year

15	CONTINGENCIES AND COMMITMENTS			
15.1	Contingencies:			
-	Letter of guarantee issued by bank on behalf of the Co	mpany of USD 5,625	,000 (2020: USI	) 5,625,000) in
	favour of Y.B Pakistan Limited (Note 1) valid upto Septen	nber 30, 2021.		
-	In connection with the development of the project and	ursuant the Letter of I	ntent (LOI) dated	June 23, 2021
	the Company has arranged a Performance Guarantee of U favour of Pakhtunkhwa Energy Development Organization	SD 215,000 valid upto n, under the KPK Hyd	June 20, 2024 (2 ro Policy 2016.	020: Rs. Nil), in
-	Guarantee issued in favour of Pearl Continental Pesh	awar amounting to F	ls. 200,000 (202	0: Rs. Nil) for
	accommodation of personnel.	-		-
15.2	Commitments			
	Lease rentals aggregating to Rs. 10,560,000 payable by Feb	ruary 28, 2022 represe	nting the short te	rm leases.
		. –	2021	2020
16	ADMINISTRATIVE EXPENSES	Note	Rupees	Rupees
	Salaries, wages and benefits	16.1	17,882,244	966,629
	Depreciation - Operating fixed assets	4	3,350,990	60,537
	Depreciation - Right of use asset	5	9,794,793	3,264,930
	Amortization	7	583,339	-
	Rent, rates and taxes		4,107,421	2,520,624
	Vehicle running transportation		1,135,871	2,700
	Repairs and maintenance		402,866	18,850
	Traveling and conveyance		763,269	1,536,501
	Utilities		681,458	174,262
	Communication		531,772	77,390
	Office supplies		962,934	179,752
	IT supplies services		580,678	23,517
	Entertainment		2.265.492	439,691
	Security services		659,316	73,000
	Fees and subscriptions		367,798	10.028.125
	Auditor's remuneration	16.2	178.001	229,000
	Legal and professional		1.624.500	59,800
	Corporate relations	16.3	515,623	852.380
	Advertisement		175,000	12.602
	Miscellaneous		225.239	84,494
			46,788,604	20.604.784
16 1	This include provision of graphity provident fund leave	fore assistance and m	edical expense o	f Ro 1 223 A1A
10.1	(2020: Rs. Nil), Rs. 832,563 (2020: Rs. Nil), Rs. 652, 56 respectively.	68 (2020: Rs. Nil) and	Rs. 675,089 (20	20: Rs. 37,149)
			2021	2020
-			Rupees	Rupees
16.2	Auditor's remuneration			
	Statutory audit fee		100,000	100,000
	Other certifications		58,001	129,000
	Out of pocket expenses		20,000	-
			178,001	229,000
16.3	This includes donations of Rs. Nil (2020: Rs. 852,380) give	n to the Korean Emba	ssy.	
17			2021	2020
	UTHER (LOSS) / INCOME		Rupees	Rupees
	Exchange (loss)/gain - net Income related to Covid-19 concession in lance rental		(131,211,909)	181,231,319
	Interest income		-	2,400,000 63.668
				,0

<u>418,824</u> <u>418,824</u>

(131,029,254)

182,655

ŧ,

-

183,694,987

#### 19 FINANCIAL INSTRUMENTS AND FINANCIAL RISK MANAGEMENT

#### Financial risk management

The Company has exposure to the following risks from their use of financial instruments:

#### 19.1 Credit risk

#### 19.2 Liquidity risk

#### 19.3 Market risk

The Board of directors oversee how management monitors compliance with the Company's risk management policies and procedures, and reviews the adequacy of the risk management framework in relation to the risks faced by the Company. The management of the Company undertakes both regular and ad hoc reviews of risk management controls and procedures, the results of which are reported to the board of directors.

#### 19.1 Credit risk

Credit risk is the risk that one party to a financial instrument will fail to discharge an obligation and cause the other party to incur a financial loss. Concentration of credit risk arises when a number of counterparties are engaged in similar business activities or have similar economic features that would cause their ability to meet contractual obligations to be similarly affected by changes in economics, political or other conditions. Concentrations of credit risk indicate the relative sensitivity of the Company's performance to developments affecting a particular industry.

#### (a) Exposure to credit risk

The carrying amount of financial assets represents the maximum credit exposure. Credit risk of the Company arises principally from deposits, other receivables and bank balances.

The Company's credit risk exposures are categorized under the following headings:

	<u>2021</u>	2020
	Rupees	Rupees
Advances and deposits	1,990,677	1,454,688
Bank balances	1,836,993,987	2,178,515,878
Cash margin with bank against guarantee	34,034,500	
	1,873,019,164	2,179,970,566

The Company believes that no impairment allowance is necessary in respect of above financial assets as the recovery of such amounts is possible.

#### (d) Credit quality of financial assets

The credit quality of Company's financial assets have been assessed below by reference to external credit rating of counterparties. The counterparties for which external credit ratings were not available have been assessed by reference to internal credit ratings determined based on their historical information for any default in meeting

	Ratings	<u>2021</u> Rupees	<u>2020</u> Rupees
Advances and deposits	Not rated	1,990,677	1,454,688
Bank balances Cash margin with bank against guarantee		1,836,993,987	2,178,515,878
Counterparties with external credit ratings	A-1+ to AA+	1,871,028,487	2,178,515,878

#### 19.2 Liquidity risk

Liquidity risk is the risk that the Company will not be able to meet its financial obligations as they fall due. Prudent liquidity risk management implies maintaining sufficient cash and marketable securities, prudent fund management practices and the ability to close out market positions due to dynamic nature of the business. The Company's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Company's reputation.

The maturity profile of the Company's financial liabilities is as follows:

	Carrying amount	Within one year	One to five years	Total	
June 30, 2021		Rup	ees		
Deferred liabilities	1,149,414	-	-	1,149,414	
Lease liability	53,941,134	10,748,621	43,192,513	53,941,134	
Trade and other payables	1,070,614,251	1,070,614,251	-	1,070,614,251	
	1,125,704,799	1,081,362,872	43,192,513	1,125,704,799	
	Carrying amount	Within one year	One to five years	Total	
June 30, 2020	Rupees				
Deferred liabilities	-	_	_	**	
Lease liability	62,538,300	6,925,480	55,612,820	62,538,300	
Trade and other payables	48,495,709	48,495,709	-	48,495,709	
	111,034,009	55,421,189	55,612,820	111,034,009	

#### 19.3 Market risk

Market risk is the risk that the value of the financial instrument may fluctuate as a result of changes in market interest rates or the market price due to change in credit rating of the issuer or the instrument, change in market sentiments, speculative activities, supply and demand of securities and liquidity in the market. The Company incurs financial liabilities to manage its market risk. All such activities are carried out with the approval of the Board of directors. The Company is exposed to currency risks.

The Company's exposure to currency risk includes United States Dollar (USD) which is based on notional amounts is as under:

			2021	2020
			USD	USD
Bank balances			11,784,739	12,884,739
The following exchange rates have	e been applied.			
	Average rates	<b>Closing rates</b>	Average rates	Closing rates
	2021	2021	2020	2020
	(Ru	pees)	(Rup	ees)
United States Dollar (USD)	160.97	158.30	158.26	168.05

A reasonably possible strengthening (weakening) of the Pakistani Rupee against other currency at 30 June would have affected the measurement of financial instruments denominated in a foreign currency and affected surplus or deficit by the amounts shown below. This analysis assumes that all other variables, in particular interest rates, remain constant.

	June 30	), 2021	June 30, 2020			
	Statement of profit or loss		Statement of profit or loss			
Effect in Rupees	Strengthening	Weakening	Strengthening	Weakening		
	(Rup	ees)	(Rupees)			
USD Movement (2021: 10% , 2020: 10%)	186,552,420	(186,552,420)	216,528,814	(216,528,814)		

The Company is not exposed to any other type of market price risks.

#### 19.4 Accounting classifications and fair values

The following table shows the carrying amounts and fair values of financial assets and financial liabilities, including their levels in the fair value hierarchy.

		Carrying amount			Fair value			
	Note	Fair value through other comprehensive income	Amortized cost	Total	Level 1	Level 2	Level 3	Total
June 30, 2020				Rupees	هند – رس نوین داخت و هد 		ن الله علم خطر الله عن علم الله الله بور بي من الله الله عن علم الله عن علم الله الله عن علم الله الله عن علم مراجع الله الله الله الله الله الله الله الل	
Financial assets not measured at fair value								
Advances and deposits	8	-	1,454,688	1,454,688	-	-	-	-
Cash and bank balances	10	-	2,178,540,033	2,178,540,033	-	-	-	-
Cash margin with bank against guarantee	10				-			
Total		-	2,179,994,721	2,179,994,721	_	-	-	-
Financial liabilities not measured at fair value								
Lease liability	12	-	62,538,300	62,538,300	-	-	-	-
Trade and other payables	14		48,495,709	48,495,709	-	-	-	-
June 30, 2021								
Financial assets not measured at fair value								
Advances and deposits	8	-	1,990,677	<b>1,990,677</b>	-	-	-	-
Cash and bank balances	10	-	1,837 <b>,196,975</b>	1,837,196,975	-	-	-	-
Cash margin with bank against guarantee	10	<b></b>	34,034,500	34,034,500				
Total			1,873,222,152	1,873,222,152	-	-	-	-
Financial liabilities not measured at fair value								
Lease liability	12	-	53,941,134	53,941,134	-	-	-	-
Deferred liabilities	13	-	1,149,414	1,149,414	-	-	-	-
Trade and other payables	14		1,070,614,251	1,070,614,251	-			-
			1,125,704,799	1,125,704,799	-	-	-	-

#### **REMUNERATION OF CHIEF EXECUTIVES, DIRECTORS AND EXECUTIVES**

Directors and Chief Executive Officer are not entitled for any remuneration. Moreover, the aggregate amounts incurred during the year for remuneration, including all benefits to the executives of the Company were as

	2021 Rupees	2020 Rupees
Remuneration	5,986,564	-
House rent	2,680,150	-
Utilities	595,593	-
Provident fund	1,197,310	-
Gratuity payable	872,492	-
Other benefits	1,741,546	-
	13,073,655	
Number of executives	4	Nil
21 TRANSACTIONS WITH RELAT	ED PARTIES	

Related parties comprise of the holding entity, group entities, directors, key management personnel and entities over which directors are able to exercise significant influence. Significant transactions with related parties during the year, other than those which have been disclosed elsewhere in these financial statements are as follows:

	Note	2021 Rupees	2020 Rupees
Holding company	-		
			0 004 744 027
Equity received from holding company		-	2,091,741,037
Management fee payable to holding company	21.1	174,608,030	45,710,851
Associates			
Received from holding company's Branch Office, Islamabad	303,655	-	
Loan given/received back to/from holding company's	2,000,000	-	
Islamabad			
Share of rent from holding company's Branch Office, Islama	182,655	-	
		177,094,340	2 137 451 888

21.1 The Company has entered into services management support agreement with Korea South East Power Co., Ltd. (the holding company). In accordance with the terms of the agreements, the holding company provides management assistance to the Company in performance of their obligations under the Letter of Intent (LOI). Management will also assist for obtaining Letter of Support (LOS) and will sign relevant project agreements including Implementation Agreement, Power Purchase Agreement, Water Use Agreement, EPC Contracts and O&M Agreement, in future.

21.2 The transactions with related parties are made under mutually agreed terms and conditions.

22	NUMBER OF EMPLOYEES	2021 (Number)	2020 (Number)
_	Number of employees at the year/period end	11	5
	Average number of employees	11	5
23	COVID-19 IMPACT		

The World Health Organization has declared COVID-19 (the virus) a global pandemic. With the growing number of cases in Pakistan, the Government of Pakistan has provided directions to take measures to respond to the virus. While the virus has impacted the global economy, the Company's operations and financial results have not been materially impacted. In future also, the Company does not foresee any adverse impact on its operations and financial results.

#### 24 **GENERAL**

Figures have been rounded off to the nearest rupee, unless otherwise stated.

#### DATE OF APPROVAL OF FINANCIAL STATEMENTS 25

These financial statements were approved by the board of directors of the Company in their meeting held on October 6th 2021

DIRECTOR

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CHIEF EXECUTIVE



Form 34

THE COMPANIES ACT, 2017 THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018 [Section 227(2)(f)]

#### PATTERN OF SHAREHOLDING

PART-I

(Please complete in typescript or in bold block capitals.)

1.1 Name of the Company	ny KC			(OA	OAK POWER LIMITED									
<u>PART-II</u>														
2.1. Pattern of holding shareholders as at	g of th	ie shares	heid	by	the	3	0	0	6	]	2	0 2	1	
2.2. No of <u>Shareholdings</u>			2			]		Tota	al s	hare	es hel	<u>d</u>		
3	snare	nolding fro	m 1 to	100 8	snare	S								
	share	shareholding from 101 to 500 shares												
	share share	shareholding from 501 to 1000 shares												
	share	holding fro	m 1001	to 5	000									
	share	holding fro	m 5001	to 1	0000	•								
1	share 20,91	shareholding from 20,917,001 to 20,917,384						,384						
[]	(Add a	ppropriate	slabs of	shar	eholdi.	ngs)	٦				2	0.017	200	
2.2 Categories of shareholders						,399								
2.3 Categories of shareholders				<u>u</u> 										
2.3.1 Directors, Chief Executive Officer, and their spouse and minor children.										0%				
2.3.2 Associated Companies, undertakings and related parties.					20,917,384 10						00%			
2.3.3 NIT and ICP					-						-			
2.3.4 Banks De Institutions, Institutions.	ent Fir nking Fir	nancial nancial						-				-		
2.3.5 Insurance Companies						-								
2.3.6 Modarabas and Mutual Funds					-						-			
2.3.7 Shareholders	2.3.7 Shareholders holding 10%				20,917,384					]100%				
2.3.8 General Public a. Local	c I			Г					-	ſ			-	
b. Forei	gn			Γ							]			
2.3.9 Others (to be specified)									-	Ē				

Note: In case there are more than one class of shares carrying voting rights, the information regarding each such class shall be given separately.



Asrit Kedam Hydropower Project

26 January 2022



Mr. Yoon Ansang Chief Executive Officer KOAK Power Limited (a subsidiary of Korea South East Power Co.) Plot No. 7C, G-8 Markaz, Islamabad, Pakistan

#### Expression of Interest: 215 MW Asrit-Kedam Hydropower Project (the "Project")

Dear Mr. Asang,

We refer to the aforementioned Project which KOAK Power Limited ("KOAK"), the project company and a subsidiary of Korea South-East Power Co. ("KOEN") is presenting and requesting us to participate in its financing. KOAK has indicated that the Project consists of the design, engineering, construction and operation of a 215 MW hydro power plant located at Asrit-Kedam, Swat District, Khyber Pakhtunkhwa , Pakistan. The power generated by the Project will be sold to state owned Central Power Purchasing Authority under a 30 year take-or-pay Energy Purchase Agreement (EPA). It is also understood that in line with power policy of the country, the power purchaser will take the hydro risk and its obligations under the EPA will be counter guaranteed by the Government of Pakistan under an Implementation Agreement. Total project costs are estimated to be around USD 500 million, to be financed by 75% debt and 25% equity. KOEN will be the major sponsor of the project and together with its subsidiary KOAK will be responsible to develop, complete, commission and the maintain the Project.

The Asian Development Bank (ADB) is interested to consider participating - both as a lender and as a minority shareholder - in the financing of the Project. Such financing would be dependent upon a number of factors including our full satisfaction with the Project's financial, economic, environmental, integrity, social, procurement, structural and documentary underpinnings as well as the receipt of all requisite internal approvals and compliance with other guidelines set by ADB. Accordingly, ADB's interest in providing financing to the Project is subject to satisfaction of its due diligence review of the Project, and approval by ADB's management, Investment Committee, and Board of Directors. The amount and terms of ADB's financing facilities will be discussed at the appropriate stage but will be capped at up to \$100 million.

We would be pleased to enter into more detailed discussions with you on the financing of the Project once you have further advanced your discussions with the relevant Government authorities. Nothing herein shall constitute an offer or commitment by ADB to provide financing for the Project. If you have any questions or clarifications, please do not hesitate to contact Haroun Khawaja, Principal Investment Specialist (phone: +63-2-8632-6312 / email: hkhawaja@adb.org)

Yours Sincerely,

derathery

Mayank Choudhary Officer-in-Charge Infrastructure Finance Division South Asia, Central Asia, and West Asia Private Sector Operations Department

ASIAN DEVELOPMENT BANK 6 ADB Avenue, Mandaluyong City 1550 Metro Manila, Philippines Tel +63 2 8632 4444 Fax +63 2 8636 2444 www.adb.org



January 24, 2016

Korea South-East Power Company 32, Sadeul-ro 123 beon-gil, Jinju-si, Gyeongsangnam-do. Korea <u>stonebin1004@koenergy.kr</u>

Attention: Mr. Seokbin Hong, General Manager

Dear Mr. Hong:

l refer to our discussions concerning the ~\$450million, 215MW Asrit-Kedam hydropower project to be located on the Swat River in the Khyber Pakhtunkhwa province of Pakistan (the "Project"). We understand that Korea South-East Power Company ("KOEN") will be the lead sponsor developing the Project. We understand that you may have an interest in working with International Finance Corporation ("IFC") in developing financing options for the Project, including participation by IFC in the debt and equity financing as well as mobilization of additional debt financing from other sources to complete the financial plan.

I confirm that, based on our preliminary review of summary Project information provided by you, IFC is interested in pursuing opportunities of this nature, subject to IFC's comprehensive appraisal process, acceptable shareholders, satisfactory EPC and operation & management arrangements, design of a satisfactory security package and sponsor support arrangements, confirmation of the economic and financial viability of the Project. approval by IFC's Board of Directors and execution of mutually satisfactory documentation.

IFC's investment from our own resources is typically limited to 25% of project cost. This could be complemented by mobilization of additional resources through an IFC syndicated loan from sources such as Development Finance Institutions, Export Credit Agencies or international commercial banks.

You will appreciate that our statement of interest to consider financing this Project does not constitute a binding obligation of IFC to pursue further appraisal or financing for the Project. Please also note that this is a non-exclusive letter of interest.

We look forward to the opportunity of working with you on this project.

Sincerely Erik Becker

Manager, Middle East & North Africa Infrastructure and Natural Resources

Accepted and Agreed:

2121 Pennsylvania Ave., N.W. Washington, D.C. 20433 USA Phone: (202) 473-1000 . Facsimile: (202) 477-6391



Asrit Kedam Hydropower Project

# D12 Board of Directors Resolution KOAK POWER LIMIED

Asrit Kedam Hydropower Project



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pg. 1

Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

Ref: KOAK/CS/True Extracts/ 476 /2022

#### TRUE EXTRACTS APPROVAL OF THE RESOLUTIONS BY THE BOARD OF DIRECTORS ON 1<sup>ST</sup> JUNE 2022

#### TO RESOLVED THAT THE COMPANY BE AND IS HEREBY AUTHORIZED TO APPLY FOR THE POWER GENERATION LICENSE TO NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA) AND TO AUTHORIZED AND EMPOWERED CHIEF EXECUTIVE OFFICER OF THE COMPANY TO SIGN, EXECUTE AND DEAL WITH THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA) REGARDING THE GENERATION LICENSE AND OTHER RELATED APPROVALS AND REPRESENT AND SIGN ALL THE RELATED DOCUMENTS IN RESPECT OF THE SAME ON BEHALF OF THE COMPANY

Whereas, under the conditions of LOI, Company needs to submit its application to National Electric Power Regulatory Authority (NEPRA) for Generation License and to authorized and empowered Chief Executive Officer of the Company to sign, execute and deal with the NEPRA regarding the generation license and other related approvals and represent and sign all related documents in respect of the same on behalf of the Company.

Therefore, all Board members unanimously passed following resolutions.

**"RESOLVED THAT KOAK POWER LIMITED**, a company incorporated under the laws of Pakistan with its registered office located at 12A, CBC Building, 1st Floor, G-8 Markaz, Islamabad (the "Company") be and is hereby authorized to submit an application for Generation License (including any subsequent modification) to the National Electric Power Regulatory Authority (the "NEPRA") for the grant of Generation License in respect of its 229 MW (Gross) Asrit Kedam Hydropower Project to be located at Swat River, Swat, Khyber Pakhtunkhwa, Pakistan (the "Project") and in relation thereto, enter into and execute all documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required,"

**"RESOLVED FURTHER THAT** in respect of application for the Grant of Generation License (including any modification to the application for the Grant of Generation License) to NEPRA, MR. YOON ANSANG the Chief Executive Officer (the "Authorized Representatives"), be and is hereby acting singly empowered and authorized for and on behalf of the Company to;

i. prepare, review, execute, submit and deliver the Generation License Application (including any modification to the application for the Grant of Generation License) and related documentation required by National Electric Power Regulatory Authority, including any contracts, documents, power of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications,



notices, certificates, requests, statements, and any other instruments in respect to the Generation License;

- ii. represent the Company in all negotiations, representations, presentations, hearings, conferences and/or meetings of any nature whatsoever with any entity (including, but in no manner limited to NEPRA, any private parties, companies, partnerships, individuals, governmental and/or semi-governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever).
- iii. sign, certify and execute all necessary documentation, pay the necessary fees, appear before the NEPRA as and when required, and do all acts necessary for the completion and processing of the application for the Generation License (including any modification).
- iv. do all such acts, matters and things as may be necessary for carrying out the purpose aforesaid and giving full effect to the above resolution/resolutions."

Certified further that the above resolutions are included in the minute's book of the Company. It is further stated that the information given above is correct and true to the best of our knowledge and belief.

### On behalf of the Board and Company

TARIQ MAHMOOD Company Secretary

Place: Islamabad Dated: 1<sup>st</sup> June 2022



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**YOON, ANSANG** Director/CEO



Asrit Kedam Hydropower Project

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#### Before

## The National Electric Power Regulatory Authority

Affidavit of Yoon An Sang S/o Young Kyunhaving Passport No. M07037396 resident of Apartment 1006-B Plot No.1, Jinnah Avenue, Tower B, The Centaurus, Sector F-8, Islamabad andauthorized representative of KOAK Power Limited having its registered office at 12A, CBC Building, 1<sup>st</sup> Floor, G-8 Markaz, Islamabad (the "Company")

I, the above-mentioned Deponent, do hereby solemnly affirm and declare that:

I am the Chief Executive Officer of the Company.

I have been authorized representative of the KOAK Power Limited by virtue of Board of DirectorsResolution dated June 1, 2022.

I state that no generation application related to Asrit Kedam Hydropower Project has ever been submitted to or refused by NEPRA.

I further state that the applicant has not been granted any other license by the NEPRA.







Asrit Kedam Hydropower Project



1<sup>st</sup> Floor, 12-A CBC Building, G-8 Markaz, Islamabad, Pakistan Tel: 051–8735923, 051–8735924

#### **Project Location**

The Asrit Kedam Hydropower Project (AKHPP) is located in the Khyber Pakhtunkhwa Province (previously "North-West Frontier Province") of Pakistan on the Swat River in the reach between the Asrit and Kedam Villages. The Swat River is formed by the junction of the Gabral and the Ushu Rivers at the Kalam. The river flows southward and then flows westward until joined by the Panjkora River. After the confluence, the river enters the Peshawar Valley and meets with the Kabul River. The total length of the Swat River is about 225km and its catchment basin in the intake site of Asrit-Kedam project covers an area of 2,213km<sup>2</sup>. A hydrometric station has been in operation since 1960 at the Kalam, located around 12km upstream of the intake of the Asrit-Kedam project. Average annual flow at the intake site of the project is estimated to be about 96.4m<sup>3</sup>/s. The Project location map is shown below:





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Asrit Kedam Hydropower Project

# Letter of Intent issued by PEDO KOAK POWER LIMIED

Asrit Kedam Hydropower Project



PEDO



PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION Government of Khyber Pakhtunkhwa Peshawar

> No. 431-38/PEDO/DREPP/KOEN/LOI Dated: 23.06.2021

То

M/S Korea South East Power Company (Lead Applicant), through M/s KOAK Power Limited (Project Company), Plot # 7-C, G-8 Markaz, Islamabad.

#### Subject: LETTER OF INTENT (LOI) FOR APPROXIMATELY 215 MW ASRIT-KEDAM HYDRO POWER PROJECT (the "Project")

#### WHEREAS

- A) Government of Khyber Pakhtunkhwa (GoKP) signed Memorandum of Understanding (MOU) on May 15, 2017 with M/S Korea South East Power Company (KOEN) for the development of 215 MW Asrit-Kadam Hydropower Project under the KP Hydro Power Policy 2016. Notice to Proceed (NTP) was issued on January 10, 2018.
- B) Proposal dated November 17, 2020 including the Statement of Qualification (SOQ) (the "Proposal") was submitted by M/S Korea South East Power Company (KOEN) (the "Main Sponsor"), having its registered address at 32, Sadeul-ro 123beon-gil, Jinju-si, Gyeongsangnam-do, Korea; (Main Sponsor Korea South East Power Company (KOEN) referred herein as the "Sponsors");
- C) PEDO issued No Objection Certificate (NOC) dated June 21, 2021; and
- D) The Main Sponsors through KOAK Power Limited delivered an irrevocable, unconditional, on demand bank guarantee No. HMB/LG/99/02/1500017/2021 dated June 21, 2021, on terms acceptable to PEDO, issued by Habib Metropolitan Bank Limited, Islamic Banking Branch, Hill View Plaza, Near Fresco Sweets, Jinnah Avenue, Blue Area, Islamabad, in the amount of US \$ 215,000/- (United State Dollar Two Hundred and Fifteen Thousands only) valid up to June 20, 2024 (hereinafter referred to as the 'Performance Guarantee') in favour of PEDO.

#### **NOW THEREFORE**

In terms of the provisions of the KP Hydro Power Policy 2016 and associated Guidelines (the "**Policy**"), the LOI is issued to the Sponsors for updating/conducting a bankable feasibility study (the "**Feasibility Study**") for establishing, in private sector, an approximately 215 MW Asrit-Kedam Hydropower Project to be located on Swat River in Swat District, Khyber Pakhtunkhwa (KP), Pakistan (the "Project") and to perform such actions as provided hereinafter in accordance with the following terms and conditions:

Room # 332, Plot # 38 / B-2, PEDO House, Phase-5, Hayatabad, Peshawar, Tel: 091-9217246



PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar



The Sponsors shall be required to update/carry out the Feasibility Study, complete, at 1. internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy for the Project, at no risk and cost to, and without any obligation on part of, the GOKP and its agencies, within 12 months from the date of issuance of this LOI. Indicative Terms of Reference (TOR) for the Feasibility Study at Annex-A. The Feasibility Study shall include, but not limited to, an environmental & social impact assessment study, optimized layout of the Project components, detailed design of power house and its allied structures, load flow and stability studies, design of interconnection/transmission lines, details pertaining to infrastructure, detailed bill of quantities and rate analysis of major items, project cost, financing plan, financing terms, tariff calculations and assumptions of financial calculations including economic/financial analysis. You are advised to liaise with the power purchaser while determining your plant size and site, project layout, transmission line and interconnection arrangements, etc. In addition you will also be required to liaise and coordinate with the sponsors of other upstream and downstream projects at Swat River in order to ensure that the design and other parameters/features of the Project do not affect such other projects.

2. The Sponsors shall submit detailed project milestones within one month of signing of this LOI and shall submit monthly progress reports showing progress against these milestones.

3. PEDO will appoint a Panel of Experts (POE) to monitor the conduct of the Feasibility Study and its progress, to verify attainment of the aforesaid milestones and to ensure implementation of the project consistent with national and provincial needs.

4. The Sponsors shall be jointly and severally liable for all obligations and liabilities hereunder. Furthermore, the approval of Feasibility Study by PEDO is subject to fulfillment by the Sponsors of the terms and conditions under and in accordance with the Policy and commitment made under SOQ.

5. Within ninety (90) days after the approval of Feasibility Study by GOKP/PEDO, you are also required to finalize and file a complete feasibility stage tariff petition before National Electric Power Regulatory Authority (NEPRA) in accordance with NEPRA's Mechanism for Determination of Tariff for Hydropower Projects. Furthermore, within sixty (60) days after such tariff determination / approval by NEPRA of the feasibility stage tariff, the Sponsors, after meeting all requirements under the Policy including but not limited to posting of an irrevocable, unconditional, on demand bank Guarantee on terms acceptable to PEDO/PPIB in an amount equal to US\$ 5,000/MW shall apply to PPIB for issuance of Tripartite Letter of Support (LOS).

6. PEDO shall be entitled to encash the Performance Guarantee and the LOI shall stand terminated without any notice. In the event, the Sponsors delays, defaults or fails either to:

- i Complete Feasibility Study within 12 months from the date of issuance of this LOI in accordance with the terms hereof.
- ii. File petition before NEPRA, in accordance with NEPRA's Mechanism for Determination of Tariff for Hydropower Projects, within ninety (90) days of the

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# PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar



approval of the Feasibility Study by GOKP/PEDO, for tariff determination.

- Apply to PPIB for issuance of Tripartite LOS within sixty (60) days of tariff determination by NEPRA; or
- iv. Extend the validity of the Performance Guarantee as and when required.

7. If PEDO acting in its sole discretion determines that any extension is required by the Sponsors in relation to their obligations to achieve any milestone(s) under the LOI, PEDO shall be entitled acting on an application in writing made to it by the Main Sponsors at least thirty (30) days before the expiry of such milestone, to grant in writing to the Sponsors such extension as is prescribed under and subject to such conditions as provided in the Policy.

8. The Performance Guarantee shall secure the Sponsor's obligations under and in accordance with the terms of this LOI. The Performance Guarantee shall remain valid and in full force until the date falling three (3) months beyond the expected date for issuance of Tripartite LOS, If the Performance Guarantee is due to expire within thirty (30) days and is required to be maintained by the Sponsors, the Sponsors shall renew the Performance Guarantee no later than ten (10) days before its expiry, failing which PEDO shall be entitled to encash the Performance Guarantee in full and hold such cash as security for the obligations of the Sponsors under the LOI.

9. The Sponsors shall hold not less than fifty one percent (51%) of the equity during Lock in Period (commencing from the date of issuance of this LOI until the sixth ( $6^{\text{th}}$ ) anniversary of the commissioning of the Project). The Main Sponsor shall hold not less than twenty percent (20%) of the equity during the Lock in Period.

10. This LOI shall be effective from the date hereof, and remain valid till the issuance of Tripartite LOS by PPIB or unless terminated earlier in accordance with the terms hereof. Nevertheless, this LOI shall lapse if the signed copy is not received at PEDO within fifteen (15) days of its issuance.

11. This LOI shall in no way be construed as an award of the Project as no such vested legal or contractual rights shall accrue, in your favor, till such time, valid Project Agreements (as defined in the LOS) are executed in accordance with the terms and conditions contained therein.

12. Issuance of this LOI or any act done in terms hereof or its termination, lapse or expiry or Sponsors' conduct of Feasibility Study hereunder cannot form the basis of any claim for compensation or damages by the Sponsors or any party claiming through them against the Government of Khyber Pakhtunkhwa, PEDO or any of its agencies on any grounds whatsoever, during or after the expiration, lapse or termination of the LOI.

13. The obligations and liabilities of the Sponsors under the LOI and the Performance Guarantee shall be joint and several. Any notice or communication by or to the Main Sponsor under this LOI shall be deemed a notice or communication to or by the entire Sponsors.

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14. The rights and obligations of the parties pursuant to and under this LOI shall be governed by the laws of Pakistan and the Courts of Pakistan shall have exclusive jurisdiction in relation to any dispute or matter arising out of or in connection herewith. The court of jurisdiction will be at Peshawar High Court.

This LOI has been issued in duplicate on the date hereof. Kindly sign the attached copy of this LOI at the place indicated and returns the same to us no later than fifteen (15) days of its issuance.



Encl.: 1) Indicative Terms of Reference (TOR) for the Feasibility Study of Hydropower Project (Annex-A)

Cc:

- 1. Chairman NEPRA, NEPRA Tower, Ataturk Avenue, G-5/1 (east), Islamabad.
- 2. MD NTDCL, 4th Floor, PIA Tower, Egertorn Road Lahore.
- 3. CEO, CPPA-G, Shaheed-e-Millat Secretariat, Blue Area Islamabad.
- 4. MD PPIB, Immigration Tower, G-8/1, Mauve Area Islamabad.
- 5. CEO PESCO, WAPDA House, Shami Road, Peshawar.
- 6. PS to Secretary E&P Department, Civil Secretariat, Peshawar.
- 7. PS to Secretary Environment Department, Civil Secretariat, Peshawar.

# ESIA approval by EPA (KPK) KOAK POWER LIMIED

Asrit Kedam Hydropower Project



## Environmental Protection Agency Environment Department

Govt. of Khyber Pakhtunkhwa No. EPA/EIA/AshvitKedan/238 Date: 27/04/2012

Viqar Ahmad Khan, Director Administration, Yunus Brothers, Gadoon Textile Mills Limited 200/201, Industrial Estate Gadoon Amazai, District Swabi,

Subject:

Supplier Provident

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#### Environmental Impact Assessment Report of 215 Mega Watt Asrit Kedam Hydropower Plant on River Swat in Balakot District Swat

I am directed to enclose herewith Legal Environmental Approval/ Jourt 1 Let. on 11/4 report of Ashrit Kidam Hydro Power Project (209 MW), District Swat for your information and further implementation. The Schedule VII (copy enclosed) must be submitted to this Agency within a month on Stamp Paper of Rs. 30/- as an undertaking for the compliance of terms and conditions as mentioned in the Legal Approval as well as mitigation measures proposed in the EIA Report.

124.2.1

Deputy Director 

montal in the Section 2011 (Dams Asrat Kidam

3<sup>10</sup> Floor, SDU Building, Khyber Road, Peshawar Cantt Felephone: 92 (91) 9210263, Fax: 92 (91) 9210280

#### SCHEDULE-VI

#### **Decision on EIA**

	Hame, address of proponent:	Yunus Brothers Group, 1-A, Gordhandas Market, M.A. Jinnah Road, Karachi, Tel # (021) 2438523 Fax # (021) 2414597, 2443028
		Ashrit Kidam Hydro Power Project has planned to install on the right bank of River Swat. It will utilize the available head between Ashrit Khwar and Kidam Khwar, which are the two tributaries of the River Swat. It will comprises a 209 MW run-of-the-river hydroelectric power plant on River Swat with an average generation capacity of 945 GWh or average daily production of 107 MWh. The project include a weir and intake, a headrace power tunnel running on the right side of the Swat Valley and a power house at a distance or 600 meter up stream of the confluence of Kidam Khwar and Swat River. The weir and intake will be located about 100 meter downstream of the confluence of Ashrit Khwar in Swar River and underground power house located in the vicinity of Kedam.
`	Location of project.	The project is located in District Swat.

#### 3. Date of filing of EIA.

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18/06/2008 (Ref: EPA Diary No.1431)

This construction Agracy, and a whyber Pakhtunkhwa has decided to accord approval of the Environmental Impact Assessment for Ashrit Kidam Hydro Power Project (209 MW) District Swat, for construction phase, in line with the quidelines issued by Pak. EPA and IEE/EIA Regulations, 2000, subject to the following terms & conditions:-

Page 1 of 4

- a) The proponent will adopt all precautionary and mitigation measures identified in EIA report as well as any unanticipated impacts during the construction and operation phase of the project.
- c) Any land or building acquired on temporary basis should be handed over to the owner in its original position.
- d) Retaining wall should be constructed as and where required to protect the soil erosion due to the project.
- e) Present right of way of irrigation (if any) should be protected.
- f) Non-Technical jobs should be provided to the local community. Employment record for all positions shall be provided to EPA, Khyber Pakhtunkhwa and priority should also be given to local in technical jobs.
- g) Separate NOC is required for batching or crushing plant.
- h) No extension would be permitted in the future in the existing hydro power without prior approval of EPA, Govt. of Khyber Pakhtunkhwa.
- i) The proponent shall provide the copy of this approval and EIA Report to the contractor for information and compliance.
- j) Actual cutting of trees and plantation plan should be submitted to this Agency before the physical work starts.
- k) The proponent should ensure to avoid dumping of debries into down slop. A prior area should be identified for disposal of debries and be stabilized by proper plantation, bio engineering and engineering techniques.
- In case the blasting is inevitable, the control techniques, in accordance with Pakistan Explosive Act should be adopted in sliding and prospective sliding prone areas.
- m)The proponent should ensure the strict and efficient health and safety measures for the protection of workers and passers by backed by a comprehensive emergency response plan.
- n) In case the articles of archeology importance like artifacts, coins rockarts and other archeology relics are discovered, the work at the site should immediately be stopped and the concerned department or agency should be consulted for appropriate action.

Page 2 of 3

- o) Filters at the entrance of the tunnel shall be installed to protect fish population and construct a fish farm to protect the indigenous and introduced fish.
- p) Social development programme in the area (health, education, communication etc) in consultation with local community may be implemented in the project area.
- 6. The proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.
- 7. The proponent shall be liable for compliance of Sections 13,14,17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.
- 8. This approval is accorded only for the installation/ construction phase of the project. The proponent will obtain approval for operation of the hydro power project in accordance with the Section 13 (2) (b) and Section 18 of the IEE/EIA Regulations, 2000.
- 9. Any change in the approved project shall be communicated to EPA, Khyber Pakhtunkhwa and shall be commenced after obtaining the approval.
- (i). This approval shall be treated as null and void if all or any of the conditions mentioned above is/are not complied with.
- 11 This approval does not absolve the proponent of the duty to obtain any other approval or clearance that may be required under any law in force.
- 12. There is no legal case pending in the courts against the project.
- 13. In exercise of the power under Section 12 of the Pakistan Environmental Protection Act, 1997, the undersigned is pleased to approve the EIA Report for construction phase of the project with above mentioned terms and conditions.

Tracking/File.No. EPA/EIA/AK-HPP/238

DIRECTOR GENERAL <sup>2</sup> '|4|\\ EPA, Khyber Pakhtunkhwa. 3<sup>rd</sup> Floor, SDU Building, Khyber Road Peshawar Cantt.

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# FS Report approval by PEDO KOAK POWER LIMIED

Asrit Kedam Hydropower Project



То

PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar



No.241-47/PEDO/CEREPP/FS/AKHPP Dated: May 31, 2022

Mr. Yoon, An Sang, Chief Executive Officer (CEO), KOAK Power Ltd. Korea South-East Power Company Limited, (KOEN), Plot 7-C, G-8 Markaz, Islamabad, Pakistan

#### Subject: <u>APPROVAL OF FEASIBILITY STUDY UPDATE FOR 229 MW ASRIT-KEDAM HPP,</u> LOCATED ON SWAT RIVER, DISTRICT SWAT

References: i. Letter of Interest (LOI) dated June 23, 2021

- ii. Feasibility Study submitted dated April 22, 2022
- iii. Minutes of POE Meeting dated April 14, 2022, issued vide PEDO letter no. 208-21/PEDO/CEREPP/PoE/MoM/AKHPP dated May 23, 2022.

PEDO is pleased to communicate following decision of Panel of experts (POE) of PEDO, monitoring the conduct of Feasibility Study for the subject project:

"The feasibility Study for 229 MW Asrit-Kedam Hydropower Project on Swat River, District Swat carried out by the consultants for M/S KOEN is approved in accordance with KP Hydropower Policy 2016 and Associated Guidelines subsequent to NOCs from Environment Protection Agency (EPA) and Power Evacuation Consent from National Transmission & Dispatch Company Limited (NTDCL)."

2. Due to nature of data and resultant conclusion, Panel of Experts jointly and/or individually will not be responsible for reliability of data, contents and conclusions given in the feasibility study.

3. As the feasibility study has been carried out at the risk & cost of the sponsor, the approval of feasibility study shall not form basis of any claim for compensation from Govt. of KP / PEDO in future.

4. In accordance with the KP Hydropower Policy 2016, upon the approval of the feasibility study by the POE, you are requested to process the case for tariff determination with NEPRA within 90 days.

5. PEDO appreciates your efforts to complete the feasibility study and expect the same pace and spirit for negotiation and finalizing tariff with NEPRA.

Director (Commercial & Tariff) PEDO, Peshawar

#### Copy for information to:

- 1. Managing Director, NTDCL, Lahore.
- 2. Managing Director, PPIB, Islamabad.
- 3. CEO, CPPA-G, Islamabad.
- 4. Registrar, NEPRA, Islamabad.
- 5. PS to Secretary, E&P Department, Peshawar.
- 6. PS to CEO, PEDO, Peshawar.

Director (Commercial & Tariff) PEDO, Peshawar


PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION



Government of Khyber Pakhtunkhwa Peshawar

PEDO House, 38/B-2, Phase-V, Hayatabad, Peshawar. Tel: (+92-91) 9217246

No. /PEDO/CEREPP/PoE/MoM/AKHPP Dated: May 23, 2022

То

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- 1. Secretary, Energy & Power Department, Peshawar
- 2. Secretary, Environment Department, Peshawar
- 3. Managing Director, NTDCL, Lahore
- 4. Managing Director, PPIB, Islamabad
- 5. Chief Executive Officer, PESCO, Peshawar
- 6. Chief Engineer (North), Irrigation, Peshawar
- 7. Mr. Amin Khalil (E&M Advisor), PEDO
- 8. Chief Engineer, RE/PP, PEDO
- 9. Director, P&F, PEDO
- 10. Mr. Muhammad Shafi (Geology / Geotechnical Expert)
- 11. Mr. Karim Khan (DD Hydrology), PEDO

### Subject: MINUTES OF THE PANEL OF EXPERT (POE) MEETING

I am directed to refer to the subject noted above and to enclose herewith minutes of the Panel of Expert (PoE) meetings held on February 17, 2022 and April 14, 2022 in the Committee Room of PEDO House Peshawar, for review/approval of feasibility study of 229 MW Asrit Kedam HPP, District Swat.

Deputy Director (RE-I) Private Power

#### Copy for information to:

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- 1. Chief Engineer (Dev), PEDO, Peshawar.
- 2. PS to CEO, PEDO, Peshawar.
  - Mr. Yoon, An Sang, CEO, KOAK Power Ltd.

Deputy Director (RE-I) Private Power

### Minutes of the Panel of Experts (PoE) of PEDO

### Dated: April 14, 2022 in PEDO House Peshawar

- 1. A meeting of the Panel of Experts (PoE) was held on April 14, 2022 at 10:30 AM in the committee room of PEDO House, Peshawar to review/approve feasibility study of 215 MW Asrit-Kedam HPP. The list of participants is attached as Annex-I.
- 2. Director REP/PP, PEDO welcomed all participants of the meeting. Afterwards, the meeting progressed towards the following agenda items.

S. No	Project	Discussions	<b>Recommendations/Decisions</b>	
1	215 MW Asrit- Kedam HPP	The forum was informed that during the course of feasibility study, several PoE meetings have been conducted wherein certain comments have been raised by the PoE.		
		The forum was further informed that during the previous meeting of the PoE the overall progress of the feasibility study particularly Geotech investigations have been deliberated upon in detail. Director (RE) PEDO briefly asked relevant sector experts of the PoE for any comments/discussions. After which the meeting progressed towards formal proceedings. The consultant then presented responses to the PoE comments made during previous meetings and PoE site visit.	Irrigation department being one of the main stakeholders joined the meeting via zoom and requested to leave early due to some other engagements, however, they cleared that the project area has been visited by them and there is no irrigation facility available in the vicinity which can be affected by the project.	
		i. The forum was apprised about the status of additional bore hole at PH location. The geological expert from consultant told that 106m of drilling has been completed at the location. The progress has been slow due to rock slip which caused a 5-6 days delay. He also informed that the RQD of the rock is getting better as we drill deeper and it can confirm the cavern PH. It was also informed that shear zones are present at 2-3 locations in the project area to which Mr. Shafi suggested satellite imagery of the area for the additional data which will be used in the next design stage, however, the FS recommendation chapter shall highlight the same. Mr. Shafi stated that Dam stability is not justified having only 10m drilled where very poor fractured rock was recovered, and the seepage will not be controllable later. Project sponsor informed that secant pile of 15m will be used	i. PoE advised that the drilling should be extended to at least 150m, however, it was mutually agreed that the drilling machine being used has certain limitation and a maximum depth of 125- 130m can be achieved only. It was agreed that the project sponsor shall continue drilling after the meeting until 125 m and further to this the consultant shall make a two-pager technical document recommending the cavern PH stating that the core recovery and RQD is better based on the result of 125m drilling and the land geology is suitable for the cavern powerhouse considering the financial implications as well.	

<ul> <li>river. The POE expressed satisfaction on the proposed layout resulted to lower cost of the project.</li> <li>The sponsor presented the BoQ, unit rate analysis of electro-mechanical equipment and of TBM were produced in support of the cost estimates. The sponsor further highlighted that based on the advice sponsor further highlighted that based on the advice transfull, revisited and desired for further reduction. The POE members pointed out that in each sub-head of civil works cost for unforeseen items has been included which is on higher side and above the total civil works cost 10% contingency is also added. The POE suggested to lower such cost too. The POE abased on latest available cost &amp; tariff determinations of NEPRA for hydropower projects. Project Sponsors made an argument that there is usually at-least 20% contingency difference between the FS stage and the final agreement after EPCC bidding for comfort of lenders. So, we don't have tog deeply in the cost tob obtained through competitive bidding process will sufficiently sourced costs and real time cost to be obtained through competitive bidding process will sufficiently sourced costs and real time cost too to obtained through competitive bidding process will sufficiently of ada, contents and conclusions reached in the Feasibility Study</li> <li>The Project Sponsor presented the construction of head race tunnel being through TBM therefore recognized that cavern power house on critical path, however, found a room of 3-months reduction of head race tunnel being through TBM therefore recognized that cavern power house on critical path, however, found a room of 3-months reduction of the project. The sponsors argued that based on the geological conditions investigated so far reveal more requirement protection works quantum and time period than usual cases. The POE suggested like other HPPs of private sector to stat construction of refluence here all deliberations.</li> </ul>	along with consolidation grouting to control the seepage. ii. The sponsor's consultant presented the comparative analysis of cavern versus surface power house and of layout components vis-à-vis intake, tunnel and power house on left and right sides of the	ii. It was also recommended by POE that that the hydrology gauging stations shall continue to be operated and the boreholes at tailrace and surge tank may also be continued to be a support in the next design stage.
<ul> <li>NEPRA and selection of EPC contractor</li> <li>iv. The Project Sponsor presented the construction methodology, and schedule spanning over five years including cavern power house on critical path was discussed by POE. The POE noted that construction of head race tunnel being through TBM therefore recognized that cavern power house on critical path, however, found a room of 3-months reduction in the overall construction period of the project. The sponsors argued that based on the geological conditions investigated so far reveal more requirement protection works quantum and time period than usual cases. The POE suggested like other HPPs of private sector to start construction of preliminary works during financial closing period to reduce the overall construction period. The sponsors</li> </ul>	river. The POE expressed satisfaction on the proposed layout resulted to lower cost of the project. iii. The sponsor presented the BoQ, unit rate analysis of civil works, overall, all EPC cost wherein quotations of electro-mechanical equipment and of TBM were produced in support of the cost estimates. The sponsor further highlighted that based on the advice of POE in the last meeting, the EPC cost was internally revisited and reduced by about 3.5%. The POE appreciated and desired for further reduction. The POE members pointed out that in each sub-head of civil works 5% cost for unforeseen items has been included which is on higher side and above the total civil works cost 10% contingency is also added. The POE suggested to lower such cost too. The POE also advised sponsors to rationalize the non-EPC cost based on latest available cost & tariff determinations of NEPRA for hydropower projects. Project Sponsors made an argument that there is usually at-least 20% contingency difference between the FS stage and the final agreement after EPCC bidding for comfort of lenders. So, we don't have to go deeply in the cost estimates as there are always some variations in differently sourced costs and real time cost to be obtained through competitive bidding process will	<ul> <li>The panel after detail deliberations and based on the data, information, analysis presented by sponsors concluded that this was the final PoE meeting and hence recommended the feasibility study update of 215 MW Asrit-Kedam Hydropower Project, conducted by M/s KOEN, for approval subject to:</li> <li>a. The Sponsors shall submit within fifteen (15) days the final Feasibility Study Report based upon addressing maximum possible recommendations / findings of the POE.</li> <li>b. POE jointly or individually shall not be responsible for accuracy and reliability Study</li> <li>c. The design approved in the Feasibility Study shall be made basis for submission of Tariff Petition to NEDA</li> </ul>
	iv. The Project Sponsor presented the construction methodology, and schedule spanning over five years including cavern power house on critical path was discussed by POE. The POE noted that construction of head race tunnel being through TBM therefore recognized that cavern power house on critical path, however, found a room of 3-months reduction in the overall construction period of the project. The sponsors argued that based on the geological conditions investigated so far reveal more requirement protection works quantum and time period than usual cases. The POE suggested like other HPPs of private sector to start construction of preliminary works during financial closing period to reduce the overall construction period. The sponsors	<ul> <li>d. Interconnection Study will be finalized by the Sponsors at the earliest for approval by concerned entity. Moreover, the Sponsors shall continue recording river flow data at the Project site</li> <li>e. The Sponsors may justify their cost estimates before NEPRA for the purposes of cost and tariff determination.</li> <li>f. The final FS Report should be properly formatted according to the international standards.</li> </ul>

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agreed to consider such option upon on-boarding EPC contractor.	
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Junai 2205/22

### Minutes of the Panel of Experts (PoE) of PEDO

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Dated: February 17, 2022 in PEDO House Peshawar

- 1. A meeting of the Panel of Experts (PoE) was held on February 17, 2022 at 10:30 AM in the committee room of PEDO House, Peshawar to review the progress of feasibility study (FS) of 215 MW Asrit-Kedam HPP. The list of participants is attached as Annex-I.
- 2. Director REP/PP, PEDO welcomed all participants of the meeting. Afterwards, the meeting progressed towards the following agenda items.

S. No	Project	Discussions	<b>Recommendations/Decisions</b>	
1 215 MW Asrit- Kedam HPP		The forum was informed that during the course of feasibility study review and updating, couple of PoE meetings have been conducted wherein certain comments were raised.		
The forum was further informed to previous meeting of the PoE the consu- the layout alternatives wherein cond was accorded for the optimized all including the Powerhouse location confirmation from the results of add drilling at powerhouse location.		The forum was further informed that during the previous meeting of the PoE the consultant presented the layout alternatives wherein conditional approval was accorded for the optimized alternative/layout including the Powerhouse location subject to confirmation from the results of additional borehole drilling at powerhouse location.	PoE advised to share the structure analysis in order to verify the same through 3 <sup>rd</sup> party experts. Furthermore, the consultant has to submit the design calculation report.	
		The consultant then presented the overall progress of the FS. It was apprised that the Dam will be a floating type to be protected and reinforced through secant pilling of about 15 m in length to avoid maximum possible seepage. PoE inquired about the structure analysis to which the consultant confirmed that they have carried out the same.	Considering the Asrit-Kedam HPP as one of the cascade projects, it was advised by the PoE that the KOAK team shall sit and share the requisite information with the downstream Madyan HPP team to have mutually agreed upon operation modalities. The project sponsor agreed to the proposal.	
PoE C right bould that reinfo the C updat appre		PoE Geotech member inquired about the effect of right bank nullah having steep gradient and huge boulders history in floods. The consultant explained that we have proposed a boulder trap to be reinforced with concrete structure and are finalizing the design which shall be included in the final updated FS. The said solution was acknowledged and appreciated.		
		i. It was apprised that previously three additional boreholes were advised to be drilled at power house site, surge tank and tailrace each, however, Geotech member explained that in a special meeting it was decided that one more borehole at power house site to be drilled and other two may be done at basic	i. Director (RE) proposed to continue the boreholes at the surge tank and tailrace for the time being as it will save time during the next phase, however, it will not affect the FS approval process. POE member also suggested to keep the	

p14

design stage. Additional bore hole at PH status was explained and the harsh weather conditions. POE geologist asked for weekly update of the drilling works and suggested a site visit in early March to physically check the core recoveries and borehole log at site.	drilling machine at the site after completion of the additional drilling so that it can be used for further investigations at the next phase.
<ul> <li>ii. Powerhouse type (Cavern vs Surface) was explained in detail explaining the benefits of underground power house with respect to overall technical situation along with cost and resettlement aspects. The consultant geologist also proposed that we should go for the cavern keeping in view the rock condition investigated so far.</li> <li>POE member asked about the trap efficiency and flushing period of desander. Consultant responded and referred to the attachments that trap efficiency is 77% and flushing period is 1.88 day. POE member was satisfied with the response.</li> </ul>	ii. POE pointed that though we support the selection of cavern powerhouse type but with concern that detail breakup of the cost and further analysis shall be provided for both the surface and cavern PH. PPIB representative further added that the consultant shall quantify those analysis based on certain parameters like technical conditions, environmental, social, land & resettlement and ultimately it will come to the costing for both types of Powerhouses as the cost difference, Justifications should be included for disqualification of surface powerhouse.
iii. It was observed that tunnel length has been increased a bit as compared to the old FS. The consultant responded that it is due to increase stability and safety. PoE inquired about the optimization analysis keeping in view this tunnel length to which the consultant responded that we have done the same. POE member from PPIB inquired about the alternate HRT option on the left bank. Consultant responded by explaining the disadvantages like increase tunnel length, , access bridges, roads and social impacts eventually translating into higher cost and construction period.	iii. PoE agreed with the tunnel alternative, however, asked for detail back-end calculations and a detail comparative report to quantify the advantages and disadvantages of HRT at the left bank.
iv. POE member from PPIB asked about the Delta Formation of sediment settling in the reservoir and its impact on the operation of the plant.	iv. KOAK team responded that we would include these details in the FS updated report.
v. POE geologist inquired about the 0.32g seismic coefficient value for PH area as it is underground and in his opinion is on the conservative side. Consultant explained in detail that Seismic hazard is less at PH as compared to DAM area and earthquake waves have less impact in the rock as compared to the surface.	v. POE geologist acknowledged the explanation, however, suggested to recheck the value through some assumptions data for estimating the seismic hazard for PH site and confirm it through quantifiable analysis.
vi. POE member from PPIB requested for relevant documentation for EPC cost with unit rate analysis and construction schedule.	vi. Consultant agreed to provide and explain all the details of cost and construction schedule to the PoE

. .

vii. NTDC was taken online for discussion on the GIS vii. Director (RE), PEDO requested NTDC to kindly consider the GIS study of the study and inclusion in IGCEP. It was mentioned by the PPIB representative said that with reference to the project for review and approval. It was further advised that the consultant shall inclusion of Asrit Kedam HPP in the IGCEP, it is pertinent to mention that the 220 kV transmission fulfill all the requirements for inclusion line for Madiyan and Matiltan HPP will be utilized, and of the project in IGCEP and PEDO will both these projects are included in the IGCEP. Since facilitate them in the whole process. both of Asrit Kedam and Kalam Asrit HPPs are in between Matiltan and Madiyan HPP, therefore it offers optimal utilization of said transmission line hence these projects may be considered for inclusion in IGCEP as per the criteria viii. POE supported the consultant viii. ESIA and RAP contents were presented by the consultants in detail. POE member from EPA inquired stance and assured full support for the NOC from the EPA. about the E-flows and discussed about the need for cascade study for the determination of the E-flows. The consultants responded that it is not fair to discuss about the cascade study at this stage, however, it may be the responsibility of the regulator to conduct such studies. ix. PoE asked for detail breakup of nonix. Economic and Financial Analysis was presented by EPC cost and comparison with other IPPs the consultant expert to the POE members. POE who have achieved the Financial Close. member from PPIB asked about the O&M cost and suggested that it should be same as NEPRA allowed It was further advised to include the comparison of Wind and Solar also in the percentage. He further added that the EPC and non-EPC cost seems to be on the higher side. The PoE Economic benefits of Hydro Project. It advised the sponsor to revisit their cost estimate and was also decided that the consultant present during next meeting. The construction before submitted the draft FS shall share methodology should also be prepared and shared to all the costing including unit rate assess the construction period. The project sponsor analysis with PoE for their review and has taken debt equity ratio of 75:25. PoE advised to discussion. consider it 80:20 in order to get reduced the tariff. The project sponsor agreed with these proposals.

MM 23-05-22

# Correspondence related to GIS KOAK POWER LIMIED

Asrit Kedam Hydropower Project



Manager (CM & RA) PESCO Peshawar

# PESHAWAR ELECTRIC SUPPLY COMPANY CHIEF ENGINEER (DEVELOPMENT) PMU

Telephone No. (091) 9211757 Fax No. (091)9213018

<u>337-39</u> No.

Dated /2022

### Subject: GRID INTERCONNECTION STUDIES OF 215 MW ASRIT KEDAM HYDROPOWER PROJECT, SWAT, KHYBER PAKHTUNKHWA

Ref: Your office letter No. CCO/M(CMRA)/Hydel/Asrit Kedam/530 dated 8.03.2022.

The subject GIS report has been received for review/comments. However, as the subject HPP is part of the integrated study for evacuation of power from other HPPs in Swat Valley at 220 kV and 132 kV voltage levels which is under progress by PEDO's consultant and is yet to be completed. Therefore, this office will review and comment on the subject GIS report after completion of the said integrated study and its acceptance by all stakeholders including NTDC and PEDO.

(Development) Chief E MU PESCO Peshawar

Copy to:

- 1. Chief Executive Officer, Koak Power Limited, Plot # 7-C, G-8 Markaz, Islamabad.
- 2. M/s Power Planners International (Pvt) Ltd. 95-H/2, Wapda Town, Lahore 54770, Pakistan.



Letter No. KOAK- 157 -2022

Date: 14 Feb ,2022

Chief Executive Officer (PESCO) Peshawar Electric Supply Company (PESCO) HQ, Wapda house, Shami Road, Peshawar, KPK

# Subject: <u>Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project.</u> Swat, Khyber Pakhtunkhwa.

Reference: NTDC Letter: GMPSP/CETP/TRP-300/759-64 dated 11-02-2022 (enclosed)

Sir,

With reference GM (PSP) NTDC, please find attached the Draft Report of Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project by KOAK Power Limited near Bahrain, Swat, Khyber Pakhtunkhwa.

The Report includes all the necessary studies required for the feasibility of interconnection with the main grid. The report comprises of following.

- 1. Load flow analysis
- 2. Short circuit analysis
- 3. Dynamic and Transient stability analysis

We request you to please expedite the review/comment process and necessary action by your good offices, your expeditious response on the subject matter will enable the Project company to achieve the further developments on fast-track basis.

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Yoon An Sang Chief Executive Officer



Cc:

- i. GM (Power System Planning), 4<sup>th</sup> Floor, PIA tower, Edgerton Road Lahore.
- ii. Power Planners International(PPI), 95 H/2, Wapda Town, Lahore



Letter No. KOAK- 158 -2022

Date: 14 Feb ,2022

Chief Executive Officer (PEDO) Pakhtunkhwa Energy Development Organization (PEDO), Plot No # 38, Sector – B2, Phase – 5, Hayatabad, Peshawar, KPK

# Subject: <u>Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project,</u> <u>Swat, Khyber Pakhtunkhwa.</u>

Reference: NTDC Letter: GMPSP/CETP/TRP-300/759-64 dated 11-02-2022 (enclosed)

Sir,

With reference GM (PSP) NTDC, please find attached the Draft Report of Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project by KOAK Power Limited near Bahrain, Swat, Khyber Pakhtunkhwa.

The Report includes all the necessary studies required for the feasibility of interconnection with the main grid. The report comprises of following.

- 1. Load flow analysis
- 2. Short circuit analysis
- 3. Dynamic and Transient stability analysis

We request you to please expedite the review process and necessary action by your good offices, your expeditious response on the subject matter will enable the Project company to achieve the further developments on fast-track basis.

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¥oon An Sang Chief Executive Officer

E AMABAI

Cc:

- i. GM (Power System Planning), 4th Floor, PIA tower, Edgerton Road Lahore.
- ii. Power Planners International (PPI), 95 H/2, Wapda Town, Lahore.



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### NATIONAL TRANSMISSION & DESPATCH CO. LTD (NTDC)

**General Manager Power System Planning** 

No. GMPSP/CETP/TRP-300/759-64

Dated: 11-02-2022

Chief Executive Officer Koak Power Limited, Plot # 7-C, G-8 Markaz, Islamabad

### Subject: Grid Interconnection Study (GIS) Report of 215 MW Asrit Kedam Hydropower Project, Swat, Khyber Pakhtunkhwa

**Ref:** Your letter No. KOAK-112-2022 dated 03-02-2022.

With reference to above letter, this office has received the subject GIS report of the 215 MW Asrit Kedam Hydro Power Project (HPP) for review. In this regard, it is intimated that the subject HPP is part of the integrated study for evacuation of power from HPPs in Swat Valley at 220 kV and 132 kV voltage levels which is presently under progress by the PEDO's consultant and has not been completed yet. This office shall give its comments on the subject GIS report after completion of the said integrated study and its acceptance by all stakeholders including NTDC, PESCO and PEDO.

Furthermore, it is suggested to discuss the overall integrated scheme with respect to its implementation aspects in Swat River including the evacuation scheme of the subject HPP in the upcoming Panel of Expert (POE) meeting which is scheduled to be held on Thursday, February 17, 2022. In the meanwhile, it is requested to share the said GIS report with PESCO and PEDO for their review/comments.

This office is available for further deliberations in this regard.

77 11/02/2012

General Manager (Power System Planning)

Cc:

- 1. Deputy Managing Director (P&E) NTDC.
- 2. Chief Executive Officer, PESCO.
- 3. Chief Executive Officer, PEDO.
- 4. PEDO's Consultant, M/s Power Planners International.
- Master File.



Letter No. KOAK- 112 -2022

Date: 3<sup>rd</sup> Feb ,2022

General Manager (Master Planning) National Transmission and Dispatch Company (NTDC) 4<sup>th</sup> Floor, PIA Tower, Egerton Road, Lahore

## Subject: <u>Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project,</u> Swat, Khyber Pakhtunkhwa.

Reference: NTDC Data Permission Letter: GMPSP/TRP-300/4287-92 dated 05-11-2021

Sir,

Please find attached the Draft Report of Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Project by KOAK Power Limited near Bahrain, Swat, Khyber Pakhtunkhwa.

The Report includes all the necessary studies required for the feasibility of interconnection with the main grid. The report comprises of following.

- 1. Load flow analysis
- 2. Short circuit analysis
- 3. Dynamic and Transient stability analysis

We request you to please expedite the review process and necessary action by your good offices, your expeditious response on the subject matter will enable the Project company to achieve the further developments on fast track basis.

ou for b

Voon An Sang Chief Executive Officer

Cc: Power Planners International, 95 - H/2, Wapda Town, Lahore



# NATIONAL TRANSMISSION & DESPATCH CO. LTD (NTDC)

### General Manager (Power System Planning)

No. GMPSP/TRP-300/4287-92

Dated: 05-11-2021

Chief Executive Officer, KOAK Power Limited, Plot # 7-C, G-8 Markaz, Islamabad. Tel: 051-8735923

### Sub: Grid Interconnection Studies of 215 MW Asrit Kedam Hydropower Plant by KOAK Power Limited, at River Swat, Khyber Pakhtunkhwa

Ref: M/s KOAK Power Limited office letter no: KOAK-658-2021 dated 03-11-2021.

This office has been requested vide above referred letter by M/s KOAK Power Limited for provision of system data to its selected study consultant, M/s Power Planners International (Pvt.) Ltd. (PPI) in order to conduct the grid interconnection/system impact study for 215 MW Asrit Kedam Hydro Power Plant (HPP).

It is stated in this regard, that the following data shall be provided by this office to M/s PPI:

- 1. Latest demand forecast of NTDC and Indicative Generation Capacity Expansion Plan (IGCEP), approved by NEPRA on 24-09-2021.
- 2. The electronic copies of the available base cases/grid system data in PSS/E software for the spot year of 2027 which also includes the incorporation of transmission plan upto that spot year. M/s PPI shall prepare the base cases for the subject study keeping in view of the timeline of the subject HPP and for some future scenarios. M/s PPI is required to have a meeting in this office on 10-11-2021 at 02:30 p.m. in this regard.
- 3. M/s PPI is suggested to conduct an integrated study for evacuation of power from the subject HPP in integration with other HPPs in the Swat Valley.

M/s PPI is allowed to use the above-mentioned system data/information for the grid interconnection/system impact study of 215 MW Asrit Kedam HPP. However, M/s PPI is advised not to use the system data/information for any other study nor should it be provided to any other company including the sponsor of the subject project without the prior permission of this office.

It is pertinent to mention that the subject 215 MW Asrit Kedam HPP is not included up to year 2030 in the IGCEP 2021 which was approved by NEPRA in September 2021. It is clarified that the project sponsor is conducting the said study at its own cost and risk, whereas, NTDC is giving data permission at this stage solely on the request of project sponsor to carry out the subject grid interconnection/system impact study. It is added that there could be some modification in the proposed interconnection scheme of the subject HPP in future due to change in timeline of the subject HPP or any other HPP in its vicinity or due to any other factor etc. and the study might have to be revised in this regard. Moreover, it should not be considered as any consent of NTDC

<sup>4&</sup>lt;sup>TH</sup> Floor, PIA Tower, Egerton Road Lahore, Pakistan TEL: +92 42 99202613, Fax : +92 42 363077381gm.psp@ntdc.com.pk www.ntdc.com.pk

that the subject HPP shall definitely be selected in the next version of IGCEP. The subject HPP shall have to compete with other candidate power projects to become part of IGCEP in future as per least cost principle.

This office is available for further deliberations in this regard.

lg 1=1 05/11/2021

**General Manager (Power System Planning)** 

### **Distribution to:**

- i) Chief Executive Officer, PEDO, Peshawar.
- ii) Deputy Managing Director (P&E) NTDC
- iii) Chief Engineer (T/L Design) NTDC
- iv) Chief Engineer (EHV-I) Islamabad, NTDC
- v) M/s PPI, WAPDA Town, Lahore.
- Master File

4TH Floor, PIA Tower, Egerton Road Lahore, Pakistan TEL: +92 42 99202613, Fax : +92 42 363077381gm.psp@ntdc.com.pk www.ntdc.com.pk



Letter No. KOAK-<u>658</u>-2021

Dated: 03rd November 2021

Managing Director (MD), National Transmission and Dispatch Company (NTDC), Room No. 414, Wapda House, Lahore

Subject: <u>Grid Interconnection Studies of 215 MW Asrit Kedam</u> <u>Hydropower Plant by KOAK Power Limited. at River Swat.</u> <u>Khyber Pakhtunkhwa.</u>

Dear Sir,

Further to our letter dated 22<sup>nd</sup> October 2021, and our subsequent discussions, we would like to confirm that proposed Commercial Operation Date (COD) for Asrit-Kedam Hydropower Project (the "Project") is **31**<sup>st</sup> March 2028.

As mentioned previously that we have engaged M/s Power Planners International (PPI) as our consultant to perform the Grid Interconnection Studies of the Project. In this respect we need the data of the network in the vicinity of the proposed Project, existing and future, to perform this study. It would be convenient for NTDC and for us if G.M. Planning (Power), NTDC allows PPI to use the system data that is already available with our consultant for performing similar studies.

In addition, we would require the following data to complete the studies.

- 1. Updated Indicative Generation Expansion Plan prepared by NTDC till the year 2030.
- 2. Transmission expansion plans involving NTDC's 500 kV and 220 kV network till 2030.
- 3. Load forecasts of NTDC till 2030.

We look forward for your favorable response in this respect and would request to provide the necessary data as early as possible so that this important international investment can move forward smoothly.

With best regards,

Kim Kyungsik Chief Executive Officer



Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

### Copy to:

- I. Managing Director, Private Power & Infrastructure Board (PPIB) Emigration Tower, G 8/1 G-8, Islamabad, Islamabad.
- II. CEO, Pakhtunkhwa Energy Development Organization (PEDO) Plot# 38, Sect B-2, Phase-5 Hayatabad Peshawar.
- III. Deputy Managing Director (DMD), Planning & Engineering National Transmission and Dispatch Company (NTDC), Wapda House, Lahore.
- IV. General Manager (Master Planning). National Transmission and Dispatch Company 4th Floor, PIA Building, Egerton Road, Lahore
- V. Power Planners International 95 H/2, Wapda Town, Lahore



Plot # 7-C, G-8 Markaz, Islamabad Tel: 051 – 8735923, 051 – 8735924

Letter No. KOAK-632-2021

Dated: 22<sup>nd</sup> October 2021

Managing Director (MD), National Transmission and Dispatch Company (NTDC), Room No. 414, Wapda House, Lahore

### Subject: <u>Grid Interconnection Studies of 215 MW Asrit Kedam</u> <u>Hydropower Plant by KOAK Power Limited, at River Swat</u>, <u>Khyber Pakhtunkhwa</u>.

Dear Sir,

KOAK Power Limited (the "Company") is the subsidiary of Korea South-East Power Co. Ltd ("KOEN"). KOEN is the premier state-owned generation company of South Korea having generation capacity of more than 10,000 MW Worldwide with an asset base of more than USD 10 billion.

Government of Khyber Pakhtunkhwa through PEDO issued the Letter of Intent (the "LOI") to KOAK Power for the development of 215 MW Asrit Kedam Hydropower Project located on River Swat in Khyber Pakhtunkhwa (the "Project") on 27 June 2021. Under the terms of LOI, the update of the Feasibility study of the Project is progressing fast and is expected to be completed by end of November 2021.

The Company intends to submit the application for Generation License to NEPRA within this year and for this purpose needs to conduct the Grid Interconnection Studies of the Project to fulfil the requirements of Generation License application. Following the issuance of Generation License the Company shall submit the petition to NEPRA for the approval Feasibility Stage Tariff so that the project cost can be determined for consideration and inclusion in next iteration of Indicative Generation Expansion Plan ("the IGCEP").

We have engaged M/s Power Planners International (PPI) as our consultant to perform the Grid Interconnection Studies of the Project. In this respect we need the data of the network in the vicinity of the proposed Project, existing and future, to perform this study. It would be convenient for NTDC and for us if G.M. Planning (Power), NTDC allows PPI to use the system data that is already available with them for performing similar studies.

In addition, we would require the following data to complete the studies.

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- 3. Load forecasts of NTDC till 2030.

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Kim Kyungsik Chief Executive Officer

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- III. Deputy Managing Director (DMD), Planning & Engineering, National Transmission and Dispatch Company (NTDC), Wapda House, Lahore.
- IV. General Manager (Master Planning). National Transmission and Dispatch Company 4th Floor, PIA Building, Egerton Road, Lahore
- V. Power Planners International 95 H/2, Wapda Town, Lahore

# Pakistan Asrit Kedam Hydropower Project UPDATE FEASIBILITY STUDY REPORT

Volume 1 – Main Report

**Executive Summary** 

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# **0.** Executive Summary

# 0.1. Introduction

Comprehensive studies for the assessment of the hydropower potential of the Swat valley were carried out between 1990 and 1995 under a Program of Pakistan-German Cooperation. In June 2006 Mirza Associates Engineering services (PVT) Ltd. Submitted a study on the development of the hydropower potential in the Swat River and proposed among others the development of the following run of river hydropower plants.

•	Gabral-Kalam HPP	: 101MW (Cascade Study, 2006)
•	Kalam-Asrit HPP	: 197MW (Cascade Study, 2006) : 238MW (FS by KOEN, 2020)
•	Asrit-Kedam HPP	: 209MW (Cascade Study, 2006) : 215MW (FS by Yunus Brothers Group, 2008) : 215MW (Technical Due Diligence by KOEN, 2016)
•	Madian HPP	<ul> <li>: 148MW (Cascade Study, 2006)</li> <li>: 157.3MW (FS by Madian Hydro Power Ltd, 2009)</li> <li>: 157.3MW (Technical Due Diligence by KOEN in 2016)</li> </ul>

The feasibility study of Asrit-Kedam HPP was performed by RSW International (RSWI) of Montreal Canada, with the assistance of NEWAGE (Pakistan) and several Pakistan consultants. It was published in Nov. 2008. The feasibility study reports consist of Executive Summary (Volume 1), Main Report (Volume 2A), Plates (Volume 2B) and others (Volume 3 ~ Volume 12). It was 215 MW hydropower project located on the Swat River in Pakistan's North West Frontier Province that was being developed on a BOOT (Build-Own-Operate-Transfer) basis under the sponsorship of the Yunus Brothers Group (Promoter).

SAMAN had done a Technical Due Diligence on F/S performed by RSWI, Sep. 2016 and then Mott MacDonald had reviewed it in order to provide a technical advisory for this Due Diligence, Aug. 2016.

As for Technical Due Diligence, it had performed the review regarding the feasibility study report as well as the scope of the data related to the feasibility study investigation provided by the client, KOEN (Korea South-East Power Co., Ltd) from June 1, 2016 to September 30, 2016. Moreover, the KOEN, SAMAN and Mott MacDonald were jointly conducted a site investigation from July 11, 2016, to July 14, 2016.

Salient Features of Asrit-Kedam HPP are as follows.

	Item	Unit	F/S	TDD	Update F/S	
	River		Swat River	Swat River	Swat River	
Location	Administrative District		Swat District	Swat District	Swat District	
	Intake Area		Swat River	Swat River	Swat River	

Table 0-1 : Salient Features of AKHPP

# Update Feasibility Study of Asrit-Kedam Hydropower Project

Item		Unit	F/S	TDD	Update F/S
Powerhouse Area			Swat River	Swat River	Swat River
	Catchment Area	km <sup>2</sup>	2,170	2,170	2,213
Hydrology	Annual Average Run- off	m³/s	94.2	94.5	96.4
	Plant Discharge	m³/s	120	120	130
	Gross Head	m	211	211	207.4
Power	Head Loss	m	10.45	10.84	12.2
Energy	Installed Capacity	MW	215	215	229.4
Estimation	Annual Gross Energy Generation	GWh	911.5	893.8	970.7
	Annual Net Energy Generation	GWh	879.6	873.3	944.7
D	Diversion Discharge	m³/s	561	564	658
Diversion Channel	Width	m	20	20	20
	Length	m	350.9	350.9	385
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam / Secant Pile
	Dam Crest	EL. m	1,718.3	1,718.3	1,714.0
Upstream	Dam Crest Width	m	6	6	6
Cofferdam	Height	m	13.5	13.5	13.2
	Length	m	66	66	57
	Dam Slope		1:1.3	1:1.5	1:1.5
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam
	Dam Crest	EL. m	1,698.0	1,698.0	1,703.0
Downstream	Dam Crest Width	m	5	5	5
Cofferdam	Height	m	6	6	7
	Length	m	40	40	55.0
	Dam Slope		1:1.3	1:1.3	1:1.3
	Туре		CGD	CGD	CGD
	Design Discharge	m³/s	732	801.6	1,091.5
	Safety Check Discharge	m³/s	900	1,333.6	2,078.5
Dam &	Dam Crest	EL. m	1,724.0	1,724.0	1,721.0
Spillway	Spillway Crest	EL. m	1,715.0	1,715.0	1,717.0 / 1,700.0
	Spillway Width (Net Width)	m	30	30	24
	Length	m	73.2	73.2	71.4
	Height	m	24	24	28.5

Item		Unit	F/S	TDD	Update F/S	
	Spillway Gate Type		Roller gate	Roller gate	Radial gate	
	Spillway Gate Size	m	W 10.0 × H 6.0 × 3 Nos.	W 10.0 × H 6.0 × 3 Nos.	W 8.0 × H 10.0 × 3 Nos.	
Desander Basin	Туре		Open Channel	Open Channel	Open Channel	
	Width	m	11.5	11.5	12.0	
	Depth	m	14.0	14.0	14.0	
	Length	m	130	130	130	
Intake	Туре		Bellmouth Type	Bellmouth Type	Bellmouth Type	
	Invert Elevation	EL. m	1,694.00	1,694.00	1701,1	
	Inlet Diameter	m	7.4 7.4		7.4	
	Gate	m	-	-	-	
Haadvaaa	Туре		Modified Horse Shoe	Modified Horse Shoe	Circular Con'c lined	
Tunnel	Diameter	m	7.4	7.4	7.4	
	Length	m	9,946.0	9,960.0	10,291.0	
	Туре		-	Circular Con'c lined	Circular Con'c lined	
Vertical Pressure Shaft	Diameter	m	-	7.4	7.4	
	Height	m	-	181.7	119.5	
Horizontal	Туре		Circular Con'c lined	Circular Con'c lined	-	
Pressure Tunnel	Diameter	m	7.4	7.4	-	
	Length	m	101	139	-	
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined	
Penstock	Diameter	m	5.1 5.1		5.1	
	Length	m	225	227	191.7	
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined	
Penstock (Manifold)	Diameter	m	4.2~2.15	4.2~2.15	4.2~2.15	
· · ·	Length	m	184.3	184.3	140.6	
	Туре		Restricted Orifice Type	Restricted Orifice Type	Restricted Orifice Type	
	Size	m	D 12.5 / D4.5	D 18.0/D4.5	D 14.0 / D4.5	
Surge Shaft	Height	m	71.0/167.3	77.5	78.3	
	Orifice size	m	3	3	3	
	Max. up-surging water level	EL. m	1,761.0	1,742.6	1,754.6	
	Min. down-surging water level	EL. m	1,656.1	1,684.7	1,680.8	
Powerhouse	Туре		Underground Cavern	Underground Cavern	Underground Cavern	

Item		Unit	F/S	TDD	Update F/S	
	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 31.6 × L 88.0	W 20.0 × H 39.0 × L 88.0	
	Turbine Type		Vertical Francis Turbine	Vertical Francis Turbine	Vertical Francis Turbine	
	Turbine Capacity	MW	3 × 60.9, 1 × 32.2	3 × 60.9, 1 × 32.2	3 × 67.4, 1 × 27.2	
	Number of Units		4	4	4	
	Turbine-Center Level	EL. m	1,491.00	1,491.00	1,495.00	
Transformer & GIS Cavern	Туре		Underground Cavern	Underground Cavern	Underground Cavern	
Transformer & GIS Cavern	Transformer Cavern Size	m	W 18.0 × H 13.6 × L 91.5	W 8.7 × H 7.25 × L 82.9	W 18.0 × H 13.9 × L 91.5	
	GIS Cavern Size	m	-	W 13.4 × H 10.2 × L 31.4	-	
	Transformer Type		3-Phase	Single-Phase	3-Phase	
	Number of Units		5	13	5	
Tailrace Tunnel	Diameter	m	5	5	5.5	
	Length	m	280	280	303.1	

### 0.1.1. Summary of Salient Features of AKHPP

Table 0-2 . Summary of Sallent Features of Alvin 1						
Ite	Unit	F/S	F/S Update			
Location			Swat River	$\leftarrow$		
	Catchment Area	km <sup>2</sup>	2,170	2,213		
Hydrology	Annual Average Run-off	m³/s	94.2	96.4		
	Installed Capacity	MW 215		229.4		
	Plant Discharge	m³/s	120.0	130.0		
Energy Generation	Annual Gross Energy Generation	GWh	911.5	970.7		
	Annual Net Energy Generation	GWh	879.6	944.7		
Dom	Туре		CGD	$\leftarrow$		
Dam	Dam Crest	EL. m	1,724.0	1,721.0		
	Diameter	m	7.4	←		
Headrace I unnel	Length	m	9,946.0	10,291.0		
	Туре		Underground Cavern	$\leftarrow$		
Powerhouse	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 39.0 × L 88.0		
	Turbine Type		Vertical Francis Turbine	$\leftarrow$		

### Table 0-2 : Summary of Salient Features of AKHPP

For this study, Mar. 2021, KOAK Power Limited (Special Purpose Company) invested by

KOEN requested Saman to review and update the previous Feasibility Study conducted by RSWI in Nov. 2008 with the results of topography survey, geotechnical investigation, transmission study and ESIA study performed by AZMEC.



# 0.1.2. Project Location

The Asrit-Kedam Hydropower Project (AKHPP) is located in the Khyber Pakhtunkhwa Province (previously "North-West Frontier Province") of Pakistan on the Swat River in the reach between the Asrit and Kedam Villages. The Swat River is formed by the junction of the Gabral and the Ushu Rivers at the Kalam. The river flows southward and then flows westward until joined by the Panjkora River. After the confluence, the river enters the Peshawar Valley and meets with the Kabul River. The total length of the Swat River is about 225km and its catchment basin in the intake site of Asrit-Kedam project covers an area of 2,213km<sup>2</sup>. A hydrometric station has been in operation since 1960 at the Kalam, located around 12km upstream of the intake of the Asrit-Kedam project. Average annual flow at the intake site of the project is estimated to be about 96.4m<sup>3</sup>/s. The Project location map is as shown in Figure 1.

### 0.2. Power Market Survey

The Power Market Survey of Pakistan includes the review of the related data of the power demand and supply to predict present and future power demands and its circumstances in Pakistan. According to National Electricity Power Regulatory Authority ("NEPRA"), by the end of September 2021, the total installed generation capacity of NTDC System reached to 34,776MW of which 28% remains of Hydro based technologies i.e., 9,898MW. The comparison of other technology-based power generation can be seen in the following chart.



### Figure 2 : Installed Capacity (MW) as of September 2021

Overall, the Power Demand (MW) of Pakistan has been growing steadily with improved development of electricity supply in the country as it is evident from the electricity peak demand trend as shown in the following Chart.



Figure 3 : Historical Peak Electricity Demand (MW) from 2013 to 2021

Peak recorded demand in the country during 2020-2021 was 23,792MW recorded during the month of June 2021 out of which 86% was of domestic use while 11% commercial, 1% industrial, 1% agricultural and 1% other. According to NEPRA the forecast of Peak Demand in 2030 will be 37,129MW. For the purpose to meet the demand, NEPRA has launched a Indicative Generation and Capacity Expansion Plan (IGCEP) in 2021.



### Figure 4 : Peak Demand Forecast 2021-2030

#### 0.3. **Topographic Survey**

Topographical survey of Asrit Kedam Hydropower Project (AKHPP) was awarded to M/S AZMEC, and it was carried out in two phases. In Phase-I, geodetic control was established in the site area according to "Survey of Pakistan" reference benchmark and survey control established during topographical studies of Kalam Asrit Hydropower Project. Verification of already carried out topographic survey and topographic and hydrographic survey alternate weir & powerhouse site was also carried out in Phase-II. In Phase-II, topographic survey of whole project was carried out through satellite photogrammetry at scale of 1:5000 with 5-meter contour interval along with additional topographic and hydrographic survey at dam site and powerhouse area.

A total of four (4) permanent survey control monuments were finalized and approved to be installed at PH and weir site. In addition to these, the already existing KA-07 was also used. The details of these are as follows:

Control Point Name	Easting (Meter)	Northing (Meter)	Elevation (Meter)	
AK-01	282513.013	3915627.064	1746.768	
Ak-02	282568.832	3914927.857	1722.423	
AK-03	281417.42	3904807.931	1554.567	
AK-04	281258.924	3904643.425	1541.589	
AK-07	282266.86	3915847.007	1758.885	

Table 0-3 · Crid Coordinates of Control Points

Topographic survey was done by aerial mapping using a UAV drone. Ground Control Points (GCPs) were collected in order to produce accurately georeferenced DEM and Ortho-photo fro mapping purpose. A number of 4 to 5 GCPs were used in single grid. Images were then processed to obtain Digital ortho-rectified imagery of aerial mapping, Digital elevation model extracted from aerial mapping, digital surface model of project area and digital ortho imagery of project area.

A total of 40 bathymetric cross sections were observed along Swat-river. 21 cross-sections of the total at weir site and 19 at powerhouse area.

Figure 5 : Bathymetric Survey Plan of Swat River



# 0.4. Seismic Hazard Assessment Study

The spatial distribution of seismic events recorded in the project region is plotted in the following figure.



Figure 6 : Seismicity Map of the Project Region

The available seismic and tectonic data provides several evidence of the seismic activity along the major faults i.e., Main Mantle Thrust (MMT) and Kohistan Fault passing south of the site and Main Karakoram Thrust (MKT) passing northwest of the project.

ICOLD recommends using ground motion having 475-year return period which is termed DBE accelerations (Weiland, 2011). As per the ICOLD standard for Underground Powerhouse the recommended ground motion for DBE is therefore 0.32g (for very dense gravelly soil foundation condition with Vs30 equal to 600m/sec).

The Project regions Seismic Study was carried out using Probabilistic Analysis and Deterministic Analysis.

### **Probabilistic Seismic Hazard Analysis involves three steps:**

- Specification of the seismic-hazard source model
- Specification of the ground motion model
- The probabilistic calculation
- Deterministic Seismic Hazard Analysis involves:
- Checking the nearest active fault
- Estimating the largest earthquake that could happen on this fault
- · Assuming the largest earthquake happens at the closest point to site
- Calculating the peak ground acceleration

The Uniform Hazard Spectra obtained through Probabilistic Analysis for Powerhouse Site is as follows:



### Figure 7 : Uniform Hazard Spectra

The main conclusion of all the seismic hazard analysis is as follows:

The Project is in the Kohistan Island Arc which is sandwiched between Indian and the Eurasian tectonic plates and very active seismically.

Several moderate sized earthquakes have been recorded in Kohistan Island Arc during the last 100 years.

Several active faults are present around the project area.

The main seismotectonic features considered critical for the seismic hazard for the project are

Main Karakoram Thrust (MKT), Kohistan Fault, Main Mantle Thrust (MMT) and Shandur Thrust.

Both probabilistic and deterministic seismic hazard evaluations were made to determine the expected ground motions at the project site.

The recommended horizontal Peak Ground Acceleration (PGA) associated with Operating Basis Earthquake (OBE) is 0.21g.

As the dam of Asrit Kedam Hydropower project is assumed to fall in high-risk consequences category, the recommended horizontal Peak Ground Acceleration (PGA) associated with Safety Evaluation (SEE) is 0.59g for all water retaining structures.

All the other appurtenant structures at the weir, tunnel and powerhouse areas are recommended to be designed for PGA of 0.32g, which is associated with ground motion of DBE having return period of 475 years.

Uniform hazard spectra for SEE, OBE and DBE are given for use in the seismic resistant design of the project structures.

It is recommended that in-situ shear wave velocity profile of the subsurface material at weir and powerhouse sites may be obtained for authenticating the assumption of Vs30.

For safety monitoring purpose Strong Motion Accelerographs may be installed at the Weir and Powerhouse sites.

## 0.5. Geological and Geotechnical Investigations

For the purpose of Geotechnical Investigation at Site, a total of 7 borehole drillings were carried out at the site area, 4 of which were done at weir area and 3 at powerhouse area. Additionally, 3 test pits were excavated at project area. Details are as follows:

BH No.	Location	Coordinates		Proposed	Drilled	Status	
	Location	E (m)	N (m)	Depth (m)	Depth(m)	Status	
AWB-1	Weir Site Area	282460	3915371	50	50	Completed	
AWB-2	Weir Site Area	282485	3915379	50	50	Completed	
AWB-3	Weir Site Area (Sand Trap Location)	-	-	50	34	Terminated	
AWB-4	Weir Site Area (Tunnel Intake)	-	-	20	16	Completed	
PHB-4	Powerhouse Site Area	281248	3905000	170*	50	Terminated	
PHB-5	Powerhouse Site Area	281270	3905065	120	120	Completed	
Total depth (m)				320	320		

 Table 0-4 : Detail of Boreholes

Another borehole PHB-07 is being carried out at the powerhouse for the confirmation of geology at Powerhouse area.
TP NO.		Location	Excavation Depth(m)	Coordinates		
	TPCM-01	Near Weir Site Area	2.0	282449	3915442	
	TPCM -02	Tinka	1.9	282746	3914433	
	TPCM -03	Near Weir Site Area	2.0	282449	3915442	

Table 0-5 : Summary of Test Pits Excavated at the Project Ar	ea
--------------------------------------------------------------	----

Field Testing was carried out at the borehole areas. Standard Penetration Tests (SPTs) generally at 1m depth interval in the boreholes according to the latest ASTM D-1586. The details of insitu tests conducted in the boreholes is as follows:

DII#	Location	Drilled Depth (m)			CDT	рт	WDT	Nadar
ВП#	Location	OB	Rock	Total	CFI	r I	VVF1	Inotes
AWB-1	Weir Site Area	40	10	50	13	6	1	Completed
AWB-2	Weir Site Area	38	12	50	20	5	1	Completed
AWB-3	Weir Site Area	34	-	34	15	5	-	Terminated
AWB-4	AWB-4 Tunnel Intake		-	16	7	-	-	Completed
PHB-4	Powerhouse Site Area	32	18	50	4	-	2	Terminated
PHB-5	Powerhouse Site Area	25	95	120	4	-	-	Completed
	185	135	320	63	16	4		

 Table 0-6 : Details of Insitu Tests Conducted in the Boreholes

OB-Overburden, SPT- Standard Penetration Test, PT- Permeability, WPT- Water Pressure Test

Additionally, constant head permeability tests were performed in boreholes after 5m interval. Summary of permeability tests is as follows:

Borehole No.	Test No.	Depth [m]	Permeability (cm/sec)
	1	10	3.50E-05
	2	15	4.91E-05
	3	26	2.53E-05
AWB-1	4	30	4.484E-05
	5	35	3.911E-05
	6	40	7.517E-05
	7	45	1.747E-06
	1	5	2.99E-04
	2	15	2.53E-05
AWB-2	3	20	2.49E-04
	4	25	2.64E-05

Table 0-7 : Summary of Determined Permeability Values in Boreholes

Borehole No.	Test No.	Depth [m]	Permeability (cm/sec)
	5	30	1.65E-04
	1	5	8.18E-04
	2	15	6.61E-04
AWB-3	3	20	2.01E-05
	4	25	3.09E-05
	5	30	2.09E-04

Water Pressure / Packer Tests were normally performed at 3-5m section during bore hole sinking.

Dovoholo No	Tost No	Test Section [m]		Lugoon Valua	Interneted Flow Type	
DUI CHOIC INO.	1 651 140.	From	То	Lugeon value	Interpreted Flow Type	
AWB-1	1	45	50	54.79	Laminar	
AWB-2	1	42	45	104.34	Laminar	
DUD 4	1	15	20	8.83	Laminar	
РПВ-4	2	32	35	4.90	Dilation	

#### Table 0-8 : Summary of Interpreted Flow Type with Lugeon Values in Boreholes

For Sampling purposes, All the core samples, soil samples obtained from the boreholes and test pits were properly preserved in core boxes, polythene/ Jute bags, then labeled and transported to the laboratory for necessary testing. Laboratory testing was done on the soil, rock, and water samples. Following is a sample petrographic record at a borehole site (AWB-02).

#### Figure 8 : Sample Borehole Recovery

PROJECT: PISRIT KEDAMA HPP BORE HOUS: AWB.02
BON NO: 04
DEPTH- 28.20m TO 3540m DATE STARTED & COMPLETION, 12-09-2021 TO 15-09-2021
Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor

Following is the Geotechnical Investigation Plan of the dam and powerhouse area.





Figure 10 : Geotechnical Investigation Plan of Powerhouse Area



#### 0.6. Hydrology and Sedimentation Studies

Swat River is one of the second tributary of Indus River and belongs to Upper Indus Basin. As shown in Figure, most of Swat-river catchment area distributes from EL.577m to over EL. 5,917m.



Figure 11 : Swat River Catchment Area

Land cover area estimates the snowmelt contribution for the catchment area. Following is the land cover area for Kalam catchment in 2015.

Туре	Dense Forest	Open Forest	Grasses /Shrubs	Cultivated Areas/Shrubs	Bare Soil /Soil	Lake /River	Alpine Grasse	Snow Glacier	Total
Area (km <sup>2</sup> )	113.53	33.34	512.67	199.6	64.31	6.11	233.57	854.63	2,018
Ratio (%)	5.6	1.7	25.4	9.9	3.2	0.3	11.6	42.4	100

Table 0-9 : Land Cover Area for Kalam Catchment in 2015

Following is the catchment area and ratio at the major locations.

	Swat River	ver Kalam Gauging Station		Dan	n	Tailrace Outlet	
	Area (km²)	Area (km²)	Ratio	Area (km²)	Ratio	Area (km²)	Ratio
F/S	13,300	2,020	1.0	2,170	1.07	-	-
F/S Update	13,300	2,020	1.0	2,213	1.10	2,483	1.23

 Table 0-10 : Catchment Area and Ratio at the Major Locations

Flow of the river is measured through different hydrological stations present at various sites. Monthly average flow at Weir Site from 1961 to 2009 is shown as follows:



Figure 12 : Monthly Average Flow at Weir Area from 1961 to 2019

2 gauging stations, Pashmal and Mankial gauging stations were installed under supervision of KOAK. Daily flow data at new observation stations is as follows:



For Design Flood Purposes, Flood Frequency Analysis was done according to the available peak data. There was a major flood in July 2010 in the Swat River during which the peak flow was recorded at around 2,537 cusec which was 364.7 cusec in July 2009.





Frequency floods are also observed in the Swat River for which adequate probability distribution function and the parameters of probability distribution were reviewed by moments

#### method.

For Glacier Lake Outburst Floods (GLOFs), potentially dangerous lakes were selected and studied for peak outbursts. The estimated design floods by the frequency analysis and GLOFs study, are as shown in following Table.

<b>Return Period Years</b>	Frequency Flood (m <sup>3</sup> /s)	GLOFs (m³/s)	Design Flood (m³/s)
100	982.7	-	982.7
200	1,091.5	-	1,091.5
1,000	1,371.7	-	1,371.7
10,000	1,851.6	226.9	2,078.5 for the dam safety check

Table 0-11 · Estima	te Design F	loods hv I	Trequency	Analysi	s and GL	OFs Study
TADIC 0-11 . ESuina	ite Design F	100US DY 1	requency	Analysi	s and OL	Or's Siduy

Sedimentation Analysis was carried out on the collected sediment from the site area. The total sediment loads at the dam site by average monthly sediment concentration is shown below.

Month	Discharge (m³/s)	Sediment Concentration (PPM)	Suspended Sediment Load(Ton)	Total Load, 20% Bed Load (Ton)	Percent of Annual Load
Jan	16.8	72.5	3,262	3,915	0.9
Feb	15.3	82.2	3,043	3,651	0.8
Mar	19.4	80	4,157	4,988	1.1
Apr	54.1	103	14,443	17,332	3.8
May	147.9	99.5	39,415	47,299	10.4
Jun	272.7	115.1	81,357	97,629	21.5
Jul	279.5	180	134,750	161,700	35.6
Aug	182.8	132.5	64,874	77,848	17.1
Sep	87	71.4	16,101	19,321	4.3
Oct	38.9	103.8	10,815	12,978	2.9
Nov	25	47.2	3,059	3,670	0.8
Dec	19.6	61.4	3,223	3,868	0.9
Total	96.4	95.7	378,499	454,199	100

Table 0-12 : Total Sediment Loads at the Dam Site by Average Monthly Sediment Concentraion

During the high flow season in June/July, the load of sediments is also higher which can be seen through the following graph.



Figure 15 : Average Total Sediment Load

#### 0.7. **Project Layout**

Asrit-Kedam Hydropower Project is located on the Swat Cascade between the Kalam-Asrit Hydropower Project and Madian Hydropower Project. The project boundary level range between EL. 1,719.7m at the upstream and EL. 1,494.0m at the downstream.

The dam is located at the Asrit Village where the height of the dam is 28.5m, the length is 71.4m, the reservoir area is 0.02km<sup>2</sup> and reservoir storage capacity is 0.12Mm<sup>3</sup>. The layout plan at the dam site is as follows:



Figure 16 : Layout Plan at Dam Site

Underground Cavern Powerhouse was considered in the Kedam Village of Swat area for the Asrit-Kedam HPP. The comparison of surface and underground powerhouse was considered before the finalization of cavern powerhouse.





Underground Type Powerhouse

Surface Type Powerhouse

The comparison of construction cost for both alternatives is as follows: (Unit: US\$)

No.	Description	Underground powerhouse	Surface Powerhouse
	CIVIL WORKS		
1	WORK ADIT TO PENSTOCK	934,135	-
2	WORK ADIT TO POWERHOUSE	730,752	-
3	ACCESS TUNNEL TO CAVERN & CABLE TUNNEL	5,547,369	-
4	VERTICAL PRESSURE TUNNEL	1,671,067	1,619,729
5	PENSTOCK EXCAVATION 5.1 M(D)	767,918	1,686,702
6	POWERHOUSE CIVIL	7,371,829	39,281,794
7	TRANSFORMER GALLERY	1,588,501	-
8	TAILRACE (1&2)	6,554,059	-
	TOTAL CIVIL WORKS COST	25,165,630	42,588,225

#### Table 0-13 : Civil Works Comparison for Underground and Surface Powerhouse

The geological factor was also considered. Following is the geological map of the powerhouse.



Figure 18 : Geological Map of the Powerhouse

The Weir and Powerhouse are approximately 10km apart from each other. The headrace tunnel was considered at the right bank of the swat river after analysis and comparison of both left and right bank for the headrace tunnel.

The comparison of tunnel length from both sides is as follows:

Alignment	Length of Headrace Tunnel (Intake – Surge Tank)	Remarks
Right Bank	10,291 m	▼ 1,771 m
Left Bank	12,062 m	

# Figure 19 : Comparison of HRT on Right Bank vs Left Bank



The detail comparison is as follows:

HRT (Headrace Tunnel) Alternative Route Comparison					
Item	Right Side (Selected)	Left Side (Not Selected)			
HRT Length	10,291m	12,062m			
HRT Cost (TBM Method)	(10,291 × 6000 USD) 61.75 Million USD	(12,062 × 6000 USD) 72.37 Million USD			
Access Roads	N-95 Highway	Access Roads Required			
Temporary Access Bridges (Dam & PH)	Not Required	2 x Required			
Permanent Access Bridge (PH)	Not Required	1 x Required			
Access Bridges Cost (Dam)	-	1 Million USD			
Access Bridges Cost (Powerhouse)	-	1.5 Million USD			
Permanent Powerhouse Access Bridge	-	1.8 Million USD			
Transportation of TBM	-	Special Arrangements Required through access bridge and platform			
Desander	Cost will be increased due to large excavation required as Hard Rock is exposed. Workability will be difficult	Flat area is available for the desander on this side hence the cost will be less, and workability will be easy.			

#### Table 0-15 : HRT Alternative Route Comparison

Alt-3 was considered as the optimal project layout.

Items		I Init	ES (2008) DD (2018)		FS Update		
		Umt	Г 5 (2006)	DD (2018)	Alt-1	Alt-2	Alt-3
	Location		Original Site	$\leftarrow$	50m downstream	700m downstream	50m downstream
	Catchment Area	km²	2,170	2,170	2,213	2,228	2,213
Dam	Storage Capacity (EL. 1,717)	m³	-	-	$0.12 \times 10^{6}$	$1.28 \times 10^{6}$	$0.12 \times 10^{6}$
	Height	m	24	24	28.5	75	28.5
	Length	m	73.2	73.2	71.4	192.4	71.4
	Crest Elevation	EL. m	1,724.0	1,724.0	1,721.0	$\leftarrow$	$\leftarrow$
Plant Discharge		m <sup>3</sup> /s	120.0	120.0	120.0	120.0	130.0
Min. Pla	nt Discharge	%	55	50	40	$\leftarrow$	$\leftarrow$
Normal Operating Water Level		EL. m	1,711.0	1,711.0	1,717.0	$\leftarrow$	<del>~</del>
Tailwater Level		EL. m	1,500.0	1,500.0	1,509.4	1,509.4	1,509.6
Gross Head		m	211.0	211.0	207.6	207.6	207.4
Hea	ad Loss	m	10.5	10.8	10.7	10.5	12.2
Rated	Net Head	EL. m	200.6	200.2	196.9	197.1	195.2

#### Table 0-16 : Comparison of Project Layout with FS 2008, DD 2018 and Alternatives of FS Update

Items		Ilm:4	ES (2009)	DD (2019)	FS Update		
		Unit	FS (2008)	DD (2018)	Alt-1	Alt-2	Alt-3
Installe	d Capacity	MW	215	215	213.5	213.8	229.4
Turbin	e Number		4 Units (34×3 Units, 18×1 Unit)	4 Units (38.2×3 Units, 15.4×1 Unit)			
	Turbine	%	95.4	94.0(94.5)	94.0(94.5)	$\leftarrow$	$\leftarrow$
Efficiency	Generator	%	98.0	98.2	98.2	$\leftarrow$	$\leftarrow$
	Transformer	%	-	99.5	99.5	$\leftarrow$	$\leftarrow$
Ecological Flow		m³/s	2	10% of Average Monthly Flow	2.89	←	←
Internal Consumption		%	1.5	0.3	1	$\leftarrow$	$\leftarrow$
Forced Outage		%	2.0	2.0	-	$\leftarrow$	$\leftarrow$
Reservo	ir Flushing	GWh	-	25.4(5 days)	15.2(3 days)	$\leftarrow$	16.4(3 days)
Annual G Gen	Gross Energy eration	GWh	911.5	893.8	931.6	932.5	970.7
Annual Gen	Net Energy eration	GWh	879.6	873.3	907.1	908.0	944.7
Plan	t Factor	%	48.4	47.5	49.8	49.8	48.3
Constru	uction Cost	USD	225,117,791	337,495,998	367,006,461	456,952,848	373,392,630
Unit Cons	struction Cost	USD/ MW	1,047,059	1,569,749	1,719,000	2,137,291	1,627,692
Unit Gen	eration Cost	USD/ KWh	0.25	0.39	0.40	0.50	0.40

# 0.8. **Project Optimization**

Optimization study is carried out to find the optimum project development scheme with the results of the previous F/S, and site survey and geotechnical investigation which are carried out to update the previous F/S.

Three alternatives were presented for the optimization study.

	Table 0 17 . The had ves for Optimization Study					
	Alt-1	Alt-2	Alt-3			
Design Discharge (m <sup>3</sup> /s)	120	120	130			
Installed Capacity (MW)	213.5	213.8	229.4			
Dam Axis	50m downstream	700m downstream	50m downstream			
Dam Height (m)	28.5	75	28.5			
Turbine Discharge	34×3 Units, 18×1 Unit	34×3 Units, 18×1 Unit	38.2×3 Units, 15.4×1 Unit			
Desander	$11.5 (W) \times 5 Basins$	No desander	$12.0(W) \times 5$ Basins			

Table 0-17 : Alternatives for Optimization Study

		Alt-1	Alt-2	Alt-3
Headrace	Diameter	7.4m	7.4m	7.4m
Tunnel	Length	10,291m	9,969m	10,291m

The optimal layout was determined as Alt-3 with an installed capacity of 229.4MW, a plant discharge of  $130m^3$ /s and levelized tariff of 7.17 cent/KWh as shown in following table.

	Plant Discharge (m³/s)	Installed Capacity (MW)	Annual Gross Energy (GWh)	Annual Generation (GWh)	Plant Factor (%)	Total Project Cost (000'USD)	Levelized Tariff (Cent/KWh)
Alt-1	120	213.5	931.6	907.1	49.8%	484,100	7.29
Alt-2	120	213.8	932.5	908.0	49.8%	585,497	8.83
Alt-3	130	229.4	970.7	944.7	48.3%	491,299	7.11

#### Table 0-18 : Comparison of 3 Alternatives

Furthermore, optimization studies were carried out for Design Flood, Dam Crest Elevation, Energy Dissipation, Desander Chamber, Waterway Tunnel Cross-section, and the Powerhouse.

## 0.9. Reservoir Operation and Energy Generation

Based on the optimized layout, the power potential and energy production is estimated through the energy simulation model of 3 large units and one small unit. The plant discharge is determined as  $130m^{3}$ /s for full units which is 28.9% in the exceedance time of the flow duration curve. The normal operating level at weir site shall be EL. 1,717m.

The head loss is calculated as 12.2m including that of intake, headrace tunnel, vertical pressure tunnel, steel penstock, manifold, draft tube, tailrace tunnel and minor losses. The turbine and generator efficiency at 100% Load shall be 94% and 98.2% respectively although unit efficiencies of turbine, generator and transformer totally depend on manufacturer proposal.



Figure 20 : Load vs Efficiency Graph for Turbine and Generator

Outage and internal consumption apply in the energy modeling, shutting down the power plant during 3 days for reservoir flushing and high sediment concentration during wet season. Internal consumption is determined as 1% of the installed capacity.

Outage	Unit	F/S
Outage for the Reservoir Flushing	GWh	16.4 (3 days flushing during rainy season)
Powerhouse Service (Internal Consumption)	GWh	9.7
Total Outage	GWh	26.1

Table 0-19	: Estimated Ann	ual Outage
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The operating conditions of the power plant are as follows:

Table 0-20 : Operating Conductors of the Fower Frank				
Outage	Unit	F/S		
Installed Capacity	MW	229 (3+1 Units)		
Plant Discharge	m³/s	130		
Min. Plant Discharge per Unit	%	40		
Annual Average Daily Flow	m³/s	96.4		
Operating Water Level	EL. m	1,717		
Gross Head	m	207.4		

Head Loss (Fu	all Units Operation)	m	12.2
Efficiency	Turbine		94.0
	Generator	%	98.2
	Transformer		99.5
Ecological Flow		m³/s	2.89
Internal Consumption		%	1
Reserv	oir Flushing	days	3

The plant factor shall be 47.0% calculated by dividing Annual Net Energy Production (923.1GWh) by Installed Capacity (229.4MW) and (24hrs x 365days).

												(				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Gross Energy	Auxilli ary	Reservoir Flushing	Annual Net Energy
Energy	18.6	15.2	21.4	63.4	148.2	163.0	168.7	165.4	106.9	48.9	28.7	22.2	970.7	9.7	16.4	944.7

 Table 0-21 : Annual energy Generation (GWh)

The estimated annual energy is estimated as shown in Table 0-21. The annual gross energy and net energy are estimated as 970.7GWh/year and 944.7GWh/year respectively. The plant factor is 48.3%.

# 0.10. Design of Civil Structures

## 0.10.1. General

Basically, all the structures and design data are updated based on the results of geological investigation and topographic survey which are performed for this update study. Since the previous F/S was submitted in 2008, hydrology data had been observed prior to the large flood event, 2010, and site conditions such as topography, infrastructures and so on have been changed. With these new investigation and survey results, additional design data and the changed project development circumstance, this update study is being performed. The followings are the major changed issues

- The location and layout of the main dam and stilling basin, head regulator and connection channel, desander, intake, waterway tunnel route, surge tank, powerhouse and tailrace tunnel are reviewed and updated based on the results of geological investigation and topographic survey including river cross section survey.
- The size of the structures for proper function are reviewed with design data.
- Based on the new topography, the dimension of all structures are adjusted

The detail explanation on the changed size of the structures and design data are as followings.

Item		Unit	F/S	TDD	F/S Update
	Catchment Area	km <sup>2</sup>	2,170	2,170	2,213
Hydrology	Annual Average Run-off	m³/s	94.2	94.5	96.4
	Plant Discharge	m³/s	120	120	130
	Gross Head	m	211	211	207.4
Power Concretion &	Head Loss	m	10.5	10.8	12.2
Energy	Installed Capacity	MW	215	215	229.4
Estimation	Annual Gross Energy Generation	GWh	911.5	893.8	970.7
	Annual Net Energy Generation	GWh	879.6	873.3	944.7
	Diversion Discharge	m³/s	561	564	658
Diversion Channel	Width	m	20	20	20
	Length	m	350.9	350.9	385
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam / Secant Pile
	Dam Crest Level	EL. m	1,718.3	1,718.3	1,714.0
Upstream	Dam Crest Width	m	6	6	6
Cofferdam	Height	m	13.5	13.5	13.2
	Length	m	66	66	57
	Dam Slope		1:1.3	1:1.5	1:1.5
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam
	Dam Crest Level	EL. m	1,698.0	1,698.0	1,703.0
Downstream	Dam Crest Width	m	5	5	5
Cofferdam	Height	m	6	6	7
	Length	m	40	40	55
	Dam Slope		1:1.3	1:1.3	1:1.3
	Туре		CGD	CGD	CGD
	Design Discharge	m³/s	732	801.6	1,091.5
	Safety Check Discharge	m³/s	900	1,333.6	2,078.5
Dam &	Side Wall Level	EL. m	1,724.0	1,724.0	1,721.0
Spillway	Spillway Crest Level	EL. m	1,715.0	1,715.0	1,717.0
	Spillway Width (Net Width)	m	30	30	24
	Length	m	73.2	73.2	71.4
	Height	m	24	24	28.5

Table 0-22 : Comparison on the Major Features of F/S and F/S Update

Item		Unit	F/S	TDD	F/S Update	
	Spillway Gate Type		Roller gate	Roller gate	Radial gate	
	Spillway Gate Size	m	W 10.0 × H 6.0 × 3 Nos.	W 10.0 × H 6.0 × 3 Nos.	W 8.0 × H 10.0 × 3 Nos.	
	Туре			Open Flow		
Desander	Width	m	11.5	11.5	12.0	
Basin	Depth	m	14.0	14.0	14.0	
	Length	m	130	130	130	
	Туре		Bellmouth Type	Bellmouth Type	Bellmouth Type	
I. dalar	Invert Elevation	EL. m	1,694.0	1,694.0	1,701.1	
Intake	Inlet Diameter	m	7.4	7.4	7.4	
	Gate	m	-	-	-	
	Туре		Modified Horse Shoe	Modified Horse Shoe	Circular Con'c lined	
Headrace Tunnel	Diameter	m	7.4 7.4		7.4	
i unnei	Length	m	9,946.00	9,960.00	10,291.0	
	Туре		-	Circular Con'c lined	Circular Con'c lined	
Vertical Pressure Shaft	Diameter	m	-	7.4	7.4	
	Height	m	-	181.7	119.5	
Horizontal Pressure	Туре		Circular Con'c lined	Circular Con'c lined	-	
	Diameter	m	7.4	7.4	-	
Tunnel	Length	m	101	139	-	
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined	
Steel Penstock	Diameter	m	5.1	5.1	5.1	
I CHISTOCH	Length	m	225	227	191.7	
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined	
Penstock (Manifold)	Diameter	m	4.2~2.15	4.2~2.15	4.2~2.15	
(1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,	Length	m	184.3	184.3	140.6	
	Туре		Restricted Orifice Type	Restricted Orifice Type	Restricted Orifice Type	
	Size	m	D 12.5 / D4.5	D 18.0 / D4.5	D 14.0 / D4.5	
	Height	m	71.0/167.3	77.5	78.3	
Surge Shaft	Orifice size	m	3.0	3.0	3.0	
	Max. up-surging water level	EL. m	1,761.0	1,742.6	1,754.6	
	Min. down-surging water level	EL. m	1,656.1	1,684.7	1,680.8	
Powerhouse	Туре		Underground Cavern	Underground Cavern	Underground Cavern	

	Item	Unit	F/S	TDD	F/S Update
	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 31.6 × L 88.0	W 20.0 × H 39.0 × L 88.0
	Turbine Type		Vertical Francis Turbine	Vertical Francis Turbine	Vertical Francis Turbine
	Turbine Capacity	MW	3 × 60.9, 1 × 32.2	3 × 60.9, 1 × 32.2	3 × 67.4, 1 × 27.2
	Number of Units		4	4	4
	Turbine-Center Level	EL. m	1,491.0	1,491.0	1,495.0
	Туре		Underground Cavern	Underground Cavern	Underground Cavern
Transformer	Transformer Cavern Size	m	W 18.0 × H 13.6 × L 91.5	W 8.7 × H 7.3 × L 82.9	W 18.0 × H 13.9 × L 91.5
& GIS Cavern	GIS Cavern Size	m	-	W 13.4 × H 10.2 × L 31.4	-
	Transformer Type		3-Phase	Single-Phase	3-Phase
	Number of Units		5	13	5
Tailrace	Diameter	m	5.0	5.0	5.5
Tunnel	Length	m	280	280	303.1

# 0.10.2. Detail Explanation on the Changed Design

## 0.10.2.1. Hydrology

In the previous F/S, the river flow data from 1961 to 2004 was available. During site visit, daily flowdata from 2005 to 2006 and average monthly flow data and maximum instantaneous flow data from 2005 to 2010 are collected. The Table shows the added daily flow data from 2005 to 2006 for energy generation model, and the river flow data in F/S Update is a period of 1961 to 2010. The average river flow of the added daily flow data is slightly greater than that of F/S.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
F/S (m <sup>2</sup>	³/s)	15.8	14.5	18.1	52.3	141.9	269.1	271.7	177.4	83.8	37.4	24.4	18.8	94.2
2005 (m	n³/s)	21.2	21.2	36.0	83.2	141.4	318.5	394.8	177.2	84.3	37.3	21.5	20.5	113.1
2006 (m	n³/s)	19.4	19.4	21.4	53.0	190.0	180.5	215.8	148.7	62.7	31.2	21.1	20.5	82.0
F/S Update (1	m³/s)	16.8	15.3	19.4	54.1	147.9	272.7	279.5	182.8	87.0	38.9	25.0	19.6	96.4

Table 0-23 : The Added Daily River Flow at the Dam Site

#### A. Catchment Area

The catchment area in the F/S was estimated as 2,170km<sup>2</sup>. During examining the catchment boundary of the F/S, no digitized catchment boundary map and soft copy of the catchment boundary are collected so that the catchment boundary is reevaluated with Google Map. It is estimated as 2,213km<sup>2</sup>.

	Swat River Kalam Gauging Station		Dan	ı	Tailrace Outlet		
	Area (km²)	Area (km²)	Ratio	Area (km²)	Ratio	Area (km²)	Ratio
F/S	13,300	2,020	1.0	2,170	1.07	-	-
F/S Update	13,300	2,020	1.0	2,213	1.10	2,483	1.23

Table 0-24 : Catchment Area and Ratio at the Major Locations

#### B. Annual Average River Flow

The annual average river flow at the dam site is derived by the catchment area ratio to Kalam gauging station and the added river flow data. Thus, the annual average river flow is increased as 96.4m<sup>3</sup>/s from 94.2m<sup>3</sup>/s by the increased catchment area ratio and the greater average river flow of 2005~2006.

## 0.10.2.2. Power Generation & Energy Estimation

Basically, the energy generation scheme of the run-of-river type, the number of unit and operating hours are maintained as those of the previous F/S. 2.89m<sup>3</sup> for the ecological flow is considered while no ecological flow was applied in the previous F/S.

#### 0.10.2.3. Plant Discharge

The optimization study was carried out with 120m<sup>3</sup>/s of the plant discharge of the previous F/S, 130m<sup>3</sup>/s of the plant discharge of Kalam HPP, and storage type scheme with 120m<sup>3</sup>/s of the plant discharge. The optimal plant discharge is determined as 130m<sup>3</sup>/s of the plant discharge. Considering the plant discharge, 130m<sup>3</sup>/s of Kalam HPP, it is a reasonable option to insure continuity in the cascade development scheme in SWAT River.

#### 0.10.2.4. Gross Head

The gross head is decreased due to the increase of the tailrace water level from EL. 1,500m to EL. 1,509.6m while the operating water level is raised as EL. 1,717m from EL. 1,711m. The tailwater level is estimated by stage-discharge curve which is derived by HEC-RAS model. The geometry data of the tailrace outlet area for HEC-RAS simulation is obtained by river cross section survey.

#### 0.10.2.5. Head Loss

No detail parameters for head loss estimation are provided in the previous F/S. Thus, the head loss is reevaluated with the designed structures and layouts in this Update F/S. It is increased as 12.2m from 10.5m.

#### **0.10.2.6. Installed Capacity**

The installed capacity is increased as 229.4MW from 215MW due to the increased plant discharge from  $120m^{3}/s$  to  $130m^{3}/s$ .

# 0.10.2.7. Annual Net Energy Generation

As the installed capacity is increased, the annual net energy generation is increased as 944.7GWh/year from 911.5GWh/year considering 3 days reservoir flushing outage and internal consumption.

## 0.10.3. Diversion Channel

The 2 stages diversion scheme is maintained. First stage is a diversion channel with cofferdam, and second stage is a conduit with cofferdam, using the spillway in the main dam body.

## 0.10.3.1. Diversion Discharge

The design discharge of diversion channel is increased as  $658m^{3/s}$  from  $561m^{3/s}$ . Design discharge of the major structures is estimated by flood frequency analysis including the large flood,  $2,537m^{3/s}$ , in 2010.

## 0.10.3.2. Diversion Channel Size

Based on the result of topography survey on the headworks area, overall elevation is raised up. Thus, the depth of the diversion channel is increased. Flood routing for diversion channel is carried out with the increased design flood.









## 0.10.3.3. Diversion Channel Length

Based on the result of topography survey on the headworks area, the length from the inlet to the outlet is increased as 385.0m from 350.9m even though the same location and route apply as shown in above Figures

## 0.10.4. Upstream Cofferdam

#### A. Cofferdam Type

The cofferdam type is the same as a rockfill type of the previous F/S. While curtain grout was introduced to prevent from seepage underneath the upstream cofferdam, sheet file is introduced in Update F/S.







Figure 24 : Typical Section of the Upstream Cofferdam in F/S Update

#### B. Cofferdam Crest Level

The cofferdam crest level is determined as EL. 1,714m from 1,718.3m by flood routing analysis, considering the increased release capacity of diversion channel.

#### C. Cofferdam Height and Length

Even though the cofferdam crest level is lowered by 4.3m, and the location of cofferdam is the same to the previous F/S. the dam height from the riverbed to the crest is lowered as 13.2m from 13.5m because the topography of the headworks area is raised. The length is also decreased as 57.0m from 66.0m according to the width of river.

## 0.10.5. Downstream Cofferdam

## A. Cofferdam Type

The cofferdam type is the same as a rockfill type.

#### B. Cofferdam Crest Level

The cofferdam crest level is raised as EL. 1,703m from 1,698m by flood routing analysis, considering the increase release capacity of diversion channel and the increased design flood that results the water level at the downstream cofferdam to be higher.

## C. Cofferdam Height and Length

The location of cofferdam is the same to the previous F/S. Based on the result of topography survey on the headworks area, the dam height from the riverbed to the crest is increased as 7.0m from 6.0m and the length is increased as 55.0m from 40.0m according to the width of river.

## 0.10.6. Dam & Spillway

#### A. Design Discharge

The design discharge of the dam and spillway is increased as 1,091.5m<sup>3</sup>/s from 732.0m<sup>3</sup>/s. Design discharge of the major structures is estimated by flood frequency analysis including the large flood, 2,537m<sup>3</sup>/s, in 2010.

#### B. Safety Check Discharge

The design discharge of the dam is increased as 2,078.5m<sup>3</sup>/s from 900.0m<sup>3</sup>/s. Design discharge of the major structures is estimated by flood frequency analysis including the large flood, 2,537m<sup>3</sup>/s, in 2010.

#### C. Dam Crest Level

Even though the design flood is increased, the dam crest level is lowered as EL. 1,721.0m from EL. 1,724.0m due to the increased release capacity of the spillway. The crest level of the spillway and the dam are lowered to EL. 1,700m, and the free overflow spillway for the floating debris removal is provided that leads the release capacity of the spillway to be increased.

#### D. Spillway Width

In order to provide the free overflow spillway at the left side of the dam, the spillway width narrows by 6m, from 30.0m to 24m.



#### Figure 25 : Headworks Layout in F/S



Figure 26 : Headworks Layout in F/S Update

# E. Dam Height

Based on the result of topography survey on the headworks area, the dam height from the riverbed to the crest is increased as 28.5m to 24.0m.



Figure 27 : Dan Elevation in F/S





# F. Spillway Gate Type

The spillway gate type is changed to radial gate type, considering the reservoir depth and flow control function.

#### G. Spillway Gate Size

The spillway gate height is increased as 10.0m from 6.0m due to the lowered crest level that leads the released capacity of the spillway to be increased.



Figure 29 : Spillway Section in F/S

Figure 30 : Spillway Section in F/S Update



# H. Spillway Gate Type

The spillway gate type is changed to radial gate type, considering the reservoir depth and flow control function during operation.

# 0.10.7. Desander Basin

#### A. Desander Width and Depth

The design flood for the desander is increased as  $130m^3/s$  from  $120m^3/s$ . It has 5 basins including 1 basin for desander flushing without outage, and each basin width is increased as 12.0m from 11.5m.



Figure 31 : Typical Section of Desander in F/S

Figure 32 : Typical Section of Desander in F/S Update



## 0.10.8. Intake

## A. Invert Elevation

The invert elevation is raised to EL. 1,701m from EL. 1,694m according to the result of topographic survey. The operating water level for the desander and forebay is determined as EL. 1,717m in this Update F/S so that the intake structure is raised as much as possible.



#### Figure 33 : Typical Section of the Forebay and Intake in the Previous F/S



Figure 34 : Typical Section of the Forebay and Intake in F/S Update





#### Figure 36 : Front View of Intake in Update F/S



# 0.10.9. Headrace Tunnel

#### A. Length

The length of the headrace tunnel is increased as 10,291.0m from 9,946.0m. The layout and profile are slightly adjusted, considering TBM application and rock cover depth. The cross section type is changed from modified horse shoe type to circular type, considering TBM application.



Figure 38 : Headrace Tunnel Layout in F/S Update



Figure 39 : Headrace Tunnel Profile in F/S



#### Figure 40 : Headrace Tunnel Profile in F/S Update



#### **0.10.10. Vertical Pressure Tunnel**

In the previous F/S, the headrace tunnel was inclined to the powerhouse from the intake so that the vertical pressure tunnel was not introduced. In the Update F/S, the headrace tunnel is almost horizontal to the surge tank and then the vertical pressure tunnel starts. The cross section type and diameter are the same to those of the headrace tunnel, and the length is 119.5m.

#### 0.10.11. Horizontal Pressure Tunnel

The horizontal pressure tunnel does not apply in the Update F/S. From the end of the vertical pressure tunnel the steel penstock is installed to secure the safety on the high pressure.

#### 0.10.12. Steel Penstock and Manifold

The steel penstock starts from the surge tank. Due to movement to the surge tank of the powerhouse, the steel penstock length is decreased as 191.7m from 225.0m. The manifold length also is decreased as 140.6m from 184.3m due to the layout change of the manifold by the rotation of the powerhouse direction.





#### Figure 42 : Steel Penstock and Manifold Layout in F/S Update

#### 0.10.13. Surge Tank



Considering the topographic survey result, the surge tank size is estimated with the increased design discharge, 130m<sup>3</sup>/s and the lengthen headrace tunnel. The surge tank is enlarged as a

diameter of 14.0m from 12.5m and heighten as 78.3m from 71.0m. With this size of the surge tank, the maximum upsurging water level is lowered as EL. 1,754.6m from EL. 1,761.0m while the minimum down surging water level is raised as EL. 1,680.8m from EL. 1,656.1m.

## 0.10.14. Powerhouse



Figure 45 : Typical Section of the Powerhouse in the Previous F/S

Figure 46 : Typical Section of the Powerhouse in Update F/S



#### A. Powerhouse Size

The powerhouse size is enlarged as W 20.0 × H 39.0 × L 88.0 from W 20.0 × H 31.6 × L 75.2 in order to secure installation and maintenance space.

#### **B. Turbine Center Level**

Since the Francis turbine, one of the reaction turbine types, is introduced, it should be submerged and secure draft head. The turbine center level is estimated considering draft head and the tailwater level. It is raised to EL 1,495m from EL. 1,491m.



#### Figure 47 : Powerhouse Plan in the Previous F/S

Figure 48 : Powerhouse Plan in Update F/S



## 0.10.15. Tailrace Tunnel

The length of the tailrace tunnel is increased as 744.02m from 280.0m because the power house location is moved to the surge tank direction to secure the rock cover depth.





# 0.10.16. TBM vs NATM

For the tunneling of the head race tunnel, Tunnel Boring Machine (TBM) shall be used. The comparison of TBM with NATM (New Austrian Tunneling Method – Drill and Blast) is as follows:

Item	NATM method (Drill & Blasting)	TBM method (Mechanical excavation)
Introduction		
	Excavation by using the drill & blast method, rock bolt(R/B) + shotcrete(S/C) and assistant reinforcement	Excavation using the tunneling machine Excavation is followed by R/B, S/C support Consisting of the cutter head, drive head, clamping pad
Geological conditions	From soil to hard rock Poor or fluctuating geological conditions	Soft rock with 50-180MPa of UCS It is difficult at unstable face, fickle ground, swelling ground, extremely weathered zones, and fractured zones
Advantage	Simple combination of excavation equipment (jumbo, S/C machine, loader, dump etc.) Prompt react against the geologically poor zone	Favorable for long mountain tunnel because of mechanical excavation Minimizations of the blast, induced vibration, and noise The most advantageous in the aspects of construction period due to full face excavation
Disadvantage	The most disadvantageous in the aspects of excavation period because of the conventional tunneling method. Poor working environment Civil complaint due to blast, induced vibration, and noise Increase of the relaxed zone due to blast	Requirements of special reinforcement in geologically poor zone High price of machine Requirements of electrical facilities for excavation Requirements of space for assemblages and rock muck disposal Requirements of fixing and widening the access road because of heavy machine Limited geological information due to the cutter head obstructing the tunnel face Potential difficulties in shear zones
Construction Cost	122,198,948 USD	99,935,582 USD
Period		54 Months

#### Table 0-25 : NATM vs TBM

Item	NATM method (Drill & Blasting)	TBM method (Mechanical excavation)
Applied		Ø

# 0.11. Design of Electro-Mechanical Equipment

The mechanical equipment and main mechanical auxiliaries in the powerhouse consists of following items:

- Turbine I : three(3) vertical shaft single-stage Francis-turbines including hydraulic/ electronic turbine governors
- Turbine II : one(1) vertical shaft single-stage Francis-turbines including hydraulic/electronic turbine governors
- butterfly valve in front of each turbine with auxiliaries

Auxiliary mechanical systems such as:

- cooling water system
- drainage and dewatering system
- heating ventilation and air conditioning system
- fire fighting system
- oil purifying equipment
- compressed air system
- workshop equipment and tools
- main inlet valve
- main lifting equipment

The estimated rated net head is 195.2m and net dicharge is  $130m^3/s$  for all units. (Turbine I:  $38.2m^3/sec \times 3$  units and Turbine II:  $15.4 m^3/sec \times 1$  unit). The turbines shall have an optimum and economically viable output of  $67.4kW \times 3$  Units and  $27.2kW \times 1$  Unit. According to the type selecting diagram by "Hydropower Engineering USA", vertical Francis Turbines were selected.



Figure 51 : Turbine Selecting Diagram

Main features of the turbine are as follows:

1 able 0-20 : Main reatures of 1 urbine								
Division	Turbine I	Turbine II						
Turbine output (kW, unit)	67.4	27.2						
Number of units	3	1						
Type of turbine	Vertical Francis	Vertical Francis						
Design discharge (m <sup>3</sup> /sec, unit)	38.2	15.4						
Dlaut diasharra (11.3/1000 allaurit)	114.6	15.4						
Plant discharge (m <sup>2</sup> /sec, all unit)	130							
Rated net head (m)	195.2	195.2						
Efficiency (%)	94.0 (94.5%)	94.0 (94.5%)						
Selected Specific speed (m-kW)	134.6	114.0						
Rotational speed (min 1)	375	500						
Turbine setting elevation (EL.m)	1,497.7	1497.7						
Tail water level (1 Unit operation, EL.m)	1,505.0	1,504.7						

Table 0-26 : Main Features of Turbine

Main parts of turbine include:

- Spiral Case
- Stay Ring
- Runner
- · Head Covers, Discharge Rings and Bottom Rings
- Guide Vanes
- Main Shaft
- Turbine Guide Bearing
- Pit Liner
- Draft Tube
- Governor
- Pressure Oil System

The material of the runner shall be 13/4 Cr:Ni with a HVOF coating considering the amount of sediment in the water in which size of silt is more than 0.2mm.

Mechanical Auxilliaries include:

- Cooling Water System
- · Shaft seal water supply filter system
- Dewatering System
- Drainage System
- · Heating, Ventialation, Air-conditioning System
- Fire Fighting System
- Oil Purifying Equipment
- Workshop Equipment and Tools
- · Compressed Air System Low Pressure
- · Compressed Air System High Pressure

At the upstream of each turbine, one Flow through valve (Biplane type butterfly valve) shall be installed for emergency and repair shutdown valve of the turbine. The specification of Main Inlet Valve is as follows:

Division	Turbine I	Turbine II
Number of units	3	1
Type of valve	Flow-through valve (Biplane type butterfly valve)	Flow-through valve (Biplane type butterfly valve)

#### Table 0-27 : Specification of Main Inlet Valve

Division	Turbine I	Turbine II
Nominal diameter (m)	app. 2.2	app. 1.5
Static head (m)	219.3	219.3

Main Lifting Equipment include the overhead crane of the Powerhouse having a main hoist capacity of 170ton and Crane for GIS Room.

## 0.12. Design of Electrical Equipment

The design concept is based on the assumption to interconnect the AKHPP to a 220kV high voltage transmission line at the Switchyard. The key single line diagram of electrical facility of power plant is as follows:



Figure 52 : Key Single Line Diagram of Electrical Facility of Powerplant

Electrical Equipment within the powerhouse include the Generator, the Step-Up Transformers, the Station Service Transformers, the 220kV GIS Switchgear, Auxiliary Electrical Equipment, Protection Relaying system & metering and control & monitoring system.

Table 0-28 : Design Parameter of Gen	ierator
--------------------------------------	---------

Division	Specification
Capacity (Unit1 to 3/Unit 4)	74.88 MVA/30.19MVA

Division	Specification
Power Factor (PF)	0.9
Rated Speed	375RPM/500RPM
Frequency	50Hz
Terminal Voltage	11 ±5%kV
Stator coil Connection	Y connection
Neutral Point Ground Method	High resistance grounding method using Single-phase transformer for grounding and secondary resistor.

The circuit breakers of generator have the following specification:

Division	Specification
Number of Circuit Breakers	4
Number of Phase of Each Systems	3
Nominal Operating Voltage	12kV
Frequency	50Hz
Lightning Impulse voltage	75kV
Rated Current(Unit 1 to 3/Unit 4)	4000A/2000A
Rated Short-Time Current	50kA

### Table 0-29 : Specifications of Circuit Breakers of Generator

Each Unit will have one step up transformer while one spare transformer will be available for emergency. 3-Phase Transformers will have following design parameters.

Division	Specification
Number of Three-Phase Transformer	4+1
Туре	Three-phase, two windings
Rated bank Output of Three-Phase Transformer (Unit 1 to 3/Unit 4/Spare)	75MVA/35MVA/75MVA
Frequency	50Hz
Type of Cooling	OFWF
Primary Voltage Rating	11kV
Primary BIL Level	75kV
Secondary Voltage Rating	220kV
Secondary BIL Level	950kV

#### Table 0-30 : 3-Phase Transformers Specifications

An automatically operated firefighting water-deluge system will be provided for all 3-phase unit step up transformers. Two 3-Phase Transformers will be provided for auxiliary power supply from the generator bus ducts of all units.

A 220 kV SF6 gas-insulated switchgear (GIS) will be installed in a separated room above the transformer room in the powerhouse. The Design Parameter of 220kV GIS Switchgear is as follows:

Table 0 51 : Design 1 arameter 01 220k V GIS Switcingear			
Description	Specification	Remarks	
Normal voltage	220kV		
Rated voltage	245kV		
Rated frequency	50Hz		
Rated current(Continuous at 40°C ambient)	2,000A/2,000A	For generator for line	
Short time rated current (RMS)	40kA		

The auxiliary power requirements for each unit will be provided through the 400V AC Auxiliary Power Supply. UPS Systems and Diesel Generator Sets will be provided for backup. Meanwhile, Protection Relaying System and Metering shall also be provided.

For reliable, efficient, and safe operation of the power station, a monitoring and control system will be provided, configuration of which is as follows:



### Figure 53 : Monitoring and Control System Configuration

Moreover, Telephone System and Power Line Carrier Communication shall be provided too. For the electrical equipment at the dam Site, a medium voltage aerial distribution line will be installed at site along with three pole mounted step-down transformers and an interrupter switch. Further, a 220kV Terminal Gantry will be located close to the power outlet structure.

## 0.13. Design of Hydro Mechanical Equipment

T I I A 22 D

Item No.	Description	Specifications
1	Number of gates	3
2	Type of gate	Radial gate
3	Sealing system	Rubber seals
4	Sill level, m.a.s.l.	1,700.00
5	Normal level, m.a.s.l.	1,717.00
6	Static head at sill, m	17.0
7	Opening width, m	8.0
8	Opening height, m	10.0
9	Type of hoist	Hydraulic cylinder

0 11

Radial Gateway for Spillway has the following design:

For the three spillway radial gates, one set of stoplog will be proposed having 5 sections. The gate will be slide type with rubber seals having an approximate height of 10m and will be operated by the Gantry Crane.

The Gantry Crane at Spillway will be electrically operated with an estimated capacity of 30ton.

For desander, there will be a total of 5 trash rack sets with width of 5.2m each and height of opening shall be 5m with an inclination of 81°. The trash rack cleaner will be movable, rake, knuckle crane gripper with the rake width of 3m and cleaner travel of 35m.

The Intake gate will have the following design parameter:

Item No.	Description	Specifications
1	Number of gates	5
2	Type of gate	Fixed wheel gate (roller gate)
3	Sealing system	Rubber seals
4	Sill level, m.a.s.l.	1,710.00
5	Static head at sill, m	7.0
6	Opening width, m	5.2
7	Opening height, m	5.0
8	Type of hoist	2 Drum wire rope winch

 Table 0-33 : Intake Gate Design Parameters

There shall be 10 desander roller gates (fixed wheel gate) having rubber seals and will be hoisted on 2 Drum wire rope winch. The desander flush will have 5 sluice gates having rubber seals with an inside diameter of 2m and will be hoisted on an electric hoist. Gantry Crane shall

be provided for desander gate.

The trash rack at intake has the following design and applicable data:

Item No.	Description	Specifications
1	Number of trash rack, set	1
2	Width of each trash rack opening, m	11.0
3	Height of opening, m	15.0
4	Bottom elevation of trash rack, m.a.s.l.	1,701.00
5	Inclination angle of trash rack, degree	80.0°

The steel penstock shall have the following design parameters:

Item No.	Description	Specifications
1	Maximum discharge, m <sup>3</sup> /s	130
2	Steel Penstock diameter / length, m	5.1 / 191.7
3	Manifold diameter / length, m	4.2 / 12.7, 2.9 / 106.6, 2.15 / 21.3
4	Turbine setting elevation(EL. m)	1,495.0
5	Static head, m	222
6	Encased or exposed supported	Encased

The Draft tube gate will have the following design parameters:

### Table 0-36 : Draft Tube Gate Design Parameter

Item No.	Description	Specifications
1	Number of gates	3/1
2	Type of gate	Slide gate
3	Sealing system	Rubber seals
4	Flood water level, m.a.s.l.	1,514.1
5	Sill level, m.a.s.l.	1,488.5
6	Static head at sill, m	30.1
7	Opening width, m	5.5/4.2
8	Opening height, m	2.2/1.9
9	Type of hoist	Overhead crane

## 0.14. Grid Interconnection Study

The Grid Interconnection Studies (Load Flow Studies) were carried out by the Power Planners

International (PPI) for KOAK Power Limited. The summary of the studies concludes the following:

- According to The Integrated Study, Asrit Kedam HPP will be connected by looping in out at one of the 220kV double circuit from Kalam Asrit HPP to Chakdara-New 220kV G/S. The conductor would be 220kV Twin Bundle ACCC Plano with thermal rating of 1,727 MVA.
- The proposed scheme for Asrit Kedam HPP will require the following bays in the switch yard
- Two-line bays of 220kV for connection with 220kV Kalam Asrit HPP and 220kV Chakdara-New G/S
- Four transformer bays for the four GSU transformers (3x75MVA & 1x40MVA)
- In view of the expected Commercial Operation Data (COD) of Asrit Kedam HPP in the last quarter of 2027, the above proposed interconnection scheme has been tested for the following scenarios using load flow studies:
- Peak Load Summer 2028
- Off-Peak Load Summer 2028
- Peak Load Winter 2028
- Off-Peak Load Winter 2028
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of Asrit Kedam HPP under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at hydropower plant G/S and the substations of 220kV and 132kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear proposed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the under study HPPs.
- The maximum short circuit levels at 220kV Asrit Kedam HPP bus bars for the Year 2028 for 3-Phase and 1-Phase are 11.75kA and 11.83kA respectively. It would be advisable to go for standard size switchgear of short circuit rating of 50kA. It would provide large margin for future increase in short circuit levels as generation additions are expected in the valley and network reinforcements will be introduced to accommodate those additions.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for peak load condition of summer 2028. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems and is therefore recommended to be adopted. It meets all the criteria of grid code under steady state load flow, short circuit currents and dynamic/transient conditions given all the proposed requirement of the network are implemented.

## 0.15. Environmental Impact Assessment

## 0.15.1. Summary

The proposed project will be developed on land purchase from private owners and the Government of Khyber Pakhtunkhwa in Asrit and Kedam village of Tehsil Behrain, District Swat of Khyber Pakhtunkhwa province (KPK).

This synopsis presents the existing Environmental and Social (E&S) baseline conditions and evaluation of the EIA with respect to the following parameters of the Hydropower plant:

- Design and Construction phase;
- · Operational and maintenance phase; and
- Decommissioning phase.

The EIA study for the proposed 229 MW Asrit Kedam Hydropower Project uses major international (IFC, ADB etc.) and national guidelines relating to Hydropower plant projects' design, construction, operation and decommissioning.

The proposed project weir (35°21'28.61"N, 72°36'22.87"E) is to be located at Asrit village, Swat district of KPK province at approximately 14 km about downstream from the confluence of Gabral and Ushu Rivers and The powerhouse (35°15'52.61"N, 72°35'43.78"E) is located at a point 500m upstream of Kedam Khwar, which is about 14km downstream from the intake. The site is at about 70 km away from Saidu Sharif Airport, Swat.

The Hydropower project is being developed in an area, which is mountainous, having agricultural areas, with sparse forest, and barren and range land. No sensitive ecological habitats with high ecological value were found during the field survey of the EIA. Similarly, Involuntary Resettlement Category, the proposed project falls in Category-B. The construction of the 229 MW Asrit-Kedam project have impact on 36 DPs (less than 200), who will experience major impacts in terms of losing their housing and 10% or more of their productive assets project vicinity is expected to be adversely impacted by the proposed project activities.

## 0.15.2. The EIA Methodology

Various steps undertaken for the EIA preparation include understanding of the proposed project; review of provincial, national and international legislation and guidelines; EIA scope and methodology; a collection of secondary data including physical, biological & socioeconomic environment and heritage aspects; primary field data collection; potential environmental impacts identification; recommendations for mitigation and monitoring measures; development of Environmental Management Plan (EMP) and reporting.

Field surveys for EIA study were carried out by a team of environmental specialists, fisheries expert, sociologists/gender experts, wildlife experts, botanist and archaeologists along with representatives from KPK Wildlife, forest and revenue Departments in the first week of September 2021. Field data collection included ground trusting of available secondary information. Secondary information was obtained from KOAK Power (Private) Limited, other sources like previous environmental studies in the region, published data and schedule rates

from forest, revenue, agriculture and wildlife departments and respective District Census Reports (DCRs).

The approach for identification of environmental and social impact assessment was based on MECE (Mutually Exclusive, Collectively Exhaustive) methodology which guides to include a broad range of aspects with respect to financing arrangements, regulatory requirements and environmental controls of lender, details of technology and plant layout etc.

## 0.15.3. Study Zone

Consultants explored the spatial boundaries of the environmental impact assessment and attempted to cover all the areas prone to any changes either directly or indirectly with Asrit-Kedam HPP. The experts considered various stages of the project specifically the construction and operation phases. Additionally, the cumulative level of various Hydropower projects in Basin were considered keeping in view the developmental plans of Pakhtunkhwa Energy Development Organisation (PEDO). The permanent footprint of the proposed project includes the area that will be acquired for the weir, reservoir, powerhouse, roads and some other facilities. The temporary footprint includes the land that will be required or disturbed due to the temporary facilities that will be developed during the construction phase in the weir, powerhouse and other infrastructure components.

## 0.15.3.1. Aquatic Study Zone

Swat River stretches starting from Asrit(Swat River) which is considered the upstream section of the proposed HPP to the downstream (Kedam ) is taken as an aquatic study zone. The length of the river is approx. 11.5km which includes the tributaries in the stretch.

## 0.15.3.2. Terrestrial Study Zone

500m buffer is taken on each side of the river where Project-related facilities are to be located as well as the reservoir.

## 0.15.3.3. Socio-economic Study Zone

During the socio-economic studies 500m buffer on each side of the river including the settlements are considered. In order to cover the communities around the permanent project facilities or the temporary, a 1km cover as buffer radius is taken to identify range of communities around the project facilities.

## 0.15.4. Physical Baseline

## 0.15.4.1. Topography

The project area is mountainous, with an altitude generally between 5000 to 6000 feet above mean sea level (amsl).

## 0.15.4.2. Land Use and Cover

The mountain ranges generally run from north to south. The reservoir area of the project is under agriculture, forest, barren and range land. A moderate number of forest trees, fruit trees, mixed shrubs and grassy patches also exist.

## **0.15.4.3.** Climatic Conditions

The project area falls in sub-humid and sub-tropical zone of district swat with moderate summer and extreme cold winter. The hottest month is June with mean maximum and minimum temperature of 33°C and 16°C respectively, and the coldest month is January with mean maximum and minimum temperature of 11°C and -2°C, while the annual precipitation averages 866 mm (34.1 in).

## 0.15.4.4. Water Resources

For drinking water in project area twelve water samples, including some from Asrit Nullah, near weir site and other near powerhouse site were collected by an EPA-KP certified Environmental lab.

All the water quality parameters are within NEQS and WHO drinking water standards.

## 0.15.4.5. Ambient Air Quality

The ambient air quality was measured for respirable particulate matter (PM), sulfurdioxide (SO2) and oxides of nitrogen (NOX). Air quality sampling was carried out at two different locations in the Study Area during September 2021.

Key observations of the basis of the sampling conducted by the Environmental sampling laboratory are

- The 24-hour PM10 and PM2.5 concentration comply with both the NEQS and IFC-EHS limits at all sampling locations (Powerhouse Site, Weir Site and Disposal Area).
- The 24-hour concentrations of SO2, CO, NO2 and NO comply with both the NEQS and IF-EHS limits.
- The air quality in the area is also good, revealed from instrumental analysis on air quality monitoring .

## 0.15.4.6. Noise Quality

During the site study baseline, ambient noise levels in the study area of Asrit-Kedam were assessed. Noise measurements were taken at 3 locations (Weir, Powerhouse and Disposal Area) which are considered the possible sources of noise pollution from project activities. The sampling duration was extended to 24hours at each of the sites

There are no major industries in and around the project area; therefore, noise pollution was observed to be generally below 65 dB (A).

## 0.15.5. Ecological Resources

The project area falls in sub-humid and sub-tropical zone of district Swat with moderate summer and extreme cold winter. However, all the habitats in the project, the area doesn't not fall under the protected wildlife category, whereas some of the area at weir (approx. 14.25 acre) is classified as a protected forest area by the KPK Forest Department which shall be de-notified by the Government as per applicable laws. Further details on the ecological resources are provided below.

## 0.15.5.1. Terrestial Fauna

Key fauna associated with this habitat are :

A total of 7 mammals were recorded/observed from the project area. Red fox, Rhesus monkey, Asiatic Jackal, and Leopard Cat. Among these species, none are listed as vulnerable by IUCN.

The common small mammals are Indian Gerbil, House Mouse, Woolly Flying Squirrel, Asian Palm Civet, Indian Bush Rat, Himalayan Marmot and Stoat. A total of 3 reptiles were recorded/observed from the project area and the common species are lizards, Bengal Monitor Lizard, Varanus bengalenis, Spiny-tailed Lizard Saara hardwickii, and Leopard Gecko Eublepharis macularius along with species of frogs and snakes. None of these species are listed in IUCN Red List as endangered or near threatened.

## 0.15.5.2. Terrestial Flora

Similarly, regarding floral attributes, a total of 44 vegetation species belonging to various plant families were found on the project site and close vicinities. None of the rare, endemic or threatened floral species were identified during the EIA site visit and are widely distributed in KPK and particularly in Swat district.

## 0.15.5.3. Aquatic Fauna

During the aquatic sampling and survey two fish of commercial importance i.e the exotic brown trout (Salmo trutta) and the indigenous snow carp (Schizothorax plagiostomus) were found near Kalam, i-e upstream of weir site. During population abundance trials total catch of the brown trout was 90%. Field reconnaissance presents that none of the aquatic species are critically endangered.

## 0.15.5.4. Avifauna

A total of 12 birds' species were recorded from the project area. House Sparrow, House Crow, Raven, Chukar Partridge and other commonly observed bird species The birds such Collared dove, Little brown dove, House crow, House sparrow, Red-vented bulbul, Common & Bank myna, Little green bee-eater, Crested lark and White cheeked bulbul. Among the raptors, Black kite, Brahminy kite, Common buzzard, Common kestrel, Marsh harrier, Steppe eagle, Tawny eagle and White eyed buzzard were also recorded can be seen. The diversity of species in a particular area depends not only on the number of species found, but also on their individuals' counts. Most of the species belong to the status of least concerned in terms of IUCN Redlist, however, Parakeet and Balck Patridge is considered to be in a vulnerable state due to hunting. These two species were not found specifically in the project area during surveys but are commonly reported in secondary data (literature).

## 0.15.6. Socioeconomic Environment

The proposed 229MW Asrit-Kedam hydropower project start from Kedam village and leads towards Asrit village by passing through Balakot, Ramet and Mankial villages of Tehsil Bahrain district Swat. In order to find out the social status of the residents, social survey in the study area villages were carried out at the different locations shown below

Sr.No.	Villages	Estimated No. of Houses	<b>Estimated Population</b>
1	Asrit	62	558
2	Balakot	450	4,050
3	Chodram	70	630
4	Chamgharai	100	900
5	Ramait	250	2,250
6	Mankial	1,500	13,500
7	Kulalain	50	450
8	Kewa	30	270
9	Shina	25	225
10	Biji	40	360
11	Beion	50	450
12	Jal	80	720
13	Hawai	100	900
14	Laishahi	90	810
15	Dan	60	540
16	Kedam	150	1,350
17	Guranai	120	1,080
18	Pankey	60	540
	Total	3,287	29,583

A total of 18 settlements were surveyed during the field activities, ranging in size from 25-1500. The total estimated number of household in the study area is 3,287. The household surveys, indicated that average household size is 9 persons.

The population of the project area is a mixture of Torwali, Gujar, Oshojo, Kashmiri, Kohistani and Pashtun. The major language of project area is Taroli and Pashto , while Urdu and English are also used by educated class of the area.

Education facilities are very petite in the proposed project area. Just a Higher Secondary School for boys and Primary school for girls is available in the proposed Project area in Mankial, while most of the other villages have only primary schools. As per survey results majority of the community send their children to these schools for basic education. In the project area no proper medical facilities are available expect the basic health units. Therefore, locals have to move Mingora, Abbottabad or Peshawar. The area boasts great biodiversity and natural beauty, the valley has dramatic natural beauty and there are many places which have attractions for the tourists.

Kalam, one of the favourite tourist destination is just 16 km upstream of the proposed weir site. Majority of the female does not take part in any activity except household works and livelihood

earning is the responsibility of males.

As per social survey there is no any archaeological/historical site exist in the Area of Influence.

Communities around the project area own livestock commonly which include bullocks/buffalos, cows, goats, donkeys and a small number of horses. Livestock owners often engage herders to rear goats, whereas poultry, cows and buffalo are reared at home. The area is also a common ground for the nomadic movements (between low land and uplands).

Small scale sediment mining is carried out to some extent around the powerhouse and weir areas which are accessible. The mineable sediment resource is being extracted to meet small-scale construction demand, involving construction and maintenance of local residential and commercial buildings. The mining techniques are crude, involving use of labor for dredging and use of local livestock and tractors for movement of sediment.

During the surveys, it was found that a mining lease for granite marble was awarded to a party in the area of influence. The subject lease is in the process of denotification as per existing laws

None of the settlements surveyed in the Socioeconomic study area are connected to a municipal sewage system like in cities. Human waste in some parts of the Mankiyal and Balakot is disposed of in septic tanks in properly constructed houses, however in majority of areas all wastewater eventually runs off into the River Swat. Most settlements surveyed reported access to pit latrines of some type.

During the socio-economic survey, the respondents of the community observe tourism as major influx of capital into the local area economy.

## 0.15.7. Environmental Flows

Required Environmental Flow (E-Flow) will be released from the weir to meet the requirements of the aquatic ecosystem furthermore some local khwar like Balakot khwar and Cham Khwar tributaries join Swat River in between Weir and Powerhouse which will additionally hydrate the channel. However, the Proponent. has devised a scheme where inhouse diversion within the weir structure will allow minimum of 2.87 Cumec flow to maintain the river ecology.

## 0.15.8. Project Benefits

Hydropower provides renewable, sustainable and indigenous energy with wide-ranging benefits including, support to the climate change initiatives, reducing reliance on fossil fuels, social advantages, improved tourism, cheaper electricity and economic benefits.

## 0.15.9. Impacts and Mitigations

The EIA covers potential E&S impacts of the proposed project activities in the project area. Potential impacts on the physical, biological, socioeconomic, and cultural environment that may arise from the proposed project activities and the related mitigation measures that will be adopted to reduce or minimize the identified impacts have been assessed and are summarized in Table 0-36.

The only major adverse impact of the project is the acquisition of 73.34 acre of land out of

which approx. 13 acres is cultivated land and 14.25 acre of forest land. Similarly, marginal human settlement in the project is expected to be severally impacted by the proposed project activities, including minor resettlement of 21 structures (15 houses and 06 abandoned structures). A comprehensive Land Acquisition and Resettlement Action plan (LARP) is prepared to mitigate, and monitor the mitigation of this impact timely.

Apart from the permanent land acquisition, the project will also acquire approx. 25 acre land temporarily, on lease, for the construction of labor camp and waste disposal area. The existing land use of the selected areas for these purposes is same, i-e the areas are already being used by labor camps and material/disposal yards for some other construction projects (Road project) so there is no or very minute change in land use is expected as the land is already modified.

A	Total Land	Cultivated Land			
Area	Area (Acre)	Area (Acre)			
A. Permanent Land Acquisition					
Weir & Reservoir	29.54	0.00			
Powerhouse	31.90	10.79			
Access Road	11.90	2.28			
Total	73.34	13.08			
	B. Temporary Land Acquisition	n			
Camp 1	1.34	0.20			
Camp 2	1.42	0.70			
Camp 3	4.93	4.20			
Disposal Area 1	12.89	0.00			
Disposal Area 2	4.48	0.28			
Total	25.06	5.38			

Table 0-37 : Details of Impact on Land

Moreover approximately 191 trees will be cut down due to construction of weir, powerhouse, access road and associated facilities for the project details is given below Table.

	Project Component	Forest/ Wood Trees			Fruit Trees	
Sr.No.		Name	No.	Ave Girth (centimetre)	Name	No.
1	Weir Site	Deodar	12	15-30	Apple	4
		Kail		15-30	Fig	2
		Fir		0-15	Date Plum	4
		Broad Leaved	2	0-15		
Total (A)			14			10

Table 0-38 : Details of Affected Trees

	Project Component	Forest/ Wood Trees			Fruit Trees	
Sr.No.		Name	No.	Ave Girth (centimetre)	Name	No.
		Deodar	8	15-30	Apricot	9
2	Derechause	Kail	15	15-30	Walnut	15
2	Powerhouse	Fir	15	0-15	Peach	15
		Wood Trees	61	0-15	Apple	21
Total (B)			99			60
	Access Road	Deodar		15-30	Apricot	
2		Kail		15-30	Walnut	
3		Fir		0-15	Peach	
		Broad Leaved	8	0-15	Apple	
Total (C)		8				
Total (A+B+C)			121			70
Total			121			
Grand Total (Wood and Fruit Trees)				191		

The loss of trees will also be compensated by successful plantation of native species. The lost trees will be replaced at a ratio of 1:10 with consultation of forest department. A tree plantation plan is established for plantation of 1,910 trees, in this regard to ensure growth of plantation till maturity.

**Forest Trees**: Additional forest surveys were conducted by Forest Dept KPK to access number of trees at weir area in March 2022. Total of 25 Forest Dept trees"Deodar" were recorded at weir area with 14.25 acre's of land belonging to the Forest Department. This 14.25 acre of land will be acquired by denotification of forest land by the government as per applicable laws.

Apart from the above impacts of land acquisition, inundation of reservoir and tree cutting, all other impacts of the project are temporary, reversible and can be mitigated easily with the implementation of EMP and Good International Industry Practice (GIIP).

## 0.15.10. Environmental Management Plan (EMP)

For the effective implementation of mitigation measures and management of residual impacts an EMP has been developed.

The EMP provides a delivery mechanism to address potential environmental impacts of the proposed hydropower project activities, to enhance project benefits and to introduce standards of good practice in all project related activities. The EMP has been prepared with the prime objective of:

- Defining legislative requirements, guidelines and best industry practices that apply to the project;
- Defining mitigation measures required for avoiding or minimizing potential impacts assessed by the EIA;
- · Defining roles and responsibilities of the Proponent and the execution contractors; and
- Defining requirements for monitoring and reporting.

The Proponent will be responsible for the overall implementation of environmental mitigation measures and the LARP through their construction contractor and OM operator in collaboration with government departments.

The project indicative EMP cost amounts to 354,874,000 PKR or 2,075,086 USD in various heads such as Lenders studies, monitoring and evaluation, tree plantation, fish hatchery, strengthening, training, M&E, Social investment Programs, EIA studies, and Stakeholders engagement plan implementation.

## 0.15.11. Corporate Social Responsibility

As a Corporate Social Responsibility (CSR), the project implementation is expected to raise hopes of the project area population for their general welfare. It is, therefore, necessary that the project sponsor may provide facilities in the form of education, health, improvement of existing access roads and development of parks to the people of the project area.

Considering the betterment of the local community and based on the consultations carried out with the local community and local administration, initiatives such as tree plantation, construction of hatchery, parks/grounds, health facilities, drinking water, jobs etc are proposed as CSR.However, the Proponent will finalize CSR programs before the start of construction activities based on consultation with affected community and line departments and will share with stakeholders before finalization

## 0.15.12. Conclusion

The EIA has examined the proposed project activities in detail, the baseline E&S conditions of the project area and assessed the project's potential E&S impacts. Mitigation measures to help minimize the identified potential impacts have been recommended and an EMP has been developed for effective implementation of these mitigation measures.

The prime objective of the proposed Hydropower plant in Asrit-Kedam, Swat District of KPK province is to provide green, sustainable and environment friendly energy in comparison to already available traditional sources of energy based on non-renewable fossil fuels.

The proposed Hydropower plant will contribute in meeting national renewable energy and climate change targets. Based on the same, the EIA concludes that if mitigation measures for all identified impacts in the EIA are implemented as per the recommendations, no significant or adverse change in the baseline environmental or social conditions will occur.

The releases from the weir are 2.877cumec, which are provided in the project to meet the environmental, ecological, aesthetic of the downstream villages up to the powerhouse. Drinking

water (generally spring, stream and nullah water is used), other human needs and environmental requirements will remain the priority for the downstream releases.

Operation of the powerhouse and maintenance of the weir structure will result in the creation of job opportunities, and better opportunities of business and transport and tourism development.

The project will significantly change the visual landscape. For mitigation of this impact, proper landscaping will have to be done and an overall Landscape Plan will have to be prepared. Tree planting will be well organized and where possible vegetation and natural habitats will have to be restored or newly created

The contractor will ensure to prepare Site-Specific Management Plan (SSMP) including temporary traffic management, waste management plan, blasting management plan, oil spill management plan and HSE plan. The SSMP should be deliverable by the contractors and approved by both EPA and Project Lenders before construction commences. The Company will ensure adherence to the environmental legislation and regulations. The Company/contractor(s) will employ local labour as far as possible

Therefore, it is concluded that the proposed construction, installation, operation and decommissioning of Asrit-Kedam Hydropower Plant has low intensity of adverse impacts, likely to be of short term duration, moderate and of local consequences and are insignificant. A vigilant implementation of mitigation measures, along with CSR Plan and EMP will ensure that environmental impacts are managed, minimized and are within acceptable limit.

## 0.16. Transportation and Infrastructure Survey

Various transportation facilities are available for access to the weir and power house site mainly through the N-95 National Highway. The transportation rout includes the following:

- Transportation Route from Karachi Sea Port to Swat
- Transportation Route from Swat to Asrit (Weir Site)

Transportation through rail and through road, both are available for Karachi to Swat. Most of the way is covered through the motorways while from Hyderabad to Sukhur, National Highway shall be used. Following is the newly constructed Swat Expressway from Islamabad-Peshawar Motorway to Chakdara.

Figure 54 : Newly Built Swat Motorway



## 0.17. Construction Method and Schedule

Based on the project scope, bill of quantities, sequence of activities and their dependence on the expected hydrological conditions at the site, a construction period of approximately 5 years has been planned. The construction schedule assumes that the construction will be awarded to an experienced and qualified contractor with international experience in similar projects and understanding local conditions.

The construction sections for completing Asrit-Kedam Hydropower Project are largely classified into 3 sections such as the upstream Headworks section, Power Waterway section and the lower Power Station section to be planned for parallel construction.

Structure plan for Asrit-Kedam HPP consists of the following items.

- Weir and Sluiceway, Head Regulator and Desander
- Power Intake, Headrace Tunnel, Surge Tank, Vertical Pressure Shaft, Horizontal Steel Penstock and Wye branches, Tailrace Tunnel and Outlet
- Underground Powerhouse, Access Tunnel and Cable Tunnel etc.

Main concrete and steel structures are as following and once the concrete structure finishes, installation of steel structures begins. After preparing concrete structures, installation of steel structures will start.

- Concrete Structures
- Weir and sluiceway, head regulator and desander
- Power intake and outlet, lining concrete for headrace tunnel, vertical pressure shaft,
- surge tank and tailrace tunnel
- Backfill concrete for horizontal steel penstock and wye branches
- Underground powerhouse and outdoor switchyard

## Steel Structures

- Penstock for horizontal pressure tunnel and wye branches
- Gates at sluiceway and gantry crane
- Gates at head regulator
- Gates at desander and intake
- Crane for powerhouse and transformer room, draft tube outlet gate
- Gates for tailrace outlet

The estimate of the construction time for each unit process was calculated in consideration of the construction performance of similar projects, and the result of construction period for each unit process is shown:

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
1. Headworks					
Relocation Road		L=430.0m	15.0m/day	1.1	
Dam & Weir	Concrete	H=28.5m (=19lift) W=71.4m	1lift/7day (H=1.5m) 2Team	5.3	
Head Regulator & Desander	Concrete	H=22.5m (=15lift) W=62.957m	1liftt/7day (H=1.5m) 2Team	4.2	
2. Power Waterway					
Intake	Concrete	L=25.0m B,H=7.4m	1Block/1month	2.0	
Work Adit for HRT	Excavation	L=300.0m B,H=10.8m	2.0m/day	5.0	
Headrace Tunnel(Pilot)	Excavation(NATM)	L=100.0m B,H=10.8m	2.0m/day	1.7	

### Table 0-39 : Construction Period Bifurcation

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
Headrace Tunnel	Excavation(TBM)	L=10,167m D=8.3m	- Good (50%) 500m/month - Fair (30%) 400m/month -Poor (15%) 300m/month -Very Poor(5%) 100m/month	28.1	
Headrace	Excavation(NATM)	L=124.0m D=8.3m	2.0m/day	2.1	
Tunnel	Lining Concrete	L=500.0m D=7.4m (Form length=30.0m)	30.0m³/day	1.7	start pouring from 500m behind TBM
	Excavation(Pilot)	L=108.0m D=3.0m	2.9m/day	1.5	
Surge Tank	Excavation(Enlarge)	L=108.0m D=15.5m	2.5m/day	1.7	
	Lining Concrete	L=108.0m D=14.0m	1.5m/day	2.9	
	Excavation(Pilot)	L=131.5m D=3.0m	2.9m/day	1.8	
Vertical Pressure Shaft	Excavation(Enlarge)	L=131.5m D=8.8m	2.5m/day	2.1	
	Lining Concrete	L=131.5m D=7.4m	1.5m/day	3.5	
Steel popsteelz	Excavation	L=225.5m D=8.8-3.2m	3.0m/day	3.0	
Steel pensiock	Installation & Backfill Conc.	L=237.5m D=7.4-2.2m	1.0m/day	7.9	
Tailrace	Excavation(2Line)	L=300.0m B,H=6.3m	2.0m/day	6.0	
Tunnel	Lining Conc.(2Line)	L=300.0m B,H=5.5m	10.0m/3day	3.6	
Tailrace Outlet	Concrete (2Line)	H=14.0m (=7lift) W=6.5m	11iftt/5day (H=2.0m)	1.4	
3. Power Station					
	Excavation-1 (to Work-Adit Jt.)	L=273.0m B,H=7.7m	2.0m/day	4.6	
Access Tunnel	Excavation-1 (to Work-Adit Jt.)	L=142.7m B,H=7.7m	2.0m/day	2.4	
	Excavation-2 (to TR Room)	L=59.9m B,H=7.7m	2.0m/day	1.0	

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
	Excavation-3 (to P/H Room)	L=109.0m B,H=7.7m	2.0m/day	1.8	
Work Adit for	Excavation	L=104.5m B,H=5.7m	3.0m/day	1.2	
Powernouse Cavern Arch	Lining Concrete	L=104.5m B,H=5.0m	10.0m³/day	1.0	
	Excavation-1 (to Work-Adit Jt.)	L=188.0m B,H=5.7m	3.0m/day	2.1	
Cable Tunnel	Excavation-2 (to TR Room)	L=58.5m B,H=5.7m	3.0m/day	0.7	
	Lining Concrete	L=246.5m B,H=5.0m	10.0m³/day	2.5	
Work Adit for	Excavation	L=146.0m B,H=5.7m	3.0m/day	1.6	
Penstock	Lining Concrete	L=146.0m B,H=5.0m	10.0m³/day	1.5	
Powerhouse	Excavation	W=20.0m H=38.8m L=88.0m V=39,000m <sup>3</sup>	220.0m³/day	5.9	
	Frame Conc.(1st)	H=26.2m (=13lift)	1lift(H=2.0m) 2Team	4.3	
Transformer Room	Excavation	W=18.0m H=12.7m L=91.5m V=20,250m <sup>3</sup>	220.0m³/day	3.1	
IPB Tunnel	Excavation	W=6.5m H=6.3-10.1m L=15.0m	3.0m/day	0.2	

## 0.18. Bill of Quantities and Cost Estimation

The following table shows the EPC Cost Estimate.

CODE	DESCRIPTION	Total (PKR)	Total (USD)
А	Civil Works	35,092,134,539	200,526,483
2	Roads	1,026,400,000	5,865,143
3	Diversion Works and Cofferdam	1,832,958,154	10,474,047
4	Spillway	4,004,937,388	22,885,357
5	Desander	6,095,259,168	34,830,052
6	Work Adit to Penstock	203,319,782	1,161,827
7	Work Adit to Powerhouse	142,277,441	813,014

CODE	DESCRIPTION	Total (PKR)	Total (USD)
8	Access Tunnel to TBM	546,451,820	3,122,582
9	Access Tunnel to Cavern	1,061,815,359	6,067,516
10	Headrace Tunnel (TBM)	16,004,012,711	91,451,501
11	Headrace Tunnel (NATM), 7.4 M(D), 152 m	288,588,342	1,649,076
12	Vertical Pressure Tunnel	294,687,316	1,683,928
13, 14, 15	Steel Penstock	842,588,346	4,814,791
16	Surge Tank D=4.5 m	25,176,761	143,867
17	Surge Tank D=14 m	487,541,335	2,785,950
18	Powerhouse (Earth Works)	951,530,981	5,437,320
19	Powerhouse (Earth Works) Transformer Gallery	169,345,168	967,687
18 & 19	Powerhouse & Transformer (Support)	9,388,137	53,646
20	Tailrace Tunnel	1,105,856,330	6,319,179
	Grand Total Cost of Civil Works	35,092,134,539	200,526,483
	Contingency @5% Of Grand Total Civil Works	1,754,606,727	10,026,324
	Total Civil Works Including Contingency	36,846,741,266	210,552,807
В	Total Cost of EMH Works	19,155,403,583	109,459,449
С	Preliminary Works & Other Costs	9,341,565,391	53,380,374
Total EPC Cost		65,343,710,240	373,392,630

In detail Unit Rate Analysis was done.

## Pakistan Asrit Kedam Hydropower Project UPDATE FEASIBILITY STUDY REPORT

Volume 1 – Main Report

# **Chapter 14** Grid Interconnection Study

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## 14. Grid Interconnection Study

## 14.1. Executive Summary

- The Draft Report of 215 MW Asrit Kedam Hydro Power Plant by Korea South East Power Company Ltd. (KOEN) in Swat, Khyber Pakhtunkhwa, referred to as Asrit Kedam HPP in the remainder of the report, is submitted herewith.
- The updated generation plan, transmission plan and load forecast from NTDC has been used for the study, vide data permission letter no. GMPSP/TRP-300/4287-92 dated 05-11-2021.
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated.
- The expected commercial operation date of Asrit Kedam is the last quarter of 2027.
- The interconnection scheme for the study hydropower project has been proposed as described in 'The Integrated Study for the Evacuation of Power from 17 Hydropower Projects in the Swat Valley' (referred to as The Integrated Study wherever needed). As per The Integrated Study, Asrit Kedam HPP will be connected by looping in-out at one of the 220 kV double circuit from Kalam Asrit HPP to Chakdara-New 220 kV G/S. The conductor would be 220 kV Twin Bundle ACCC Plano with thermal rating of 1727 MVA.
- By the 2028, six hydropower projects would have been commissioned in the Swat valley, namely Daral Khwar HPP, Gorkin Matiltan HPP, Gabral Kalam HPP, Madyan HPP, Kalam Asrit HPP and Asrit Kedam HPP. Therefore, this study will deal with only six of the 17 hydropower projects identified in the valley.
- Asrit Kedam HPP is located on the main Swat River, a few kilometers north of Bahrain.
- The proposed scheme for Asrit Kedam HPP will require the following bays in their switch yard
- Two line bays of 220 kV for connection with 220 kV Kalam Asrit HPP and 220 kV Chakdara-New G/S
- Four transformer bays for the four GSU transformers (3x75MVA & 1x40MVA)
- In view of the expected Commercial Operation Data (COD) of Asrit Kedam HPP in the last quarter of 2027, the above proposed interconnection scheme has been tested for the following scenarios using load flow studies:
- Peak Load Summer 2028
- Off-Peak Load Summer 2028
- Peak Load Winter 2028
- Off-Peak Load Winter 2028
- The system conditions of normal and N-1 contingency have been examined for all cases described above to determine the maximum impact of the project.

- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of Asrit Kedam HPP under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at hydropower plant G/S and the substations of 220 kV and 132 kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear proposed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the under study HPPs.
- The maximum short circuit levels at 220 kV Asrit Kedam HPP bus bars for the Year 2028 for 3-Phase and 1-Phase are 11.75 kA and 11.83 kA respectively. It would be advisable to go for standard size switchgear of short circuit rating of 50 kA. It would provide large margin for future increase in short circuit levels as generation additions are expected in the valley and network reinforcements will be introduced to accommodate those additions.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for peak load condition of summer 2028. The stability has been tested for the worst cases, i.e. three phase fault right on the 220 kV bus bar of Asrit Kedam HPP substation followed by trip of a 220 kV single circuit from the faulted bus. The fault has been performed for fault clearing of 5 cycles (100 ms), as understood to be the normal fault clearing time of 220 kV protection system. Also the extreme worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms for single phase fault. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems and is therefore recommended to be adopted. It meets all the criteria of grid code under steady state load flow, short circuit currents and dynamic/transient conditions given all the proposed requirement of the network are implemented.

## 14.2. Background

Northern Pakistan, in general, and Khyber Pakhtunkhwa Province, in particular, has rich potential for small and big hydropower projects. Several small hydropower projects, of a couple of MW capacity, are operational and supplying cheap electricity to the local population and a potential for bigger hydropower projects is readily available in the valley.

Pukhtunkhwa Electricity Development Organization (PEDO) has identified several public and private sector projects along the Swat River and its tributaries. These projects include both small and medium-sized hydropower projects. PEDO has facilitated in conducting a comprehensive study to plan for the evacuation of power from all the identified potential in the valley referred to as The Integrated Study. Power Planners International Pvt. Limited has served as consultants for the said study.

Korea South East Power Company Limited (KOEN) is one such investor which plans to develop a 215 MW Asrit Kedam hydropower plant in the Swat valley. The same sponsor also plans to install a 238 MW hydropower project by the name Kalam Asrit hydropower plant on the same river at about the same time as Asrit Kedam HPP.

The net output planned to be generated from the site of Asrit Kedam HPP is about 215 MW. The electricity generated from this project would be supplied to the grid system of NTDC through the 220 kV grid network proposed in the Integrated Study. Asrit Kedam HPP is expected to start commercial operation by the end of 2027. The approximate location of Asrit Kedam HPP can be seen in the map attached in Appendix – B and the neighboring network is evident from Sketch-2 attached in Appendix - B.

The Integrated Study has proposed a conceptual scheme to evacuate power from the 17 HPPs identified by PEDO. A short summary of the conceptual scheme is presented here:

- A collector station of 220/132 kV is proposed at the site of Kalam Asrit HPP with 3x250 MVA transformers.
- A comprehensive scheme developed consists of the following main circuits running along the length of the corridor:
- A 132 kV Rail double circuit, carrying power from Mahodand HPP, Artistic-II, HPP and Artistic-III HPP to Gorkin Matiltan HPP.
- A 132 kV twin Bundle Rail double circuit, carrying power accumulated at Matiltan HPP and Ushu-II HPP to Gabral Kalam HPP.
- A 132 kV Rail double circuit carrying power from Chota Jabba HPP, Osman Swati HPP, Gabral Utror HPP and Bankhwar HPP to Gabral Kalam HPP.
- A 132 kV twin bundle ACCC Plano double circuit, carrying power accumulated at Gabral Kalam HPP to the collector and generating station of Kalam Asrit HPP.
- A 220 kV twin bundle ACCC Plano double circuit of around 110 km length, carrying power from Kalam Asrit HPP to Chakdara-New G/S, with Chokel Khwar HPP and Asrit Kedam HPP and Madyan HPP looped in-out at the circuit.
- A 132 kV Rail double circuit carrying power from Kedam Khwar HPP, Daral Khwar-II HPP and the existing Daral Khwar HPP to 132 kV Madyan G/S.

## 14.3. Objectives

The overall objective of the Study is to evolve an interconnection scheme between Asrit Kedam HPP and NTDC network, for stable and reliable evacuation of 215 MW of electrical power generated from this plant, fulfilling the N-1 reliability criteria. The specific objectives of this report are:

- To develop scheme of interconnections at 220 kV for which right of way (ROW) and space at the terminal substations would be available.
- To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
- To check if the contribution of fault current from the plant unit increases the fault levels at the adjoining substations at 220 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at Asrit Kedam HPP.

• To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping

## 14.4. Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection scheme is as follows:

## 14.4.1. Steady State:

• Voltage ±5%, Normal Operating Conditions

 $\pm$  10 %, Contingency Conditions

· Frequency 50 Hz Nominal, continuous

49.8 Hz to 50.2 Hz variation in steady state

49.4 - 50.5 Hz, Min/Max Contingency Freq. Band

• Power Factor 0.85 Lagging, 0.90 Leading

## 14.4.2. Short Circuit:

- 132 kV Substation Equipment Rating 40 kA
- 220 kV or 500 kV Substation Equipment Rating 50 kA or 63 kA

## 14.4.3. Dynamic/Transient:

The system should revert to normal condition after transients die out with good damping, without losing synchronism. The system is tested under the following fault conditions:

- a) Permanent three-phase fault on any primary transmission element; including: transmission circuit, substation bus section, transformer or circuit breaker. It is assumed that such a fault shall be cleared by the associated circuit breaker action in 5 cycles.
- b) Failure of a circuit breaker to clear a fault ("Stuck Breaker" condition) in 9cycles after fault initiation.

## 14.5. Assumptions of Data

As per the data provided by the client following data has been modeled:

## 14.5.1. Asrit Kedam HPP Data

- Gross Capacity of Power Plant = 232.7 MW

- Net Capacity of the Power Plant	= 215 MW
- Lump sum MVA capacity	= 258.5 MVA
- Generating Voltage	= 11  kV
- No. of Units	= 4 (3x66.996MW & 1x31.6982MW)
- Power Factor	= 0.85  lagging/0.95 leading
- GSU transformers	= 3x75 MVA & 1x40 MVA
- Transformer Impedance	= 10%

The detailed generic parameters, which have been used in this study, for all the machines are attached in Appendix-B.

## 14.5.2. Network Data

The input data of NTDC has been used in this study vide data permission letter no. GMPSP/TRP-300/4287-92 dated 05-11-2021. The 220 kV and 132 kV network in the area in Swat valley, is shown in Sketches in Appendix-B.

## 14.6. Study Approach and Methodology

## 14.6.1. Understanding the Problem

In Pakistan, there is huge potential for hydropower generation in the Northern parts of the country whereas the big load centers are located mostly in the Central part of the country. The primary grid of 500 kV runs longitudinally from Peshawar in the North to Karachi in the South, with 220 kV and 132 kV tributaries all along its way.

Another typical feature of hydropower plants is that their output varies seasonally; they produce full power during high water season whereas their output touches the lowest Ebb during the low water period. A mix of thermal power located mainly in the central and Southern parts, offsets these differences in the generation outputs of hydropower plants. It gives rise to different patterns of power flows between North and South in different seasons. Over and above that, lies the peak load and low load power flow patterns during high and low water periods respectively.

Asrit Kedam HPP has a potential to generate about 215 MW of electricity during high water season.

The adequacy of the 220 kV and 132 kV network in and around the Swat valley will be investigated in this study report for absorbing and transmitting this power, fulfilling the reliability criteria.

## 14.6.2. Approach to the Problem

The consultant has applied the following approaches to the problem:

- Summer 2028 has been selected for the load flow analysis as per COD of Asrit Kedam HPP because it represents the high water peak load conditions. The lines in the vicinity of this plant will be loaded to the maximum extent, allowing us to judge the complete impact of the plant on the transmission system in its vicinity.
- The network model comprises of all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for the year 2028.
- Load flow and short circuit studies have also been performed for off peak summer 2028 and peak and off-peak winter 2028 to gauge the performance of the proposed plant in low load and/or low water conditions.
- An interconnection scheme without any physical constraints, such as right of way or availability of space in the terminal substations, have been identified.
- Performed technical system studies to confirm technical feasibility of the interconnection. Proposed scheme has been subjected to standard analysis like load flow, short circuit and transient stability study to check the strength of the machines and the proposed interconnection schemes under disturbed conditions.
- Determine the relevant equipment for the proposed technically feasible scheme.

## 14.7. Development of Interconnection Scheme

## 14.7.1. The Existing Network

The network, at the time of commissioning of Asrit Kedam HPP, will have Daral Khwar HPP evacuated towards 132 kV Madyan G/S and Gorkin Matiltan HPP, Gabral Kalam HPP, Kalam Asrit HPP and Madyan HPP in the Swat valley evacuated to 220 kV Chakdara-New G/S.

## 14.7.2. The Interconnection Scheme of Asrit Kedam HPP

The interconnection scheme for the Asrit Kedam hydropower project has been proposed as described in The Integrated Study. As per The Integrated Study, Asrit Kedam HPP will be connected by looping in-out at one of the 220 kV double circuit from Kalam Asrit HPP to Chakdara-New 220 kV G/S. The conductor would be 220 kV Twin Bundle ACCC Plano with thermal rating of 1727 MVA.

By the 2028, six hydropower projects would have been commissioned in the Swat valley, namely Daral Khwar HPP, Gorkin Matiltan HPP, Gabral Kalam HPP, Madyan HPP, Kalam Asrit HPP and Asrit Kedam HPP. Therefore, this study will deal with only six of the 17 hydropower projects identified in the valley.

The proposed scheme for Asrit Kedam HPP will require the following bays in their switch yard

- Two line bays of 220 kV for connection with 220 kV Kalam Asrit HPP and 220 kV Chakdara-New G/S
- Four transformer bays for the four GSU transformers (3x75MVA & 1x40MVA)

## **14.8.** Detailed Load Flow Studies

The base cases have been developed for the peak and off-peak conditions of summer 2028 using the network data provided by NTDC. Detailed load flow studies have also been carried out for peak and off-peak load conditions of winter 2028.

## 14.8.1. Peak Load Case Summer 2028

The peak load case for summer 2028 has been studied in detail and N-1 contingency scenarios have been analyzed based on the scheme and reinforcements described in Chapter-4.

## 14.8.1.1. Without Kalam Asrit HPP and Asrit Kedam HPP

The scenario of summer 2028 is simulated without Kalam Asrit HPP and Asrit Kedam HPP to assess the network performance without both the hydropower projects. As Kalam Asrit HPP and Asrit Kedam HPP are expected to commission at around the same time, therefore, both the plants have been removed from this analysis. This will allow us to judge the network performance during the summer load conditions when the power output from all surrounding hydropower plants will be maximum due to high water levels.

As described in the Integrated Study Phase 3 report, in the scenario when only four hydropower projects namely Matiltan HPP, Daral Khwar HPP, Madyan HPP and Gabral Kalam HPP are commissioned, the need for a 220 kV transmission line is not justified. Therefore, the 220 kV transmission line between Kalam Asrit and Chakdara-New has been proposed to be operated on 132 kV, until sufficient hydropower generation is commissioned in the valley to justify operation on 220 kV voltage level. Now, this poses a problem that the transmission voltage of Madyan HPP is 220 kV so the GSU transformers at Madyan switchyard will be of 220/11 kV1 and cannot dispatch power at 132 kV.

<sup>1</sup>Assumed generation voltage at Madyan HPP to explain the point

Hence, in the case when Madyan HPP has commissioned and no other HPP has commissioned in the 220 kV line route, we have proposed that one of the 220/132 kV transformer required for the 220/132 kV switch yard of Kalam Asrit in the future, may be placed at Madyan HPP switchyard to step the power down from 220 kV to 132 kV and evacuate this power on the 220 kV circuit being operated on 132 kV voltage level.

This seems to be the most economical solution of the problem as the said 220/132 kV transformers

- a) Will always remain a property of NTDC
- b) will be required in the future at Kalam Asrit 220/132 kV switchyard anyway
- c) can easily be transported back to Kalam Asrit when line is to be energized at 220 kV
- d) can be temporarily utilized at Madyan HPP switchyard to disperse power. With all the above discussion in view, the scheme will look as shown in Sketch-1 in Appendix-B.

This scheme has been simulated in PSS/E load flow the results of load flow for this case are

plotted in Exhibit 0.0 of Appendix-C.

The power flows on the circuits under normal conditions are seen well within the rated capacities. Also, the voltages on the bus bars are within the permissible operating range of  $\pm$  5 % off the nominal. We find no capacity constraints on the 132 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix -C as follows:

- Exhibit 0.1 G-Matiltan to Gabral Kalam 132kV Single Circuit Out
- Exhibit 0.2 Madyan HPP to Gabral Kalam 132kV Single Circuit Out
- Exhibit 0.3 Madyan HPP to Chakdara New 132kV Single Circuit Out
- Exhibit 0.4 Chakdara New 220/132 kV Single Transformer Out
- Exhibit 0.5 Chakdara New to Nowshera 220kV Single Circuit Out
- Exhibit 0.6 Chakdara New to Mardan 220kV Single Circuit Out

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 10$  % off the nominal for contingency conditions' criteria. We find no capacity constraints on 220 kV circuits under normal and contingency conditions.

## 14.8.2. With Kalam Asrit HPP and Asrit Kedam HPP

In order to simulate the scenario when both Kalam Asrit HPP and Asrit Kedam HPP commission by 2028, the base case developed for section 5.1.1 has been used and both the hydropower plants are modelled as per the data given in section 4. In this scenario, the 220/132 kV transformer at Madyan HPP will be transported back to Kalam Asrit switchyard and Madyan would be evacuating power at 220 kV voltage level because the 220 kV circuit between Kalam Asrit HPP and Chakdara-New HPP will have been energized at 220 kV.

This scheme has been simulated in PSS/E load flow the results of load flow for this case are plotted in Exhibit 1.0 of Appendix-C.

The power flows on the circuits under normal conditions are seen well within the rated capacities. Also, the voltages on the bus bars are within the permissible operating range of  $\pm$  5 % off the nominal. We find no capacity constraints on the 132 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix -C as follows:

- Exhibit 1.1 Kalam Asrit to Asrit Kedam 220kV Single Circuit Out
- Exhibit 1.2 Asrit Kedam to Chakdara New 220kV Single Circuit Out
- Exhibit 1.3 Kalam Asrit to Madyan HPP 220kV Single Circuit Out
- Exhibit 1.4 Kalam Asrit 220/132 kV Single Transformer Out

- Exhibit 1.5 Gabral Kalam to Kalam Asrit 132 kV Single Circuit Out
- Exhibit 1.6 Madyan HPP to Chakdara New 220 kV Single Circuit Out
- Exhibit 1.7 Chakdara New to Nowshera 220 kV Single Circuit Out
- Exhibit 1.8 Chakdara New to Mardan 220 kV Single Circuit Out

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 10$  % off the nominal for contingency conditions' criteria. We find no capacity constraints on 220 kV circuits under normal and contingency conditions.

## 14.8.3. Off-Peak Load Case Summer 2028

The scenario of Asrit Kedam and Kalam Asrit with off-peak load of about 80% has been studied. The results of load flows under normal conditions have been plotted in Exhibit 2.0 in Appendix-C.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 5$  % off the nominal. We find no capacity constraints on 220 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix-C as for the previous scenario. The list of contingencies has not been repeated here to avoid redundancy.

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 10$  % off the nominal for contingency conditions' criteria. We find no capacity constraints on 220 kV circuits under normal and contingency conditions.

## 14.8.4. Peak Load Case Winter 2028

The scenario of peak winter 2028 has been studied for the interconnection of Asrit Kedam HPP as the hydropower plants are at their low generation potential. The loads in the system have been reduced to 64% in this case. Similarly, the hydropower plants in the system are at their peak winter dispatches. The generation of Asrit Kedam HPP has been reduced to roughly 33% to depict winter dispatch. The results of load flows with Asrit Kedam HPP under normal conditions have been plotted in Exhibit 3.0 in Appendix-C.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 5$  % off the nominal. We find no capacity constraints on 220 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix -C as for the previous scenario.

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 10$  % off the

nominal for contingency conditions' criteria. We find no capacity constraints on 220 kV circuits under normal and contingency conditions.

## 14.8.5. Off-Peak Load Case Winter 2028

The scenario of off-peak winter 2024 has been simulated using off-peak winter loads, which have been further reduced to 70% of peak winter loads. Similarly the hydropower plants in the system are at their off-peak winter dispatches. The generation of Asrit Kedam HPP has been reduced to roughly 25% to depict off-peak winter dispatch. The results of load flows with Asrit Kedam HPP under normal conditions have been plotted in Exhibit 4.0 in Appendix-C.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 5$  % off the nominal. We find no capacity constraints on 220 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix-C as for the previous scenario.

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of  $\pm 10$  % off the nominal for contingency conditions' criteria. We find no capacity constraints on 220 kV circuits under normal and contingency conditions.

## 14.8.6. Conclusion of Load Flow Analysis

From the analysis discussed above, we conclude that the proposed interconnection scheme is adequate to evacuate the 215 MW power of Asrit Kedam HPP and 238 MW power of Kalam Asrit HPP under normal and contingency conditions. The interconnection ensures reliability and availability under all events of contingencies, i.e. planned or forced outages studied in this report for the base year 2028. The bus bar voltages remain well within the permissible limits in all the contingency events.

Hence, the proposed interconnection scheme of Asrit Kedam HPP has no constraints according to the Load Flow Analysis.

## 14.9. Short Circuit Analysis

## 14.9.1. Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies.

The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2028 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Chapter 2 of this report.

# 14.9.2. Fault Current Calculations Year 2028 - without Asrit KedamHPP and Kalam Asrit HPP

In order to assess the short circuit strength of the 220 kV network without Asrit Kedam HPP and Kalam Asrit HPP, three-phase and single-phase fault currents have been calculated for NTDC in the vicinity of the site of the Plant. The results are attached in Appendix – D.

The short circuit levels have been calculated and plotted on the bus bars of 220 kV of substations lying in the electrical vicinity of our area of interest and are shown plotted in the Exhibit 5.0 attached in Appendix-D. Both 3-phase and 1-phase fault currents are indicated in the Exhibit 5.0 which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 220 kV and 132 kV bus bars of our interest. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 14-1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 220 kV and 132 kV substations.

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Madyan HPP 132 kV	15.82	16.42
Chakdara-New 220 kV	11.51	9.26
Nowshehra 220 kV	38.31	27.73
Chakdara-New 132 kV	20.26	19.48
Chakdara 132 kV	18.43	16.13

Table 14-1 : Maximum Short Circuit Levels without Asrit Kedam HPP and Kalam Asrit HPP - Year 2028

### 14.9.3. Fault Current Calculations with Asrit Kedam HPP and KalamAsrit -Year 2028

Maximum fault currents have been calculated for the electrical interconnection of proposed scheme. Fault types applied are three phase and single-phase at the 220 kV bus bar of Asrit Kedam HPP and Kalam Asrit HPP itself and other bus bars of the 220 kV substations in the electrical vicinity of Asrit Kedam HPP and Kalam Asrit HPP. The graphic results are shown in

### Exhibit 5.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 220 kV bus bars of the network in the electrical vicinity of Asrit Kedam HPP and Kalam Asrit HPP and the 220 kV bus bar of the HPPs themselves are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 14-2.

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Asrit Kedam 220kV	11.75	11.83
Kalam Asrit 220kV	11.38	11.33
Kalam Asrit 132kV	10.65	11.07
Madyan 220 kV	10.37	10.16
Chakdara-New 220 kV	14.75	13.46
Nowshehra 220 kV	39.01	28.11
Chakdara-New 132 kV	17.00	15.43
Chakdara 132 kV	16.20	13.95

Table 14-2 : Maximun	n Short Circuit Level	s with Asrit Kedam	HPP and Kalam	Asrit HPP – Year 20	)28
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Comparison of Table 14-1 and Table 14-2 show that for some bus bars there is a slight decrease in short circuit levels for both three-phase and single–phase, on the 220 kV bus bars after the connection of Asrit Kedam HPP and Kalam Asrit HPP. This is due to the fact that the 220 kV circuit from the location of Kalam Asrit HPP to Chakdara-New 220 kV is proposed to be operated at 132 kV until the commissioning of Kalam Asrit HPP and Asrit Kedam HPP, which causes a rise in the short circuit levels.

# 14.9.4. Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Asrit Kedam HPP and Kalam Asrit HPP, we don't find any violations of short circuit ratings of the proposed equipment on the 220 kV bus bars in the vicinity of the plant due to fault current contributions from Asrit Kedam HPP and Kalam Asrit HPP.

Therefore, industry standard switchgear of the short circuit rating of 50 kA would be fine to be installed at 220 kV switchyard of Asrit Kedam HPP and Kalam Asrit HPP. It would provide large margin for future increase in short circuit levels as generation additions are expected in the valley and network reinforcements will be introduced to accommodate those additions.

# 14.10. Dynamic Stability Analysis

# 14.10.1. Assumptions & Methodology

# 14.10.1.1. Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Chapter 2 of this report.

We have employed the generic dynamic models available in the PSS/E model library for dynamic modeling of the generator, exciter and the governor as follows;

- Generator	GENSAL
- Excitation System	EXST1
- Speed Governing System	HYGOV
- Stabilizer	PSS2A

Power System Stabilizer has also been proposed to be installed for damping of oscillations and smooth and stable operation of the power plant.

# 14.10.1.2. System Conditions

The scenario of summer 2028 has been selected for the study because it represents the peak load season after the COD of Asrit Kedam HPP and Kalam Asrit HPP and thus the loading on the lines in the vicinity of the HPPs will be maximum, allowing us to judge the full impact of the plant.

The proposed HPPs have been modeled in the dynamic simulation with generic parameters as detailed parameters for these projects is not available. All the power plants of WAPDA/NTDC from Tarbela to Hub have been dynamically represented in the simulation model.

# 14.10.1.3. Presentation of Results

The plotted results of the simulations runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for fourteen seconds. Usually all the transients due to non-linearity die out within a few seconds after disturbance is cleared in the system.

# 14.10.1.4. Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of Asrit Kedam HPP i.e. right at the 220 kV bus bar of Asrit Kedam HPP substation, cleared in 5 cycles, as normal clearing time for 220 kV i.e. 100 ms, followed by a permanent trip of a 220 kV single circuit from the faulted buses. Also to fulfil the Grid Code criteria case of stuck breaker (breaker failure) single phase fault has also been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms.

# 14.10.2. Dynamic Stability Simulations' Results – Summer 2028

The transient stability analysis is carried out for peak load case of summer 2028 with the interconnection of Asrit Kedam HPP and Kalam Asrit HPP.

Results of this analysis are discussed one by one below:

### Table 14-3 : 3-Phase Fault at Asrit Kedam for 5 cycles

### Fault Type: 3-Phase

### Fault Location: Arsit Kedam 220 kV bus bar

### Fault Duration: 5 cycles (100 ms)

### Line Tripping: Madyan to Kelam Asrit 220 kV single circuit

Variable	Bus/Line	Response	Figure No.
Voltage	Asrit Kedam 220 kV Madyan 220 kV Kelam Asrit 220kV Chakdara-New 220 kV Kelam Asrit 132 kV Gabral Kalam 132 kV	The voltages of all the bus bars recover after fault clearance	1.1
Frequency	Asrit Kedam 220 kV	Recovers after fault clearance	1.2
MW/MVAR Output of the Plant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	1.3
Speed and Pmechanical of the Plant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	1.4
Line Flows (MW/MVAR)	Madyan to Kalam Arsit 132 kV intact single circuit	Attains steady state value after damping of oscillations	1.5
Rotor Angles	G-Matiltan 11 kV Ghazi Brotha 500 kV Daral Khwar 11 kV Mangla 132 kV Nelum Jehlum 500 kV Guddu-New 500 kV (reference angle)	Damps down quickly and attain a steady state value	1.6

### Table 14-4 : 3-Phase Fault at Asrit Kedam for 9 cycles

### Fault Type: 1-Phase

### Fault Location: Arsit Kedam 220 kV bus bar

### Fault Duration: 9 cycles (180 ms)

### Line Tripping: Madyan to Kelam Asrit 220 kV single circuit

Variable	Bus/Line	Response	Figure No.
Voltage	Asrit Kedam 220 kV Madyan 220 kV Kelam Asrit 220kV Chakdara-New 220 kV Kelam Asrit 132 kV Gabral Kalam 132 kV	The voltagesof all the busbars recoverafter fault clearance	2.1
Frequency	Asrit Kedam 220 kV	Recovers after fault clearance	2.2
MW/MVAR Output of thePlant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	2.3

Speed and P <sub>mechanical</sub> of the Plant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	2.4
Line Flows (MW/MVAR)	Madyan to Kalam Arsit 132 kV intactsingle circuit	Attains steadystate value after damping of oscillations	2.5
Rotor Angles	G-Matiltan 11 kV Ghazi Brotha 500 kV Daral Khwar 11 kV Mangla 132 kV Nelum Jehlum 500 kV Guddu-New 500 kV(reference angle)	Damps down quickly and attain a steady state value	2.6

### Table 14-5 : 3-Phase Fault at Chakdara-New for 5 cycles

Fault Type: 3-Phase

Fault Location: Chakdara-New 220 kV bus bar

Fault Duration: 5 cycles (100 ms)

Line Tripping: Madyan to Chakdara-New 220 kV single circuit

Variable	Bus/Line	Response	Figure No.
Voltage	Chakdara-New 220 kV Asrit Kedam 220 kV Madyan 220 kV Kelam Asrit 220kV Kelam Asrit 132 kV Gabral Kalam 132 kV	The voltagesof all the busbars recoverafter fault clearance	3.1
Frequency	Chakdara-New 220 kV	Recovers after fault clearance	3.2
MW/MVAR Output of thePlant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	3.3
Speed and P <sub>mechanical</sub> of the Plant	Asrit Kedam unit-1 11 kV	Recovers after damping down oscillations	3.4
Line Flows (MW/MVAR)	Madyan to Chakdara-New 220 kVintact single circuit	Attains steadystate value after damping of oscillations	3.5
Rotor Angles	G-Matiltan 11 kV Ghazi Brotha 500 kV Daral Khwar 11 kV Mangla 132 kV Nelum Jehlum 500 kV Guddu-New 500 kV(reference angle)	Damps down quickly and attain a steady state value	3.6

# 14.10.3. Conclusion of Dynamic Stability Analysis

The results of dynamic stability carried out for peak load conditions of summer 2028 show that the system is strong and stable enough to damp the oscillations for the proposed scheme in case of severest possible faults of 220 kV systems near to and far of Asrit Kedam HPP and Kalam Asrit HPP. Therefore, there is no problem of dynamic stability for interconnection of Asrit

Kedam HPP and Kalam Asrit HPP; it fulfills all the criteria of dynamic stability.

# 14.11. Conclusions and Recommendations

- The Draft Report of 215 MW Asrit Kedam Hydro Power Plant by Korea South East Power Company Ltd. (KOEN) in Swat, Khyber Pakhtunkhwa, is submitted herewith.
- The updated generation plan, transmission plan and load forecast from NTDC has been used for the study, vide data permission letter no. *GMPSP/TRP-300/4287-92 dated 05-11-2021*.
- The expected commercial operation date of Asrit Kedam is the last quarter of 2027.
- According to The Integrated Study, Asrit Kedam HPP will be connected by looping in- out at one of the 220 kV double circuit from Kalam Asrit HPP to Chakdara-New 220 kV G/S. The conductor would be 220 kV Twin Bundle ACCC Plano with thermal rating of 1727 MVA.
- · Asrit Kedam HPP is located on the main Swat River, a few kilometers north of Bahrain.
- The proposed scheme for Asrit Kedam HPP will require the following bays in their switch yard
- Two line bays of 220 kV for connection with 220 kV Kalam Asrit HPP and 220 kV Chakdara-New G/S
- Four transformer bays for the four GSU transformers (3x75MVA & 1x40MVA)
- In view of the expected Commercial Operation Data (COD) of Asrit Kedam HPP in the last quarter of 2027, the above proposed interconnection scheme has been tested for the following scenarios using load flow studies:
- Peak Load Summer 2028
- Off-Peak Load Summer 2028
- Peak Load Winter 2028
- Off-Peak Load Winter 2028
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of Asrit Kedam HPP under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at hydropower plant G/S and the substations of 220 kV and 132 kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear proposed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the under study HPPs.
- The maximum short circuit levels at 220 kV Asrit Kedam HPP bus bars for the Year 2028 for 3-Phase and 1-Phase are 11.75 kA and 11.83 kA respectively. It would be advisable to go for standard size switchgear of short circuit rating of 50 kA. It would provide large margin for future increase in short circuit levels as generation additions are expected in the valley and network reinforcements will be introduced to accommodate those additions.

The dynamic stability analysis of proposed scheme of interconnection has been carried out for peak load condition of summer 2028. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.

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The proposed scheme of interconnection has no technical constraints or problems and is therefore recommended to be adopted. It meets all the criteria of grid code under steady state load flow, short circuit currents and dynamic/transient conditions given all the proposed requirement of the network are implemented.

# Pakistan Asrit Kedam Hydropower Project UPDATE FEASIBILITY STUDY REPORT

Volume 1 – Main Report

**Executive Summary** 

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# **0.** Executive Summary

# 0.1. Introduction

Comprehensive studies for the assessment of the hydropower potential of the Swat valley were carried out between 1990 and 1995 under a Program of Pakistan-German Cooperation. In June 2006 Mirza Associates Engineering services (PVT) Ltd. Submitted a study on the development of the hydropower potential in the Swat River and proposed among others the development of the following run of river hydropower plants.

•	Gabral-Kalam HPP	: 101MW (Cascade Study, 2006)
•	Kalam-Asrit HPP	: 197MW (Cascade Study, 2006) : 238MW (FS by KOEN, 2020)
•	Asrit-Kedam HPP	: 209MW (Cascade Study, 2006) : 215MW (FS by Yunus Brothers Group, 2008) : 215MW (Technical Due Diligence by KOEN, 2016)
•	Madian HPP	<ul> <li>: 148MW (Cascade Study, 2006)</li> <li>: 157.3MW (FS by Madian Hydro Power Ltd, 2009)</li> <li>: 157.3MW (Technical Due Diligence by KOEN in 2016)</li> </ul>

The feasibility study of Asrit-Kedam HPP was performed by RSW International (RSWI) of Montreal Canada, with the assistance of NEWAGE (Pakistan) and several Pakistan consultants. It was published in Nov. 2008. The feasibility study reports consist of Executive Summary (Volume 1), Main Report (Volume 2A), Plates (Volume 2B) and others (Volume 3 ~ Volume 12). It was 215 MW hydropower project located on the Swat River in Pakistan's North West Frontier Province that was being developed on a BOOT (Build-Own-Operate-Transfer) basis under the sponsorship of the Yunus Brothers Group (Promoter).

SAMAN had done a Technical Due Diligence on F/S performed by RSWI, Sep. 2016 and then Mott MacDonald had reviewed it in order to provide a technical advisory for this Due Diligence, Aug. 2016.

As for Technical Due Diligence, it had performed the review regarding the feasibility study report as well as the scope of the data related to the feasibility study investigation provided by the client, KOEN (Korea South-East Power Co., Ltd) from June 1, 2016 to September 30, 2016. Moreover, the KOEN, SAMAN and Mott MacDonald were jointly conducted a site investigation from July 11, 2016, to July 14, 2016.

Salient Features of Asrit-Kedam HPP are as follows.

Item		Unit	F/S	TDD	Update F/S	
	River		Swat River	Swat River	Swat River	
Location	Administrative District		Swat District	Swat District	Swat District	
	Intake Area		Swat River	Swat River	Swat River	

Table 0-1 : Salient Features of AKHPP

# Update Feasibility Study of Asrit-Kedam Hydropower Project

Item		Unit	F/S	TDD	Update F/S
	Powerhouse Area		Swat River	Swat River	Swat River
	Catchment Area	km <sup>2</sup>	2,170	2,170	2,213
Hydrology	Annual Average Run- off	m³/s	94.2	94.5	96.4
	Plant Discharge	m³/s	120	120	130
	Gross Head	m 211		211	207.4
Power	Head Loss	m	10.45	10.84	12.2
Energy	Installed Capacity	MW	215	215	229.4
Estimation	Annual Gross Energy Generation	GWh	911.5	893.8	970.7
	Annual Net Energy Generation	GWh	879.6	873.3	944.7
D	Diversion Discharge	m³/s	561	564	658
Diversion Channel	Width	m	20	20	20
	Length	m	350.9	350.9	385
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam / Secant Pile
	Dam Crest	EL. m	1,718.3	1,718.3	1,714.0
Upstream	Dam Crest Width	m	6	6	6
Cofferdam	Height	m	13.5 13.5		13.2
	Length	m	66	66	57
	Dam Slope		1:1.3	1:1.5	1:1.5
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam
	Dam Crest	EL. m	1,698.0	1,698.0	1,703.0
Downstream	Dam Crest Width	m	5	5	5
Cofferdam	Height	m	6	6	7
	Length	m	40	40	55.0
	Dam Slope		1:1.3	1:1.3	1:1.3
	Туре		CGD	CGD	CGD
	Design Discharge	m³/s	732	801.6	1,091.5
	Safety Check Discharge	m³/s	900	1,333.6	2,078.5
Dam &	Dam Crest	EL. m	1,724.0	1,724.0	1,721.0
Spillway	Spillway Crest	EL. m	1,715.0	1,715.0	1,717.0 / 1,700.0
	Spillway Width (Net Width)	m	30	30	24
	Length	m	73.2	73.2	71.4
	Height	m	24	24	28.5

Item		Unit	F/S	TDD	Update F/S
	Spillway Gate Type		Roller gate	Roller gate	Radial gate
	Spillway Gate Size	m	W 10.0 × H 6.0 × 3 Nos.	W 10.0 × H 6.0 × 3 Nos.	W 8.0 × H 10.0 × 3 Nos.
	Туре		Open Channel	Open Channel	Open Channel
Desander	Width	m	11.5	11.5	12.0
Basin	Depth	m	14.0	14.0	14.0
	Length	m	130	130	130
	Туре		Bellmouth Type	Bellmouth Type	Bellmouth Type
Intoleo	Invert Elevation	EL. m	1,694.00	1,694.00	1701,1
шаке	Inlet Diameter	m	7.4	7.4	7.4
	Gate	m	-	-	-
Haadvaaa	Туре		Modified Horse Shoe	Modified Horse Shoe	Circular Con'c lined
Tunnel	Diameter	m	7.4	7.4	7.4
	Length	m	9,946.0	9,960.0	10,291.0
	Туре		-	Circular Con'c lined	Circular Con'c lined
Vertical Pressure Shaft	Diameter	m	-	7.4	7.4
	Height	m	-	181.7	119.5
Horizontal	Туре		Circular Con'c lined	Circular Con'c lined	-
Pressure	Diameter	m	7.4	7.4	-
Tunnel	Length	m	101	139	-
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined
Penstock	Diameter	m	5.1	5.1	5.1
	Length	m	225	227	191.7
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined
Penstock (Manifold)	Diameter	m	4.2~2.15	4.2~2.15	4.2~2.15
,	Length	m	184.3	184.3	140.6
	Туре		Restricted Orifice Type	Restricted Orifice Type	Restricted Orifice Type
	Size	m	D 12.5 / D4.5	D 18.0/D4.5	D 14.0 / D4.5
~ ~ ~	Height	m	71.0/167.3	77.5	78.3
Surge Shaft	Orifice size	m	3	3	3
	Max. up-surging water level	EL. m	1,761.0	1,742.6	1,754.6
	Min. down-surging water level	EL. m	1,656.1	1,684.7	1,680.8
Powerhouse	Туре		Underground Cavern	Underground Cavern	Underground Cavern

	Item	Unit	F/S	TDD	Update F/S
	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 31.6 × L 88.0	W 20.0 × H 39.0 × L 88.0
	Turbine Type		Vertical Francis Turbine	Vertical Francis Turbine	Vertical Francis Turbine
	Turbine Capacity	MW	3 × 60.9, 1 × 32.2	3 × 60.9, 1 × 32.2	3 × 67.4, 1 × 27.2
	Number of Units		4	4	4
	Turbine-Center Level	EL. m	1,491.00	1,491.00	1,495.00
Transformer & GIS Cavern	Туре		Underground Cavern	Underground Cavern	Underground Cavern
	Transformer Cavern Size	m	W 18.0 × H 13.6 × L 91.5	W 8.7 × H 7.25 × L 82.9	W 18.0 × H 13.9 × L 91.5
Transformer	GIS Cavern Size	m	-	W 13.4 × H 10.2 × L 31.4	-
& GIS Cavern	Transformer Type		3-Phase	Single-Phase	3-Phase
	Number of Units		5	13	5
Tailrace	Diameter	m	5	5	5.5
Tunnel	Length	m	280	280	303.1

# 0.1.1. Summary of Salient Features of AKHPP

Ite	em	Unit	F/S	F/S Update		
Loca	ation		Swat River	$\leftarrow$		
	Catchment Area	km <sup>2</sup>	2,170	2,213		
Hydrology	Annual Average Run-off	m³/s	94.2	96.4		
	Installed Capacity	MW	215	229.4		
	Plant Discharge	m³/s	m³/s 120.0 130	130.0		
Energy Generation	Annual Gross Energy Generation	GWh	911.5	970.7		
	Annual Net Energy Generation	GWh	879.6	944.7		
Dam	Туре		CGD	$\leftarrow$		
Dam	Dam Crest	EL. m	1,724.0	1,721.0		
H h T	Diameter	m	7.4	$\leftarrow$		
Headrace I unnel	Length	m	9,946.0	10,291.0		
	Туре		Underground Cavern	$\leftarrow$		
Powerhouse	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 39.0 × L 88.0		
	Turbine Type		Vertical Francis Turbine	$\leftarrow$		

### Table 0-2 : Summary of Salient Features of AKHPP

For this study, Mar. 2021, KOAK Power Limited (Special Purpose Company) invested by

KOEN requested Saman to review and update the previous Feasibility Study conducted by RSWI in Nov. 2008 with the results of topography survey, geotechnical investigation, transmission study and ESIA study performed by AZMEC.



# 0.1.2. Project Location

The Asrit-Kedam Hydropower Project (AKHPP) is located in the Khyber Pakhtunkhwa Province (previously "North-West Frontier Province") of Pakistan on the Swat River in the reach between the Asrit and Kedam Villages. The Swat River is formed by the junction of the Gabral and the Ushu Rivers at the Kalam. The river flows southward and then flows westward until joined by the Panjkora River. After the confluence, the river enters the Peshawar Valley and meets with the Kabul River. The total length of the Swat River is about 225km and its catchment basin in the intake site of Asrit-Kedam project covers an area of 2,213km<sup>2</sup>. A hydrometric station has been in operation since 1960 at the Kalam, located around 12km upstream of the intake of the Asrit-Kedam project. Average annual flow at the intake site of the project is estimated to be about 96.4m<sup>3</sup>/s. The Project location map is as shown in Figure 1.

# 0.2. Power Market Survey

The Power Market Survey of Pakistan includes the review of the related data of the power demand and supply to predict present and future power demands and its circumstances in Pakistan. According to National Electricity Power Regulatory Authority ("NEPRA"), by the end of September 2021, the total installed generation capacity of NTDC System reached to 34,776MW of which 28% remains of Hydro based technologies i.e., 9,898MW. The comparison of other technology-based power generation can be seen in the following chart.



### Figure 2 : Installed Capacity (MW) as of September 2021

Overall, the Power Demand (MW) of Pakistan has been growing steadily with improved development of electricity supply in the country as it is evident from the electricity peak demand trend as shown in the following Chart.



Figure 3 : Historical Peak Electricity Demand (MW) from 2013 to 2021

Peak recorded demand in the country during 2020-2021 was 23,792MW recorded during the month of June 2021 out of which 86% was of domestic use while 11% commercial, 1% industrial, 1% agricultural and 1% other. According to NEPRA the forecast of Peak Demand in 2030 will be 37,129MW. For the purpose to meet the demand, NEPRA has launched a Indicative Generation and Capacity Expansion Plan (IGCEP) in 2021.



### Figure 4 : Peak Demand Forecast 2021-2030

#### 0.3. **Topographic Survey**

Topographical survey of Asrit Kedam Hydropower Project (AKHPP) was awarded to M/S AZMEC, and it was carried out in two phases. In Phase-I, geodetic control was established in the site area according to "Survey of Pakistan" reference benchmark and survey control established during topographical studies of Kalam Asrit Hydropower Project. Verification of already carried out topographic survey and topographic and hydrographic survey alternate weir & powerhouse site was also carried out in Phase-II. In Phase-II, topographic survey of whole project was carried out through satellite photogrammetry at scale of 1:5000 with 5-meter contour interval along with additional topographic and hydrographic survey at dam site and powerhouse area.

A total of four (4) permanent survey control monuments were finalized and approved to be installed at PH and weir site. In addition to these, the already existing KA-07 was also used. The details of these are as follows:

Control Point Name	Easting (Meter)	Northing (Meter)	Elevation (Meter)
AK-01	282513.013	3915627.064	1746.768
Ak-02	282568.832	3914927.857	1722.423
AK-03	281417.42	3904807.931	1554.567
AK-04	281258.924	3904643.425	1541.589
AK-07	282266.86	3915847.007	1758.885

Table 0-3 · Crid Coordinates of Control Points

Topographic survey was done by aerial mapping using a UAV drone. Ground Control Points (GCPs) were collected in order to produce accurately georeferenced DEM and Ortho-photo fro mapping purpose. A number of 4 to 5 GCPs were used in single grid. Images were then processed to obtain Digital ortho-rectified imagery of aerial mapping, Digital elevation model extracted from aerial mapping, digital surface model of project area and digital ortho imagery of project area.

A total of 40 bathymetric cross sections were observed along Swat-river. 21 cross-sections of the total at weir site and 19 at powerhouse area.

Figure 5 : Bathymetric Survey Plan of Swat River



# 0.4. Seismic Hazard Assessment Study

The spatial distribution of seismic events recorded in the project region is plotted in the following figure.



Figure 6 : Seismicity Map of the Project Region

The available seismic and tectonic data provides several evidence of the seismic activity along the major faults i.e., Main Mantle Thrust (MMT) and Kohistan Fault passing south of the site and Main Karakoram Thrust (MKT) passing northwest of the project.

ICOLD recommends using ground motion having 475-year return period which is termed DBE accelerations (Weiland, 2011). As per the ICOLD standard for Underground Powerhouse the recommended ground motion for DBE is therefore 0.32g (for very dense gravelly soil foundation condition with Vs30 equal to 600m/sec).

The Project regions Seismic Study was carried out using Probabilistic Analysis and Deterministic Analysis.

### **Probabilistic Seismic Hazard Analysis involves three steps:**

- Specification of the seismic-hazard source model
- Specification of the ground motion model
- The probabilistic calculation
- Deterministic Seismic Hazard Analysis involves:
- Checking the nearest active fault
- Estimating the largest earthquake that could happen on this fault
- · Assuming the largest earthquake happens at the closest point to site
- Calculating the peak ground acceleration

The Uniform Hazard Spectra obtained through Probabilistic Analysis for Powerhouse Site is as follows:



#### Figure 7 : Uniform Hazard Spectra

The main conclusion of all the seismic hazard analysis is as follows:

The Project is in the Kohistan Island Arc which is sandwiched between Indian and the Eurasian tectonic plates and very active seismically.

Several moderate sized earthquakes have been recorded in Kohistan Island Arc during the last 100 years.

Several active faults are present around the project area.

The main seismotectonic features considered critical for the seismic hazard for the project are

Main Karakoram Thrust (MKT), Kohistan Fault, Main Mantle Thrust (MMT) and Shandur Thrust.

Both probabilistic and deterministic seismic hazard evaluations were made to determine the expected ground motions at the project site.

The recommended horizontal Peak Ground Acceleration (PGA) associated with Operating Basis Earthquake (OBE) is 0.21g.

As the dam of Asrit Kedam Hydropower project is assumed to fall in high-risk consequences category, the recommended horizontal Peak Ground Acceleration (PGA) associated with Safety Evaluation (SEE) is 0.59g for all water retaining structures.

All the other appurtenant structures at the weir, tunnel and powerhouse areas are recommended to be designed for PGA of 0.32g, which is associated with ground motion of DBE having return period of 475 years.

Uniform hazard spectra for SEE, OBE and DBE are given for use in the seismic resistant design of the project structures.

It is recommended that in-situ shear wave velocity profile of the subsurface material at weir and powerhouse sites may be obtained for authenticating the assumption of Vs30.

For safety monitoring purpose Strong Motion Accelerographs may be installed at the Weir and Powerhouse sites.

# 0.5. Geological and Geotechnical Investigations

For the purpose of Geotechnical Investigation at Site, a total of 7 borehole drillings were carried out at the site area, 4 of which were done at weir area and 3 at powerhouse area. Additionally, 3 test pits were excavated at project area. Details are as follows:

<b>PH No</b>	Location	Coor	dinates	Proposed	Drilled	Status	
DII INU.	Location	E (m)	N (m)	Depth (m)	Depth(m)	Status	
AWB-1	Weir Site Area	282460	3915371	50	50	Completed	
AWB-2	Weir Site Area	282485	3915379	50	50	Completed	
AWB-3	Weir Site Area (Sand Trap Location)	-	-	50	34	Terminated	
AWB-4	Weir Site Area (Tunnel Intake)	-	-	20	16	Completed	
PHB-4	Powerhouse Site Area	281248	3905000	170*	50	Terminated	
PHB-5	Powerhouse Site Area	281270	3905065	120	120	Completed	
	Total depth (m)	320	320				

 Table 0-4 : Detail of Boreholes

Another borehole PHB-07 is being carried out at the powerhouse for the confirmation of geology at Powerhouse area.

TP NO. Location		Excavation Depth(m)	Cool	rdinates
TPCM-01	Near Weir Site Area	2.0	282449	3915442
TPCM -02	Tinka	1.9	282746	3914433
TPCM -03	Near Weir Site Area	2.0	282449	3915442

Table 0-5 : Summary of Test Pits Excavated at the Project Ar	ea
--------------------------------------------------------------	----

Field Testing was carried out at the borehole areas. Standard Penetration Tests (SPTs) generally at 1m depth interval in the boreholes according to the latest ASTM D-1586. The details of insitu tests conducted in the boreholes is as follows:

DII#	Location	Dri	led Depth	( <b>m</b> )	CDT	DT					Natar
ВП#	Location	OB	Rock	Total	CFI	ΡI	WFI	Inotes			
AWB-1	Weir Site Area	40	10	50	13	6	1	Completed			
AWB-2	Weir Site Area	38	12	50	20	5	1	Completed			
AWB-3	Weir Site Area	34	-	34	15	5	-	Terminated			
AWB-4	Tunnel Intake	16	-	16	7	-	-	Completed			
PHB-4	Powerhouse Site Area	32	18	50	4	-	2	Terminated			
PHB-5	Powerhouse Site Area	25	95	120	4	-	-	Completed			
Total		185	135	320	63	16	4				

 Table 0-6 : Details of Insitu Tests Conducted in the Boreholes

OB-Overburden, SPT- Standard Penetration Test, PT- Permeability, WPT- Water Pressure Test

Additionally, constant head permeability tests were performed in boreholes after 5m interval. Summary of permeability tests is as follows:

Borehole No.	Test No.	Depth [m]	Permeability (cm/sec)
	1	10	3.50E-05
	2	15	4.91E-05
	3	26	2.53E-05
AWB-1	4	30	4.484E-05
	5	35	3.911E-05
	6	40	7.517E-05
	7	45	1.747E-06
	1	5	2.99E-04
	2	15	2.53E-05
AWB-2	3	20	2.49E-04
	4	25	2.64E-05

Table 0-7 : Summary of Determined Permeability Values in Boreholes

Borehole No.	Test No.	Depth [m]	Permeability (cm/sec)
	5	30	1.65E-04
AWB-3	1	5	8.18E-04
	2	15	6.61E-04
	3	20	2.01E-05
	4	25	3.09E-05
	5	30	2.09E-04

Water Pressure / Packer Tests were normally performed at 3-5m section during bore hole sinking.

Borehole No.	Test No.	Test Section [m]		Lugoon Valua	Intermeted Flow Type	
		From	То	Lugeon value	Interpreted Flow Type	
AWB-1	1	45	50	54.79	Laminar	
AWB-2	1	42	45	104.34	Laminar	
DUD 4	1	15	20	8.83	Laminar	
PHB-4	2	32	35	4.90	Dilation	

### Table 0-8 : Summary of Interpreted Flow Type with Lugeon Values in Boreholes

For Sampling purposes, All the core samples, soil samples obtained from the boreholes and test pits were properly preserved in core boxes, polythene/ Jute bags, then labeled and transported to the laboratory for necessary testing. Laboratory testing was done on the soil, rock, and water samples. Following is a sample petrographic record at a borehole site (AWB-02).

### Figure 8 : Sample Borehole Recovery

PROJECT: PISRIT KEDANA HPP BORE HOUS: AWB.02
BON NO: 04
DEPTH- 28.20m TO 3540m DATE STARTED & COMPLETION, 12-09-2021 TO 15-09-2021
Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor Stor

Following is the Geotechnical Investigation Plan of the dam and powerhouse area.





Figure 10 : Geotechnical Investigation Plan of Powerhouse Area



#### 0.6. Hydrology and Sedimentation Studies

Swat River is one of the second tributary of Indus River and belongs to Upper Indus Basin. As shown in Figure, most of Swat-river catchment area distributes from EL.577m to over EL. 5,917m.



Figure 11 : Swat River Catchment Area

Land cover area estimates the snowmelt contribution for the catchment area. Following is the land cover area for Kalam catchment in 2015.

Туре	Dense Forest	Open Forest	Grasses /Shrubs	Cultivated Areas/Shrubs	Bare Soil /Soil	Lake /River	Alpine Grasse	Snow Glacier	Total
Area (km <sup>2</sup> )	113.53	33.34	512.67	199.6	64.31	6.11	233.57	854.63	2,018
Ratio (%)	5.6	1.7	25.4	9.9	3.2	0.3	11.6	42.4	100

Table 0-9 : Land Cover Area for Kalam Catchment in 2015

Following is the catchment area and ratio at the major locations.

	Swat River	Kalam Gauging Station		Dan	n	Tailrace Outlet	
	Area (km²)	Area (km²)	Ratio	Area (km²)	Ratio	Area (km²)	Ratio
F/S	13,300	2,020	1.0	2,170	1.07	-	-
F/S Update	13,300	2,020	1.0	2,213	1.10	2,483	1.23

Table 0-10 : Catchment Area and Ratio at the Major Locations

Flow of the river is measured through different hydrological stations present at various sites. Monthly average flow at Weir Site from 1961 to 2009 is shown as follows:



Figure 12 : Monthly Average Flow at Weir Area from 1961 to 2019

2 gauging stations, Pashmal and Mankial gauging stations were installed under supervision of KOAK. Daily flow data at new observation stations is as follows:



For Design Flood Purposes, Flood Frequency Analysis was done according to the available peak data. There was a major flood in July 2010 in the Swat River during which the peak flow was recorded at around 2,537 cusec which was 364.7 cusec in July 2009.





Frequency floods are also observed in the Swat River for which adequate probability distribution function and the parameters of probability distribution were reviewed by moments

### method.

For Glacier Lake Outburst Floods (GLOFs), potentially dangerous lakes were selected and studied for peak outbursts. The estimated design floods by the frequency analysis and GLOFs study, are as shown in following Table.

<b>Return Period Years</b>	Frequency Flood (m <sup>3</sup> /s)	GLOFs (m³/s)	Design Flood (m³/s)
100	982.7	-	982.7
200	1,091.5	-	1,091.5
1,000	1,371.7	-	1,371.7
10,000	1,851.6	226.9	2,078.5 for the dam safety check

Table 0-11 · Estima	te Design F	loods hv I	Trequency	Analysi	s and GL	OFs Study
TADIC 0-11 . ESuina	ite Design F	100US DY 1	requency	Analysi	s and OL	Or's Siduy

Sedimentation Analysis was carried out on the collected sediment from the site area. The total sediment loads at the dam site by average monthly sediment concentration is shown below.

Month	Discharge (m³/s)	Sediment Concentration (PPM)	Suspended Sediment Load(Ton)	Total Load, 20% Bed Load (Ton)	Percent of Annual Load
Jan	16.8	72.5	3,262	3,915	0.9
Feb	15.3	82.2	3,043	3,651	0.8
Mar	19.4	80	4,157	4,988	1.1
Apr	pr 54.1 103	103	14,443	17,332	3.8
May	147.9	99.5	39,415	47,299	10.4
Jun	272.7	115.1	81,357	97,629	21.5
Jul	279.5	180	134,750	161,700	35.6
Aug	182.8	132.5	64,874	77,848	17.1
Sep	87	71.4	16,101	19,321	4.3
Oct	38.9	103.8	10,815	12,978	2.9
Nov	25	47.2	3,059	3,670	0.8
Dec	19.6	61.4	3,223	3,868	0.9
Total	96.4	95.7	378,499	454,199	100

Table 0-12 : Total Sediment Loads at the Dam Site by Average Monthly Sediment Concentraion

During the high flow season in June/July, the load of sediments is also higher which can be seen through the following graph.



Figure 15 : Average Total Sediment Load

#### 0.7. **Project Layout**

Asrit-Kedam Hydropower Project is located on the Swat Cascade between the Kalam-Asrit Hydropower Project and Madian Hydropower Project. The project boundary level range between EL. 1,719.7m at the upstream and EL. 1,494.0m at the downstream.

The dam is located at the Asrit Village where the height of the dam is 28.5m, the length is 71.4m, the reservoir area is 0.02km<sup>2</sup> and reservoir storage capacity is 0.12Mm<sup>3</sup>. The layout plan at the dam site is as follows:



Figure 16 : Layout Plan at Dam Site

Underground Cavern Powerhouse was considered in the Kedam Village of Swat area for the Asrit-Kedam HPP. The comparison of surface and underground powerhouse was considered before the finalization of cavern powerhouse.





Underground Type Powerhouse

Surface Type Powerhouse

The comparison of construction cost for both alternatives is as follows: (Unit: US\$)

No.	Description	Underground powerhouse	Surface Powerhouse
	CIVIL WORKS		
1	WORK ADIT TO PENSTOCK	934,135	-
2	WORK ADIT TO POWERHOUSE	730,752	-
3	ACCESS TUNNEL TO CAVERN & CABLE TUNNEL	5,547,369	-
4	VERTICAL PRESSURE TUNNEL	1,671,067	1,619,729
5	PENSTOCK EXCAVATION 5.1 M(D)	767,918	1,686,702
6	POWERHOUSE CIVIL	7,371,829	39,281,794
7	TRANSFORMER GALLERY	1,588,501	-
8	TAILRACE (1&2)	6,554,059	-
	TOTAL CIVIL WORKS COST	25,165,630	42,588,225

### Table 0-13 : Civil Works Comparison for Underground and Surface Powerhouse

The geological factor was also considered. Following is the geological map of the powerhouse.



Figure 18 : Geological Map of the Powerhouse

The Weir and Powerhouse are approximately 10km apart from each other. The headrace tunnel was considered at the right bank of the swat river after analysis and comparison of both left and right bank for the headrace tunnel.

The comparison of tunnel length from both sides is as follows:

Alignment	Remarks	
Right Bank	10,291 m	▼ 1,771 m
Left Bank	12,062 m	

# Figure 19 : Comparison of HRT on Right Bank vs Left Bank



The detail comparison is as follows:

HRT (Headrace Tunnel) Alternative Route Comparison						
Item	Right Side (Selected)	Left Side (Not Selected)				
HRT Length	10,291m	12,062m				
HRT Cost (TBM Method)	(10,291 × 6000 USD) 61.75 Million USD	(12,062 × 6000 USD) 72.37 Million USD				
Access Roads	N-95 Highway	Access Roads Required				
Temporary Access Bridges (Dam & PH)	Not Required	2 x Required				
Permanent Access Bridge (PH)	Not Required	1 x Required				
Access Bridges Cost (Dam)	-	1 Million USD				
Access Bridges Cost (Powerhouse)	-	1.5 Million USD				
Permanent Powerhouse Access Bridge	-	1.8 Million USD				
Transportation of TBM	-	Special Arrangements Required through access bridge and platform				
Desander	Cost will be increased due to large excavation required as Hard Rock is exposed. Workability will be difficult	Flat area is available for the desander on this side hence the cost will be less, and workability will be easy.				

### Table 0-15 : HRT Alternative Route Comparison

Alt-3 was considered as the optimal project layout.

Items		I Init	FS (2008) DD (2018)		FS Update			
		Umt	Г 5 (2006)	DD (2018)	Alt-1	Alt-2	Alt-3	
	Location		Original Site	$\leftarrow$	50m downstream	700m downstream	50m downstream	
	Catchment Area	km²	2,170	2,170	2,213	2,228	2,213	
Dam	Storage Capacity (EL. 1,717)	m³	-	-	$0.12 \times 10^{6}$	$1.28 \times 10^{6}$	$0.12 \times 10^{6}$	
	Height	m	24	24	28.5	75	28.5	
	Length	m	73.2	73.2	71.4	192.4	71.4	
	Crest Elevation	EL. m	1,724.0	1,724.0	1,721.0	$\leftarrow$	$\leftarrow$	
Plant	Discharge	m <sup>3</sup> /s	120.0	120.0	120.0	120.0	130.0	
Min. Pla	nt Discharge	%	55	50	40	$\leftarrow$	$\leftarrow$	
Normal Operating Water Level		EL. m	1,711.0	1,711.0	1,717.0	$\leftarrow$	<del>~</del>	
Tailwater Level		EL. m	1,500.0	1,500.0	1,509.4	1,509.4	1,509.6	
<b>Gross Head</b>		m	211.0	211.0	207.6	207.6	207.4	
Head Loss		m	10.5	10.8	10.7	10.5	12.2	
Rated	Net Head	EL. m	200.6	200.2	196.9	197.1	195.2	

### Table 0-16 : Comparison of Project Layout with FS 2008, DD 2018 and Alternatives of FS Update
Itoms		Iln:4	ES (2009)	DD (2019)		FS Update	
1	tems	Unit	FS (2008)	DD (2018)	Alt-1 Alt-2		Alt-3
Installe	d Capacity	MW	215	215	213.5	213.8	229.4
Turbin	e Number		4 Units (34×3 Units, 18×1 Unit)	4 Units (38.2×3 Units, 15.4×1 Unit)			
	Turbine	%	95.4	94.0(94.5)	94.0(94.5)	$\leftarrow$	$\leftarrow$
Efficiency	Generator	%	98.0	98.2	98.2	$\leftarrow$	$\leftarrow$
	Transformer	%	-	99.5	99.5	$\leftarrow$	$\leftarrow$
Ecolog	Ecological Flow		2	10% of Average Monthly Flow	2.89	←	←
Internal (	Consumption	%	1.5	0.3	1	$\leftarrow$	$\leftarrow$
Force	d Outage	%	2.0	2.0	-	$\leftarrow$	$\leftarrow$
Reservo	ir Flushing	GWh	-	25.4(5 days)	15.2(3 days)	$\leftarrow$	16.4(3 days)
Annual G Gen	Gross Energy eration	GWh	911.5	893.8	931.6	932.5	970.7
Annual Gen	Net Energy eration	GWh	879.6	873.3	907.1	908.0	944.7
Plan	t Factor	%	48.4	47.5	49.8	49.8	48.3
Constru	uction Cost	USD	225,117,791	337,495,998	367,006,461	456,952,848	373,392,630
Unit Cons	struction Cost	USD/ MW	1,047,059	1,569,749	1,719,000	2,137,291	1,627,692
Unit Gen	eration Cost	USD/ KWh	0.25	0.39	0.40	0.50	0.40

# 0.8. **Project Optimization**

Optimization study is carried out to find the optimum project development scheme with the results of the previous F/S, and site survey and geotechnical investigation which are carried out to update the previous F/S.

Three alternatives were presented for the optimization study.

	Alt-1	Alt-2	Alt-3							
Design Discharge (m <sup>3</sup> /s)	120	120	130							
Installed Capacity (MW)	213.5	213.8	229.4							
Dam Axis	50m downstream	700m downstream	50m downstream							
Dam Height (m)	28.5	75	28.5							
Turbine Discharge	34×3 Units, 18×1 Unit	34×3 Units, 18×1 Unit	38.2×3 Units, 15.4×1 Unit							
Desander	$11.5 (W) \times 5 Basins$	No desander	$12.0 (W) \times 5 Basins$							

Table 0-17 : Alternatives for Optimization Study

		Alt-1	Alt-2	Alt-3
Headrace	Diameter	7.4m	7.4m	7.4m
Tunnel	Length	10,291m	9,969m	10,291m

The optimal layout was determined as Alt-3 with an installed capacity of 229.4MW, a plant discharge of  $130m^3$ /s and levelized tariff of 7.17 cent/KWh as shown in following table.

	Plant Discharge (m³/s)	Installed Capacity (MW)	Annual Gross Energy (GWh)	Annual Generation (GWh)	Plant Factor (%)	Total Project Cost (000'USD)	Levelized Tariff (Cent/KWh)
Alt-1	120	213.5	931.6	907.1	49.8%	484,100	7.29
Alt-2	120	213.8	932.5	908.0	49.8%	585,497	8.83
Alt-3	130	229.4	970.7	944.7	48.3%	491,299	7.11

#### Table 0-18 : Comparison of 3 Alternatives

Furthermore, optimization studies were carried out for Design Flood, Dam Crest Elevation, Energy Dissipation, Desander Chamber, Waterway Tunnel Cross-section, and the Powerhouse.

# 0.9. Reservoir Operation and Energy Generation

Based on the optimized layout, the power potential and energy production is estimated through the energy simulation model of 3 large units and one small unit. The plant discharge is determined as  $130m^{3}$ /s for full units which is 28.9% in the exceedance time of the flow duration curve. The normal operating level at weir site shall be EL. 1,717m.

The head loss is calculated as 12.2m including that of intake, headrace tunnel, vertical pressure tunnel, steel penstock, manifold, draft tube, tailrace tunnel and minor losses. The turbine and generator efficiency at 100% Load shall be 94% and 98.2% respectively although unit efficiencies of turbine, generator and transformer totally depend on manufacturer proposal.



Figure 20 : Load vs Efficiency Graph for Turbine and Generator

Outage and internal consumption apply in the energy modeling, shutting down the power plant during 3 days for reservoir flushing and high sediment concentration during wet season. Internal consumption is determined as 1% of the installed capacity.

Outage	Unit	F/S
Outage for the Reservoir Flushing	GWh	16.4 (3 days flushing during rainy season)
Powerhouse Service (Internal Consumption)	GWh	9.7
Total Outage	GWh	26.1

Table 0-19	: Estimated Ann	ual Outage
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The operating conditions of the power plant are as follows:

rable 0-20. Operating Conditions of the Fower Frant										
Outage	Unit	F/S								
Installed Capacity	MW	229 (3+1 Units)								
Plant Discharge	m³/s	130								
Min. Plant Discharge per Unit	%	40								
Annual Average Daily Flow	m³/s	96.4								
Operating Water Level	EL. m	1,717								
Gross Head	m	207.4								

Head Loss (Fu	all Units Operation)	m	12.2
	Turbine		94.0
Efficiency	Generator	%	98.2
	Transformer		99.5
Ecolo	gical Flow	m³/s	2.89
Internal	Internal Consumption		1
Reserv	oir Flushing	days	3

The plant factor shall be 47.0% calculated by dividing Annual Net Energy Production (923.1GWh) by Installed Capacity (229.4MW) and (24hrs x 365days).

									- 8/			(				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Gross Energy	Auxilli ary	Reservoir Flushing	Annual Net Energy
Energy	18.6	15.2	21.4	63.4	148.2	163.0	168.7	165.4	106.9	48.9	28.7	22.2	970.7	9.7	16.4	944.7

 Table 0-21 : Annual energy Generation (GWh)

The estimated annual energy is estimated as shown in Table 0-21. The annual gross energy and net energy are estimated as 970.7GWh/year and 944.7GWh/year respectively. The plant factor is 48.3%.

# 0.10. Design of Civil Structures

# 0.10.1. General

Basically, all the structures and design data are updated based on the results of geological investigation and topographic survey which are performed for this update study. Since the previous F/S was submitted in 2008, hydrology data had been observed prior to the large flood event, 2010, and site conditions such as topography, infrastructures and so on have been changed. With these new investigation and survey results, additional design data and the changed project development circumstance, this update study is being performed. The followings are the major changed issues

- The location and layout of the main dam and stilling basin, head regulator and connection channel, desander, intake, waterway tunnel route, surge tank, powerhouse and tailrace tunnel are reviewed and updated based on the results of geological investigation and topographic survey including river cross section survey.
- The size of the structures for proper function are reviewed with design data.
- Based on the new topography, the dimension of all structures are adjusted

The detail explanation on the changed size of the structures and design data are as followings.

	Item	Unit	F/S	TDD	F/S Update
	Catchment Area	km <sup>2</sup>	2,170	2,170	2,213
Hydrology	Annual Average Run-off	m³/s	94.2	94.5	96.4
	Plant Discharge	m³/s	120	120	130
	Gross Head	m	211	211	207.4
Power Concretion &	Head Loss	m	10.5	10.8	12.2
Energy	Installed Capacity	MW	215	215	229.4
Estimation	Annual Gross Energy Generation	GWh	911.5	893.8	970.7
	Annual Net Energy Generation	GWh	879.6	873.3	944.7
	Diversion Discharge	m³/s	561	564	658
Diversion Channel	Width	m	20	20	20
	Length	m	350.9	350.9	385
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam / Secant Pile
	Dam Crest Level	EL. m	1,718.3	1,718.3	1,714.0
Upstream	Dam Crest Width	m	6	6	6
Cofferdam	Height	m	13.5	13.5	13.2
	Length	m	66	66	57
	Dam Slope		1:1.3	1:1.5	1:1.5
	Туре		Rockfill Dam	Rockfill Dam	Rockfill Dam
	Dam Crest Level	EL. m	1,698.0	1,698.0	1,703.0
Downstream	Dam Crest Width	m	5	5	5
Cofferdam	Height	m	6	6	7
	Length	m	40	40	55
	Dam Slope		1:1.3	1:1.3	1:1.3
	Туре		CGD	CGD	CGD
	Design Discharge	m³/s	732	801.6	1,091.5
	Safety Check Discharge	m³/s	900	1,333.6	2,078.5
Dam &	Side Wall Level	EL. m	1,724.0	1,724.0	1,721.0
Spillway	Spillway Crest Level	EL. m	1,715.0	1,715.0	1,717.0
	Spillway Width (Net Width)	m	30	30	24
	Length	m	73.2	73.2	71.4
	Height	m	24	24	28.5

Table 0-22 : Comparison on the Major Features of F/S and F/S Update

	Item	Unit	F/S	TDD	F/S Update			
	Spillway Gate Type		Roller gate	Roller gate	Radial gate			
	Spillway Gate Size	m	W 10.0 × H 6.0 × 3 Nos.	W 10.0 × H 6.0 × 3 Nos.	W 8.0 × H 10.0 × 3 Nos.			
	Туре			Open Flow				
Desander	Width	m	11.5	11.5	12.0			
Basin	Depth	m	14.0	14.0	14.0			
	Length	m	130	130	130			
	Туре		Bellmouth Type	Bellmouth Type	Bellmouth Type			
T	Invert Elevation	EL. m	1,694.0	1,694.0	1,701.1			
Intake	Inlet Diameter	m	7.4	7.4	7.4			
	Gate	m	-	-	-			
	Туре		Modified Horse Shoe	Modified Horse Shoe	Circular Con'c lined			
Headrace Tunnel	Diameter	m	7.4	7.4	7.4			
Tunner	Length	m	9,946.00	9,960.00	10,291.0			
	Туре		-	Circular Con'c lined	Circular Con'c lined			
Vertical Pressure Shaft	Diameter	m	-	7.4	7.4			
i ressure snare	Height	m	-	181.7	119.5			
Horizontal	Туре		Circular Con'c lined	Circular Con'c lined	-			
Pressure	Diameter	m	7.4	7.4	-			
Tunnel	Length	m	101	139	-			
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined			
Steel Penstock	Diameter	m	5.1	5.1	5.1			
I CHISTOCH	Length	m	225	227	191.7			
	Туре		Circular Steel lined	Circular Steel lined	Circular Steel lined			
Penstock (Manifold)	Diameter	m	4.2~2.15	4.2~2.15	4.2~2.15			
(1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,	Length	m	184.3	184.3	140.6			
	Туре		Restricted Orifice Type	Restricted Orifice Type	Restricted Orifice Type			
	Size	m	D 12.5 / D4.5	D 18.0 / D4.5	D 14.0 / D4.5			
	Height	m	71.0/167.3	77.5	78.3			
Surge Shaft	Orifice size	m	3.0	3.0	3.0			
	Max. up-surging water level	EL. m	1,761.0	1,742.6	1,754.6			
	Min. down-surging water level	EL. m	1,656.1	1,684.7	1,680.8			
Powerhouse	Туре		Underground Cavern	Underground Cavern	Underground Cavern			

	Item	Unit	F/S	TDD	F/S Update
	Size	m	W 20.0 × H 31.6 × L 75.2	W 20.0 × H 31.6 × L 88.0	W 20.0 × H 39.0 × L 88.0
	Turbine Type		Vertical Francis Turbine	Vertical Francis Turbine	Vertical Francis Turbine
	Turbine Capacity	MW	3 × 60.9, 1 × 32.2	3 × 60.9, 1 × 32.2	3 × 67.4, 1 × 27.2
	Number of Units		4	4	4
	Turbine-Center Level	EL. m	1,491.0	1,491.0	1,495.0
	Туре		Underground Cavern	Underground Cavern	Underground Cavern
Transformer	Transformer Cavern Size	m	W 18.0 × H 13.6 × L 91.5	W 8.7 × H 7.3 × L 82.9	W 18.0 × H 13.9 × L 91.5
& GIS Cavern	GIS Cavern Size	m	-	W 13.4 × H 10.2 × L 31.4	-
	Transformer Type		3-Phase	Single-Phase	3-Phase
	Number of Units		5	13	5
Tailrace	Diameter	m	5.0	5.0	5.5
Tunnel	Length	m	280	280	303.1

# 0.10.2. Detail Explanation on the Changed Design

# 0.10.2.1. Hydrology

In the previous F/S, the river flow data from 1961 to 2004 was available. During site visit, daily flowdata from 2005 to 2006 and average monthly flow data and maximum instantaneous flow data from 2005 to 2010 are collected. The Table shows the added daily flow data from 2005 to 2006 for energy generation model, and the river flow data in F/S Update is a period of 1961 to 2010. The average river flow of the added daily flow data is slightly greater than that of F/S.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
F/	/S (m³/s)	15.8	14.5	18.1	52.3	141.9	269.1	271.7	177.4	83.8	37.4	24.4	18.8	94.2
20	05 (m³/s)	21.2	21.2	36.0	83.2	141.4	318.5	394.8	177.2	84.3	37.3	21.5	20.5	113.1
20	06 (m³/s)	19.4	19.4	21.4	53.0	190.0	180.5	215.8	148.7	62.7	31.2	21.1	20.5	82.0
Upc	F/S date (m³/s)	16.8	15.3	19.4	54.1	147.9	272.7	279.5	182.8	87.0	38.9	25.0	19.6	96.4

Table 0-23 : The Added Daily River Flow at the Dam Site

#### A. Catchment Area

The catchment area in the F/S was estimated as 2,170km<sup>2</sup>. During examining the catchment boundary of the F/S, no digitized catchment boundary map and soft copy of the catchment boundary are collected so that the catchment boundary is reevaluated with Google Map. It is estimated as 2,213km<sup>2</sup>.

	Swat River Kalam Gaugin		g Station Dan		ı	Tailrace Outlet	
	Area (km²)	Area (km²)	Ratio	Area (km²)	Ratio	Area (km²)	Ratio
F/S	13,300	2,020	1.0	2,170	1.07	-	-
F/S Update	13,300	2,020	1.0	2,213	1.10	2,483	1.23

Table 0-24 : Catchment Area and Ratio at the Major Locations

#### B. Annual Average River Flow

The annual average river flow at the dam site is derived by the catchment area ratio to Kalam gauging station and the added river flow data. Thus, the annual average river flow is increased as 96.4m<sup>3</sup>/s from 94.2m<sup>3</sup>/s by the increased catchment area ratio and the greater average river flow of 2005~2006.

# 0.10.2.2. Power Generation & Energy Estimation

Basically, the energy generation scheme of the run-of-river type, the number of unit and operating hours are maintained as those of the previous F/S. 2.89m<sup>3</sup> for the ecological flow is considered while no ecological flow was applied in the previous F/S.

#### 0.10.2.3. Plant Discharge

The optimization study was carried out with 120m<sup>3</sup>/s of the plant discharge of the previous F/S, 130m<sup>3</sup>/s of the plant discharge of Kalam HPP, and storage type scheme with 120m<sup>3</sup>/s of the plant discharge. The optimal plant discharge is determined as 130m<sup>3</sup>/s of the plant discharge. Considering the plant discharge, 130m<sup>3</sup>/s of Kalam HPP, it is a reasonable option to insure continuity in the cascade development scheme in SWAT River.

#### 0.10.2.4. Gross Head

The gross head is decreased due to the increase of the tailrace water level from EL. 1,500m to EL. 1,509.6m while the operating water level is raised as EL. 1,717m from EL. 1,711m. The tailwater level is estimated by stage-discharge curve which is derived by HEC-RAS model. The geometry data of the tailrace outlet area for HEC-RAS simulation is obtained by river cross section survey.

#### 0.10.2.5. Head Loss

No detail parameters for head loss estimation are provided in the previous F/S. Thus, the head loss is reevaluated with the designed structures and layouts in this Update F/S. It is increased as 12.2m from 10.5m.

#### **0.10.2.6. Installed Capacity**

The installed capacity is increased as 229.4MW from 215MW due to the increased plant discharge from  $120m^{3}/s$  to  $130m^{3}/s$ .

# 0.10.2.7. Annual Net Energy Generation

As the installed capacity is increased, the annual net energy generation is increased as 944.7GWh/year from 911.5GWh/year considering 3 days reservoir flushing outage and internal consumption.

# 0.10.3. Diversion Channel

The 2 stages diversion scheme is maintained. First stage is a diversion channel with cofferdam, and second stage is a conduit with cofferdam, using the spillway in the main dam body.

# 0.10.3.1. Diversion Discharge

The design discharge of diversion channel is increased as  $658m^{3/s}$  from  $561m^{3/s}$ . Design discharge of the major structures is estimated by flood frequency analysis including the large flood,  $2,537m^{3/s}$ , in 2010.

# 0.10.3.2. Diversion Channel Size

Based on the result of topography survey on the headworks area, overall elevation is raised up. Thus, the depth of the diversion channel is increased. Flood routing for diversion channel is carried out with the increased design flood.









# 0.10.3.3. Diversion Channel Length

Based on the result of topography survey on the headworks area, the length from the inlet to the outlet is increased as 385.0m from 350.9m even though the same location and route apply as shown in above Figures

# 0.10.4. Upstream Cofferdam

#### A. Cofferdam Type

The cofferdam type is the same as a rockfill type of the previous F/S. While curtain grout was introduced to prevent from seepage underneath the upstream cofferdam, sheet file is introduced in Update F/S.







Figure 24 : Typical Section of the Upstream Cofferdam in F/S Update

#### B. Cofferdam Crest Level

The cofferdam crest level is determined as EL. 1,714m from 1,718.3m by flood routing analysis, considering the increased release capacity of diversion channel.

## C. Cofferdam Height and Length

Even though the cofferdam crest level is lowered by 4.3m, and the location of cofferdam is the same to the previous F/S. the dam height from the riverbed to the crest is lowered as 13.2m from 13.5m because the topography of the headworks area is raised. The length is also decreased as 57.0m from 66.0m according to the width of river.

# 0.10.5. Downstream Cofferdam

# A. Cofferdam Type

The cofferdam type is the same as a rockfill type.

#### B. Cofferdam Crest Level

The cofferdam crest level is raised as EL. 1,703m from 1,698m by flood routing analysis, considering the increase release capacity of diversion channel and the increased design flood that results the water level at the downstream cofferdam to be higher.

# C. Cofferdam Height and Length

The location of cofferdam is the same to the previous F/S. Based on the result of topography survey on the headworks area, the dam height from the riverbed to the crest is increased as 7.0m from 6.0m and the length is increased as 55.0m from 40.0m according to the width of river.

# 0.10.6. Dam & Spillway

### A. Design Discharge

The design discharge of the dam and spillway is increased as 1,091.5m<sup>3</sup>/s from 732.0m<sup>3</sup>/s. Design discharge of the major structures is estimated by flood frequency analysis including the large flood, 2,537m<sup>3</sup>/s, in 2010.

## B. Safety Check Discharge

The design discharge of the dam is increased as 2,078.5m<sup>3</sup>/s from 900.0m<sup>3</sup>/s. Design discharge of the major structures is estimated by flood frequency analysis including the large flood, 2,537m<sup>3</sup>/s, in 2010.

#### C. Dam Crest Level

Even though the design flood is increased, the dam crest level is lowered as EL. 1,721.0m from EL. 1,724.0m due to the increased release capacity of the spillway. The crest level of the spillway and the dam are lowered to EL. 1,700m, and the free overflow spillway for the floating debris removal is provided that leads the release capacity of the spillway to be increased.

#### D. Spillway Width

In order to provide the free overflow spillway at the left side of the dam, the spillway width narrows by 6m, from 30.0m to 24m.



#### Figure 25 : Headworks Layout in F/S



Figure 26 : Headworks Layout in F/S Update

# E. Dam Height

Based on the result of topography survey on the headworks area, the dam height from the riverbed to the crest is increased as 28.5m to 24.0m.



Figure 27 : Dan Elevation in F/S





# F. Spillway Gate Type

The spillway gate type is changed to radial gate type, considering the reservoir depth and flow control function.

## G. Spillway Gate Size

The spillway gate height is increased as 10.0m from 6.0m due to the lowered crest level that leads the released capacity of the spillway to be increased.



Figure 29 : Spillway Section in F/S

Figure 30 : Spillway Section in F/S Update



# H. Spillway Gate Type

The spillway gate type is changed to radial gate type, considering the reservoir depth and flow control function during operation.

# 0.10.7. Desander Basin

## A. Desander Width and Depth

The design flood for the desander is increased as  $130m^3/s$  from  $120m^3/s$ . It has 5 basins including 1 basin for desander flushing without outage, and each basin width is increased as 12.0m from 11.5m.



Figure 31 : Typical Section of Desander in F/S

Figure 32 : Typical Section of Desander in F/S Update



# 0.10.8. Intake

# A. Invert Elevation

The invert elevation is raised to EL. 1,701m from EL. 1,694m according to the result of topographic survey. The operating water level for the desander and forebay is determined as EL. 1,717m in this Update F/S so that the intake structure is raised as much as possible.



#### Figure 33 : Typical Section of the Forebay and Intake in the Previous F/S



Figure 34 : Typical Section of the Forebay and Intake in F/S Update





#### Figure 36 : Front View of Intake in Update F/S



# 0.10.9. Headrace Tunnel

### A. Length

The length of the headrace tunnel is increased as 10,291.0m from 9,946.0m. The layout and profile are slightly adjusted, considering TBM application and rock cover depth. The cross section type is changed from modified horse shoe type to circular type, considering TBM application.



Figure 38 : Headrace Tunnel Layout in F/S Update



Figure 39 : Headrace Tunnel Profile in F/S



#### Figure 40 : Headrace Tunnel Profile in F/S Update



### **0.10.10. Vertical Pressure Tunnel**

In the previous F/S, the headrace tunnel was inclined to the powerhouse from the intake so that the vertical pressure tunnel was not introduced. In the Update F/S, the headrace tunnel is almost horizontal to the surge tank and then the vertical pressure tunnel starts. The cross section type and diameter are the same to those of the headrace tunnel, and the length is 119.5m.

## 0.10.11. Horizontal Pressure Tunnel

The horizontal pressure tunnel does not apply in the Update F/S. From the end of the vertical pressure tunnel the steel penstock is installed to secure the safety on the high pressure.

## 0.10.12. Steel Penstock and Manifold

The steel penstock starts from the surge tank. Due to movement to the surge tank of the powerhouse, the steel penstock length is decreased as 191.7m from 225.0m. The manifold length also is decreased as 140.6m from 184.3m due to the layout change of the manifold by the rotation of the powerhouse direction.





#### Figure 42 : Steel Penstock and Manifold Layout in F/S Update

## 0.10.13. Surge Tank



Considering the topographic survey result, the surge tank size is estimated with the increased design discharge, 130m<sup>3</sup>/s and the lengthen headrace tunnel. The surge tank is enlarged as a

diameter of 14.0m from 12.5m and heighten as 78.3m from 71.0m. With this size of the surge tank, the maximum upsurging water level is lowered as EL. 1,754.6m from EL. 1,761.0m while the minimum down surging water level is raised as EL. 1,680.8m from EL. 1,656.1m.

# 0.10.14. Powerhouse



Figure 45 : Typical Section of the Powerhouse in the Previous F/S

Figure 46 : Typical Section of the Powerhouse in Update F/S



### A. Powerhouse Size

The powerhouse size is enlarged as W 20.0 × H 39.0 × L 88.0 from W 20.0 × H 31.6 × L 75.2 in order to secure installation and maintenance space.

## **B. Turbine Center Level**

Since the Francis turbine, one of the reaction turbine types, is introduced, it should be submerged and secure draft head. The turbine center level is estimated considering draft head and the tailwater level. It is raised to EL 1,495m from EL. 1,491m.



#### Figure 47 : Powerhouse Plan in the Previous F/S

Figure 48 : Powerhouse Plan in Update F/S



# 0.10.15. Tailrace Tunnel

The length of the tailrace tunnel is increased as 744.02m from 280.0m because the power house location is moved to the surge tank direction to secure the rock cover depth.





# 0.10.16. TBM vs NATM

For the tunneling of the head race tunnel, Tunnel Boring Machine (TBM) shall be used. The comparison of TBM with NATM (New Austrian Tunneling Method – Drill and Blast) is as follows:

Item	NATM method (Drill & Blasting)	TBM method (Mechanical excavation)
Introduction		
	Excavation by using the drill & blast method, rock bolt(R/B) + shotcrete(S/C) and assistant reinforcement	Excavation using the tunneling machine Excavation is followed by R/B, S/C support Consisting of the cutter head, drive head, clamping pad
Geological conditions	From soil to hard rock Poor or fluctuating geological conditions	Soft rock with 50-180MPa of UCS It is difficult at unstable face, fickle ground, swelling ground, extremely weathered zones, and fractured zones
Advantage	Simple combination of excavation equipment (jumbo, S/C machine, loader, dump etc.) Prompt react against the geologically poor zone	Favorable for long mountain tunnel because of mechanical excavation Minimizations of the blast, induced vibration, and noise The most advantageous in the aspects of construction period due to full face excavation
Disadvantage	The most disadvantageous in the aspects of excavation period because of the conventional tunneling method. Poor working environment Civil complaint due to blast, induced vibration, and noise Increase of the relaxed zone due to blast	Requirements of special reinforcement in geologically poor zone High price of machine Requirements of electrical facilities for excavation Requirements of space for assemblages and rock muck disposal Requirements of fixing and widening the access road because of heavy machine Limited geological information due to the cutter head obstructing the tunnel face Potential difficulties in shear zones
Construction Cost	122,198,948 USD	99,935,582 USD
Period		54 Months

## Table 0-25 : NATM vs TBM

Item	NATM method (Drill & Blasting)	TBM method (Mechanical excavation)
Applied		Ø

# 0.11. Design of Electro-Mechanical Equipment

The mechanical equipment and main mechanical auxiliaries in the powerhouse consists of following items:

- Turbine I : three(3) vertical shaft single-stage Francis-turbines including hydraulic/ electronic turbine governors
- Turbine II : one(1) vertical shaft single-stage Francis-turbines including hydraulic/electronic turbine governors
- butterfly valve in front of each turbine with auxiliaries

Auxiliary mechanical systems such as:

- cooling water system
- drainage and dewatering system
- heating ventilation and air conditioning system
- fire fighting system
- oil purifying equipment
- compressed air system
- workshop equipment and tools
- main inlet valve
- main lifting equipment

The estimated rated net head is 195.2m and net dicharge is  $130m^3/s$  for all units. (Turbine I:  $38.2m^3/sec \times 3$  units and Turbine II:  $15.4 m^3/sec \times 1$  unit). The turbines shall have an optimum and economically viable output of  $67.4kW \times 3$  Units and  $27.2kW \times 1$  Unit. According to the type selecting diagram by "Hydropower Engineering USA", vertical Francis Turbines were selected.



Figure 51 : Turbine Selecting Diagram

Main features of the turbine are as follows:

Table 0-20 : Main Features of Turbine			
Division	Turbine I	Turbine II	
Turbine output (kW, unit)	67.4	27.2	
Number of units	3	1	
Type of turbine	Vertical Francis	Vertical Francis	
Design discharge (m <sup>3</sup> /sec, unit)	38.2	15.4	
Dlaut discharge (ur <sup>3</sup> /see allaurit)	114.6	15.4	
Plant discharge (m <sup>2</sup> /sec, all unit)	130		
Rated net head (m)	195.2	195.2	
Efficiency (%)	94.0 (94.5%)	94.0 (94.5%)	
Selected Specific speed (m-kW)	134.6	114.0	
Rotational speed (min 1)	375	500	
Turbine setting elevation (EL.m)	1,497.7	1497.7	
Tail water level (1 Unit operation, EL.m)	1,505.0	1,504.7	

Table 0-26 : Main Features of Turbine

Main parts of turbine include:

- Spiral Case
- Stay Ring

- Runner
- · Head Covers, Discharge Rings and Bottom Rings
- Guide Vanes
- Main Shaft
- Turbine Guide Bearing
- Pit Liner
- Draft Tube
- Governor
- Pressure Oil System

The material of the runner shall be 13/4 Cr:Ni with a HVOF coating considering the amount of sediment in the water in which size of silt is more than 0.2mm.

Mechanical Auxilliaries include:

- Cooling Water System
- · Shaft seal water supply filter system
- Dewatering System
- Drainage System
- · Heating, Ventialation, Air-conditioning System
- Fire Fighting System
- Oil Purifying Equipment
- Workshop Equipment and Tools
- · Compressed Air System Low Pressure
- · Compressed Air System High Pressure

At the upstream of each turbine, one Flow through valve (Biplane type butterfly valve) shall be installed for emergency and repair shutdown valve of the turbine. The specification of Main Inlet Valve is as follows:

Division	Turbine I	Turbine II
Number of units	3	1
Type of valve	Flow-through valve (Biplane type butterfly valve)	Flow-through valve (Biplane type butterfly valve)

#### Table 0-27 : Specification of Main Inlet Valve

Division	Turbine I	Turbine II
Nominal diameter (m)	app. 2.2	app. 1.5
Static head (m)	219.3	219.3

Main Lifting Equipment include the overhead crane of the Powerhouse having a main hoist capacity of 170ton and Crane for GIS Room.

# 0.12. Design of Electrical Equipment

The design concept is based on the assumption to interconnect the AKHPP to a 220kV high voltage transmission line at the Switchyard. The key single line diagram of electrical facility of power plant is as follows:



Figure 52 : Key Single Line Diagram of Electrical Facility of Powerplant

Electrical Equipment within the powerhouse include the Generator, the Step-Up Transformers, the Station Service Transformers, the 220kV GIS Switchgear, Auxiliary Electrical Equipment, Protection Relaying system & metering and control & monitoring system.

Table 0-28 : Design Parameter of Gen	ierator
--------------------------------------	---------

Division	Specification	
Capacity (Unit1 to 3/Unit 4)	74.88 MVA/30.19MVA	

Division	Specification	
Power Factor (PF)	0.9	
Rated Speed	375RPM/500RPM	
Frequency	50Hz	
Terminal Voltage	11 ±5%kV	
Stator coil Connection	Y connection	
Neutral Point Ground Method	High resistance grounding method using Single-phase transformer for grounding and secondary resistor.	

The circuit breakers of generator have the following specification:

Division	Specification
Number of Circuit Breakers	4
Number of Phase of Each Systems	3
Nominal Operating Voltage	12kV
Frequency	50Hz
Lightning Impulse voltage	75kV
Rated Current(Unit 1 to 3/Unit 4)	4000A/2000A
Rated Short-Time Current	50kA

#### Table 0-29 : Specifications of Circuit Breakers of Generator

Each Unit will have one step up transformer while one spare transformer will be available for emergency. 3-Phase Transformers will have following design parameters.

Division	Specification
Number of Three-Phase Transformer	4+1
Туре	Three-phase, two windings
Rated bank Output of Three-Phase Transformer (Unit 1 to 3/Unit 4/Spare)	75MVA/35MVA/75MVA
Frequency	50Hz
Type of Cooling	OFWF
Primary Voltage Rating	11kV
Primary BIL Level	75kV
Secondary Voltage Rating	220kV
Secondary BIL Level	950kV

#### Table 0-30 : 3-Phase Transformers Specifications

An automatically operated firefighting water-deluge system will be provided for all 3-phase unit step up transformers. Two 3-Phase Transformers will be provided for auxiliary power supply from the generator bus ducts of all units.

A 220 kV SF6 gas-insulated switchgear (GIS) will be installed in a separated room above the transformer room in the powerhouse. The Design Parameter of 220kV GIS Switchgear is as follows:

Description	Specification	Remarks
Normal voltage	220kV	
Rated voltage	245kV	
Rated frequency	50Hz	
Rated current(Continuous at 40°C ambient)	2,000A/2,000A	For generator for line
Short time rated current (RMS)	40kA	

The auxiliary power requirements for each unit will be provided through the 400V AC Auxiliary Power Supply. UPS Systems and Diesel Generator Sets will be provided for backup. Meanwhile, Protection Relaying System and Metering shall also be provided.

For reliable, efficient, and safe operation of the power station, a monitoring and control system will be provided, configuration of which is as follows:



#### Figure 53 : Monitoring and Control System Configuration

Moreover, Telephone System and Power Line Carrier Communication shall be provided too. For the electrical equipment at the dam Site, a medium voltage aerial distribution line will be installed at site along with three pole mounted step-down transformers and an interrupter switch. Further, a 220kV Terminal Gantry will be located close to the power outlet structure.

# 0.13. Design of Hydro Mechanical Equipment

T I I A 22 D

Item No.	Description	Specifications
1	Number of gates	3
2	Type of gate	Radial gate
3	Sealing system	Rubber seals
4	Sill level, m.a.s.l.	1,700.00
5	Normal level, m.a.s.l.	1,717.00
6	Static head at sill, m	17.0
7	Opening width, m	8.0
8	Opening height, m	10.0
9	Type of hoist	Hydraulic cylinder

0 11

Radial Gateway for Spillway has the following design:

For the three spillway radial gates, one set of stoplog will be proposed having 5 sections. The gate will be slide type with rubber seals having an approximate height of 10m and will be operated by the Gantry Crane.

The Gantry Crane at Spillway will be electrically operated with an estimated capacity of 30ton.

For desander, there will be a total of 5 trash rack sets with width of 5.2m each and height of opening shall be 5m with an inclination of 81°. The trash rack cleaner will be movable, rake, knuckle crane gripper with the rake width of 3m and cleaner travel of 35m.

The Intake gate will have the following design parameter:

Item No.	Description	Specifications
1	Number of gates	5
2	Type of gate	Fixed wheel gate (roller gate)
3	Sealing system	Rubber seals
4	Sill level, m.a.s.l.	1,710.00
5	Static head at sill, m	7.0
6	Opening width, m	5.2
7	Opening height, m	5.0
8	Type of hoist	2 Drum wire rope winch

 Table 0-33 : Intake Gate Design Parameters

There shall be 10 desander roller gates (fixed wheel gate) having rubber seals and will be hoisted on 2 Drum wire rope winch. The desander flush will have 5 sluice gates having rubber seals with an inside diameter of 2m and will be hoisted on an electric hoist. Gantry Crane shall

be provided for desander gate.

The trash rack at intake has the following design and applicable data:

Item No.	Description	Specifications
1	Number of trash rack, set	1
2	Width of each trash rack opening, m	11.0
3	Height of opening, m	15.0
4	Bottom elevation of trash rack, m.a.s.l.	1,701.00
5	Inclination angle of trash rack, degree	80.0°

The steel penstock shall have the following design parameters:

Item No.	Description	Specifications
1	Maximum discharge, m <sup>3</sup> /s	130
2	Steel Penstock diameter / length, m	5.1 / 191.7
3	Manifold diameter / length, m	4.2 / 12.7, 2.9 / 106.6, 2.15 / 21.3
4	Turbine setting elevation(EL. m)	1,495.0
5	Static head, m	222
6	Encased or exposed supported	Encased

The Draft tube gate will have the following design parameters:

#### Table 0-36 : Draft Tube Gate Design Parameter

Item No.	Description	Specifications
1	Number of gates	3/1
2	Type of gate	Slide gate
3	Sealing system	Rubber seals
4	Flood water level, m.a.s.l.	1,514.1
5	Sill level, m.a.s.l.	1,488.5
6	Static head at sill, m	30.1
7	Opening width, m	5.5/4.2
8	Opening height, m	2.2/1.9
9	Type of hoist	Overhead crane

# 0.14. Grid Interconnection Study

The Grid Interconnection Studies (Load Flow Studies) were carried out by the Power Planners

International (PPI) for KOAK Power Limited. The summary of the studies concludes the following:

- According to The Integrated Study, Asrit Kedam HPP will be connected by looping in out at one of the 220kV double circuit from Kalam Asrit HPP to Chakdara-New 220kV G/S. The conductor would be 220kV Twin Bundle ACCC Plano with thermal rating of 1,727 MVA.
- The proposed scheme for Asrit Kedam HPP will require the following bays in the switch yard
- Two-line bays of 220kV for connection with 220kV Kalam Asrit HPP and 220kV Chakdara-New G/S
- Four transformer bays for the four GSU transformers (3x75MVA & 1x40MVA)
- In view of the expected Commercial Operation Data (COD) of Asrit Kedam HPP in the last quarter of 2027, the above proposed interconnection scheme has been tested for the following scenarios using load flow studies:
- Peak Load Summer 2028
- Off-Peak Load Summer 2028
- Peak Load Winter 2028
- Off-Peak Load Winter 2028
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of Asrit Kedam HPP under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at hydropower plant G/S and the substations of 220kV and 132kV in its vicinity. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear proposed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the under study HPPs.
- The maximum short circuit levels at 220kV Asrit Kedam HPP bus bars for the Year 2028 for 3-Phase and 1-Phase are 11.75kA and 11.83kA respectively. It would be advisable to go for standard size switchgear of short circuit rating of 50kA. It would provide large margin for future increase in short circuit levels as generation additions are expected in the valley and network reinforcements will be introduced to accommodate those additions.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for peak load condition of summer 2028. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases. The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems and is therefore recommended to be adopted. It meets all the criteria of grid code under steady state load flow, short circuit currents and dynamic/transient conditions given all the proposed requirement of the network are implemented.

# 0.15. Environmental Impact Assessment

## 0.15.1. Summary

The proposed project will be developed on land purchase from private owners and the Government of Khyber Pakhtunkhwa in Asrit and Kedam village of Tehsil Behrain, District Swat of Khyber Pakhtunkhwa province (KPK).

This synopsis presents the existing Environmental and Social (E&S) baseline conditions and evaluation of the EIA with respect to the following parameters of the Hydropower plant:

- Design and Construction phase;
- · Operational and maintenance phase; and
- Decommissioning phase.

The EIA study for the proposed 229 MW Asrit Kedam Hydropower Project uses major international (IFC, ADB etc.) and national guidelines relating to Hydropower plant projects' design, construction, operation and decommissioning.

The proposed project weir (35°21'28.61"N, 72°36'22.87"E) is to be located at Asrit village, Swat district of KPK province at approximately 14 km about downstream from the confluence of Gabral and Ushu Rivers and The powerhouse (35°15'52.61"N, 72°35'43.78"E) is located at a point 500m upstream of Kedam Khwar, which is about 14km downstream from the intake. The site is at about 70 km away from Saidu Sharif Airport, Swat.

The Hydropower project is being developed in an area, which is mountainous, having agricultural areas, with sparse forest, and barren and range land. No sensitive ecological habitats with high ecological value were found during the field survey of the EIA. Similarly, Involuntary Resettlement Category, the proposed project falls in Category-B. The construction of the 229 MW Asrit-Kedam project have impact on 36 DPs (less than 200), who will experience major impacts in terms of losing their housing and 10% or more of their productive assets project vicinity is expected to be adversely impacted by the proposed project activities.

# 0.15.2. The EIA Methodology

Various steps undertaken for the EIA preparation include understanding of the proposed project; review of provincial, national and international legislation and guidelines; EIA scope and methodology; a collection of secondary data including physical, biological & socioeconomic environment and heritage aspects; primary field data collection; potential environmental impacts identification; recommendations for mitigation and monitoring measures; development of Environmental Management Plan (EMP) and reporting.

Field surveys for EIA study were carried out by a team of environmental specialists, fisheries expert, sociologists/gender experts, wildlife experts, botanist and archaeologists along with representatives from KPK Wildlife, forest and revenue Departments in the first week of September 2021. Field data collection included ground trusting of available secondary information. Secondary information was obtained from KOAK Power (Private) Limited, other sources like previous environmental studies in the region, published data and schedule rates

from forest, revenue, agriculture and wildlife departments and respective District Census Reports (DCRs).

The approach for identification of environmental and social impact assessment was based on MECE (Mutually Exclusive, Collectively Exhaustive) methodology which guides to include a broad range of aspects with respect to financing arrangements, regulatory requirements and environmental controls of lender, details of technology and plant layout etc.

# 0.15.3. Study Zone

Consultants explored the spatial boundaries of the environmental impact assessment and attempted to cover all the areas prone to any changes either directly or indirectly with Asrit-Kedam HPP. The experts considered various stages of the project specifically the construction and operation phases. Additionally, the cumulative level of various Hydropower projects in Basin were considered keeping in view the developmental plans of Pakhtunkhwa Energy Development Organisation (PEDO). The permanent footprint of the proposed project includes the area that will be acquired for the weir, reservoir, powerhouse, roads and some other facilities. The temporary footprint includes the land that will be required or disturbed due to the temporary facilities that will be developed during the construction phase in the weir, powerhouse and other infrastructure components.

# 0.15.3.1. Aquatic Study Zone

Swat River stretches starting from Asrit(Swat River) which is considered the upstream section of the proposed HPP to the downstream (Kedam ) is taken as an aquatic study zone. The length of the river is approx. 11.5km which includes the tributaries in the stretch.

# 0.15.3.2. Terrestrial Study Zone

500m buffer is taken on each side of the river where Project-related facilities are to be located as well as the reservoir.

# 0.15.3.3. Socio-economic Study Zone

During the socio-economic studies 500m buffer on each side of the river including the settlements are considered. In order to cover the communities around the permanent project facilities or the temporary, a 1km cover as buffer radius is taken to identify range of communities around the project facilities.

# 0.15.4. Physical Baseline

# 0.15.4.1. Topography

The project area is mountainous, with an altitude generally between 5000 to 6000 feet above mean sea level (amsl).

# 0.15.4.2. Land Use and Cover

The mountain ranges generally run from north to south. The reservoir area of the project is under agriculture, forest, barren and range land. A moderate number of forest trees, fruit trees, mixed shrubs and grassy patches also exist.

### **0.15.4.3.** Climatic Conditions

The project area falls in sub-humid and sub-tropical zone of district swat with moderate summer and extreme cold winter. The hottest month is June with mean maximum and minimum temperature of 33°C and 16°C respectively, and the coldest month is January with mean maximum and minimum temperature of 11°C and -2°C, while the annual precipitation averages 866 mm (34.1 in).

## 0.15.4.4. Water Resources

For drinking water in project area twelve water samples, including some from Asrit Nullah, near weir site and other near powerhouse site were collected by an EPA-KP certified Environmental lab.

All the water quality parameters are within NEQS and WHO drinking water standards.

#### 0.15.4.5. Ambient Air Quality

The ambient air quality was measured for respirable particulate matter (PM), sulfurdioxide (SO2) and oxides of nitrogen (NOX). Air quality sampling was carried out at two different locations in the Study Area during September 2021.

Key observations of the basis of the sampling conducted by the Environmental sampling laboratory are

- The 24-hour PM10 and PM2.5 concentration comply with both the NEQS and IFC-EHS limits at all sampling locations (Powerhouse Site, Weir Site and Disposal Area).
- The 24-hour concentrations of SO2, CO, NO2 and NO comply with both the NEQS and IF-EHS limits.
- The air quality in the area is also good, revealed from instrumental analysis on air quality monitoring .

#### 0.15.4.6. Noise Quality

During the site study baseline, ambient noise levels in the study area of Asrit-Kedam were assessed. Noise measurements were taken at 3 locations (Weir, Powerhouse and Disposal Area) which are considered the possible sources of noise pollution from project activities. The sampling duration was extended to 24hours at each of the sites

There are no major industries in and around the project area; therefore, noise pollution was observed to be generally below 65 dB (A).

#### 0.15.5. Ecological Resources

The project area falls in sub-humid and sub-tropical zone of district Swat with moderate summer and extreme cold winter. However, all the habitats in the project, the area doesn't not fall under the protected wildlife category, whereas some of the area at weir (approx. 14.25 acre) is classified as a protected forest area by the KPK Forest Department which shall be de-notified by the Government as per applicable laws. Further details on the ecological resources are provided below.

# 0.15.5.1. Terrestial Fauna

Key fauna associated with this habitat are :

A total of 7 mammals were recorded/observed from the project area. Red fox, Rhesus monkey, Asiatic Jackal, and Leopard Cat. Among these species, none are listed as vulnerable by IUCN.

The common small mammals are Indian Gerbil, House Mouse, Woolly Flying Squirrel, Asian Palm Civet, Indian Bush Rat, Himalayan Marmot and Stoat. A total of 3 reptiles were recorded/observed from the project area and the common species are lizards, Bengal Monitor Lizard, Varanus bengalenis, Spiny-tailed Lizard Saara hardwickii, and Leopard Gecko Eublepharis macularius along with species of frogs and snakes. None of these species are listed in IUCN Red List as endangered or near threatened.

# 0.15.5.2. Terrestial Flora

Similarly, regarding floral attributes, a total of 44 vegetation species belonging to various plant families were found on the project site and close vicinities. None of the rare, endemic or threatened floral species were identified during the EIA site visit and are widely distributed in KPK and particularly in Swat district.

# 0.15.5.3. Aquatic Fauna

During the aquatic sampling and survey two fish of commercial importance i.e the exotic brown trout (Salmo trutta) and the indigenous snow carp (Schizothorax plagiostomus) were found near Kalam, i-e upstream of weir site. During population abundance trials total catch of the brown trout was 90%. Field reconnaissance presents that none of the aquatic species are critically endangered.

# 0.15.5.4. Avifauna

A total of 12 birds' species were recorded from the project area. House Sparrow, House Crow, Raven, Chukar Partridge and other commonly observed bird species The birds such Collared dove, Little brown dove, House crow, House sparrow, Red-vented bulbul, Common & Bank myna, Little green bee-eater, Crested lark and White cheeked bulbul. Among the raptors, Black kite, Brahminy kite, Common buzzard, Common kestrel, Marsh harrier, Steppe eagle, Tawny eagle and White eyed buzzard were also recorded can be seen. The diversity of species in a particular area depends not only on the number of species found, but also on their individuals' counts. Most of the species belong to the status of least concerned in terms of IUCN Redlist, however, Parakeet and Balck Patridge is considered to be in a vulnerable state due to hunting. These two species were not found specifically in the project area during surveys but are commonly reported in secondary data (literature).
## 0.15.6. Socioeconomic Environment

The proposed 229MW Asrit-Kedam hydropower project start from Kedam village and leads towards Asrit village by passing through Balakot, Ramet and Mankial villages of Tehsil Bahrain district Swat. In order to find out the social status of the residents, social survey in the study area villages were carried out at the different locations shown below

Sr.No.	Villages	Estimated No. of Houses	<b>Estimated Population</b>
1	Asrit	62	558
2	Balakot	450	4,050
3	Chodram	70	630
4	Chamgharai	100	900
5	Ramait	250	2,250
6	Mankial	1,500	13,500
7	Kulalain	50	450
8	Kewa	30	270
9	Shina	25	225
10	Biji	40	360
11	Beion	50	450
12	Jal	80	720
13	Hawai	100	900
14	Laishahi	90	810
15	Dan	60	540
16	Kedam	150	1,350
17	Guranai	120	1,080
18	Pankey	60	540
	Total	3,287	29,583

A total of 18 settlements were surveyed during the field activities, ranging in size from 25-1500. The total estimated number of household in the study area is 3,287. The household surveys, indicated that average household size is 9 persons.

The population of the project area is a mixture of Torwali, Gujar, Oshojo, Kashmiri, Kohistani and Pashtun. The major language of project area is Taroli and Pashto , while Urdu and English are also used by educated class of the area.

Education facilities are very petite in the proposed project area. Just a Higher Secondary School for boys and Primary school for girls is available in the proposed Project area in Mankial, while most of the other villages have only primary schools. As per survey results majority of the community send their children to these schools for basic education. In the project area no proper medical facilities are available expect the basic health units. Therefore, locals have to move Mingora, Abbottabad or Peshawar. The area boasts great biodiversity and natural beauty, the valley has dramatic natural beauty and there are many places which have attractions for the tourists.

Kalam, one of the favourite tourist destination is just 16 km upstream of the proposed weir site. Majority of the female does not take part in any activity except household works and livelihood

earning is the responsibility of males.

As per social survey there is no any archaeological/historical site exist in the Area of Influence.

Communities around the project area own livestock commonly which include bullocks/buffalos, cows, goats, donkeys and a small number of horses. Livestock owners often engage herders to rear goats, whereas poultry, cows and buffalo are reared at home. The area is also a common ground for the nomadic movements (between low land and uplands).

Small scale sediment mining is carried out to some extent around the powerhouse and weir areas which are accessible. The mineable sediment resource is being extracted to meet small-scale construction demand, involving construction and maintenance of local residential and commercial buildings. The mining techniques are crude, involving use of labor for dredging and use of local livestock and tractors for movement of sediment.

During the surveys, it was found that a mining lease for granite marble was awarded to a party in the area of influence. The subject lease is in the process of denotification as per existing laws

None of the settlements surveyed in the Socioeconomic study area are connected to a municipal sewage system like in cities. Human waste in some parts of the Mankiyal and Balakot is disposed of in septic tanks in properly constructed houses, however in majority of areas all wastewater eventually runs off into the River Swat. Most settlements surveyed reported access to pit latrines of some type.

During the socio-economic survey, the respondents of the community observe tourism as major influx of capital into the local area economy.

### 0.15.7. Environmental Flows

Required Environmental Flow (E-Flow) will be released from the weir to meet the requirements of the aquatic ecosystem furthermore some local khwar like Balakot khwar and Cham Khwar tributaries join Swat River in between Weir and Powerhouse which will additionally hydrate the channel. However, the Proponent. has devised a scheme where inhouse diversion within the weir structure will allow minimum of 2.87 Cumec flow to maintain the river ecology.

### 0.15.8. Project Benefits

Hydropower provides renewable, sustainable and indigenous energy with wide-ranging benefits including, support to the climate change initiatives, reducing reliance on fossil fuels, social advantages, improved tourism, cheaper electricity and economic benefits.

### 0.15.9. Impacts and Mitigations

The EIA covers potential E&S impacts of the proposed project activities in the project area. Potential impacts on the physical, biological, socioeconomic, and cultural environment that may arise from the proposed project activities and the related mitigation measures that will be adopted to reduce or minimize the identified impacts have been assessed and are summarized in Table 0-36.

The only major adverse impact of the project is the acquisition of 73.34 acre of land out of

which approx. 13 acres is cultivated land and 14.25 acre of forest land. Similarly, marginal human settlement in the project is expected to be severally impacted by the proposed project activities, including minor resettlement of 21 structures (15 houses and 06 abandoned structures). A comprehensive Land Acquisition and Resettlement Action plan (LARP) is prepared to mitigate, and monitor the mitigation of this impact timely.

Apart from the permanent land acquisition, the project will also acquire approx. 25 acre land temporarily, on lease, for the construction of labor camp and waste disposal area. The existing land use of the selected areas for these purposes is same, i-e the areas are already being used by labor camps and material/disposal yards for some other construction projects (Road project) so there is no or very minute change in land use is expected as the land is already modified.

A	Total Land	Cultivated Land				
Area	Area (Acre)	Area (Acre)				
A. Permanent Land Acquisition						
Weir & Reservoir	29.54	0.00				
Powerhouse	31.90	10.79				
Access Road	11.90	2.28				
Total	73.34	13.08				
	B. Temporary Land Acquisition	n				
Camp 1	1.34	0.20				
Camp 2	1.42	0.70				
Camp 3	4.93	4.20				
Disposal Area 1	12.89	0.00				
Disposal Area 2	4.48	0.28				
Total	25.06	5.38				

Table 0-37 : Details of Impact on Land

Moreover approximately 191 trees will be cut down due to construction of weir, powerhouse, access road and associated facilities for the project details is given below Table.

		Forest/Wood Trees			Fruit Trees	
Sr.No.	Project Component	Name	No.	Ave Girth (centimetre)	Name	No.
	Weir Site	Deodar	12	15-30	Apple	4
1		Kail		15-30	Fig	2
1		Fir		0-15	Date Plum	4
		Broad Leaved	2	0-15		
Total (A)			14			10

Table 0-38 : Details of Affected Trees

		Forest/ Wood Trees			Fruit Trees	
Sr.No.	Project Component	Name	No.	Ave Girth (centimetre)	Name	No.
		Deodar	8	15-30	Apricot	9
2	Derechause	Kail	15	15-30	Walnut	15
2	Powernouse	Fir	15	0-15	Peach	15
		Wood Trees	61	0-15	Apple	21
	Total (B)		99			60
	Access Road	Deodar		15-30	Apricot	
2		Kail		15-30	Walnut	
3		Fir		0-15	Peach	
		Broad Leaved	8	0-15	Apple	
	Total (C)		8			
Total (A+B+C)			121			70
Total				121		
Grand Total (Wood and Fruit Trees)				191		

The loss of trees will also be compensated by successful plantation of native species. The lost trees will be replaced at a ratio of 1:10 with consultation of forest department. A tree plantation plan is established for plantation of 1,910 trees, in this regard to ensure growth of plantation till maturity.

**Forest Trees**: Additional forest surveys were conducted by Forest Dept KPK to access number of trees at weir area in March 2022. Total of 25 Forest Dept trees"Deodar" were recorded at weir area with 14.25 acre's of land belonging to the Forest Department. This 14.25 acre of land will be acquired by denotification of forest land by the government as per applicable laws.

Apart from the above impacts of land acquisition, inundation of reservoir and tree cutting, all other impacts of the project are temporary, reversible and can be mitigated easily with the implementation of EMP and Good International Industry Practice (GIIP).

# 0.15.10. Environmental Management Plan (EMP)

For the effective implementation of mitigation measures and management of residual impacts an EMP has been developed.

The EMP provides a delivery mechanism to address potential environmental impacts of the proposed hydropower project activities, to enhance project benefits and to introduce standards of good practice in all project related activities. The EMP has been prepared with the prime objective of:

- Defining legislative requirements, guidelines and best industry practices that apply to the project;
- Defining mitigation measures required for avoiding or minimizing potential impacts assessed by the EIA;
- · Defining roles and responsibilities of the Proponent and the execution contractors; and
- Defining requirements for monitoring and reporting.

The Proponent will be responsible for the overall implementation of environmental mitigation measures and the LARP through their construction contractor and OM operator in collaboration with government departments.

The project indicative EMP cost amounts to 354,874,000 PKR or 2,075,086 USD in various heads such as Lenders studies, monitoring and evaluation, tree plantation, fish hatchery, strengthening, training, M&E, Social investment Programs, EIA studies, and Stakeholders engagement plan implementation.

## 0.15.11. Corporate Social Responsibility

As a Corporate Social Responsibility (CSR), the project implementation is expected to raise hopes of the project area population for their general welfare. It is, therefore, necessary that the project sponsor may provide facilities in the form of education, health, improvement of existing access roads and development of parks to the people of the project area.

Considering the betterment of the local community and based on the consultations carried out with the local community and local administration, initiatives such as tree plantation, construction of hatchery, parks/grounds, health facilities, drinking water, jobs etc are proposed as CSR.However, the Proponent will finalize CSR programs before the start of construction activities based on consultation with affected community and line departments and will share with stakeholders before finalization

### 0.15.12. Conclusion

The EIA has examined the proposed project activities in detail, the baseline E&S conditions of the project area and assessed the project's potential E&S impacts. Mitigation measures to help minimize the identified potential impacts have been recommended and an EMP has been developed for effective implementation of these mitigation measures.

The prime objective of the proposed Hydropower plant in Asrit-Kedam, Swat District of KPK province is to provide green, sustainable and environment friendly energy in comparison to already available traditional sources of energy based on non-renewable fossil fuels.

The proposed Hydropower plant will contribute in meeting national renewable energy and climate change targets. Based on the same, the EIA concludes that if mitigation measures for all identified impacts in the EIA are implemented as per the recommendations, no significant or adverse change in the baseline environmental or social conditions will occur.

The releases from the weir are 2.877cumec, which are provided in the project to meet the environmental, ecological, aesthetic of the downstream villages up to the powerhouse. Drinking

water (generally spring, stream and nullah water is used), other human needs and environmental requirements will remain the priority for the downstream releases.

Operation of the powerhouse and maintenance of the weir structure will result in the creation of job opportunities, and better opportunities of business and transport and tourism development.

The project will significantly change the visual landscape. For mitigation of this impact, proper landscaping will have to be done and an overall Landscape Plan will have to be prepared. Tree planting will be well organized and where possible vegetation and natural habitats will have to be restored or newly created

The contractor will ensure to prepare Site-Specific Management Plan (SSMP) including temporary traffic management, waste management plan, blasting management plan, oil spill management plan and HSE plan. The SSMP should be deliverable by the contractors and approved by both EPA and Project Lenders before construction commences. The Company will ensure adherence to the environmental legislation and regulations. The Company/contractor(s) will employ local labour as far as possible

Therefore, it is concluded that the proposed construction, installation, operation and decommissioning of Asrit-Kedam Hydropower Plant has low intensity of adverse impacts, likely to be of short term duration, moderate and of local consequences and are insignificant. A vigilant implementation of mitigation measures, along with CSR Plan and EMP will ensure that environmental impacts are managed, minimized and are within acceptable limit.

## 0.16. Transportation and Infrastructure Survey

Various transportation facilities are available for access to the weir and power house site mainly through the N-95 National Highway. The transportation rout includes the following:

- Transportation Route from Karachi Sea Port to Swat
- Transportation Route from Swat to Asrit (Weir Site)

Transportation through rail and through road, both are available for Karachi to Swat. Most of the way is covered through the motorways while from Hyderabad to Sukhur, National Highway shall be used. Following is the newly constructed Swat Expressway from Islamabad-Peshawar Motorway to Chakdara.

Figure 54 : Newly Built Swat Motorway



## 0.17. Construction Method and Schedule

Based on the project scope, bill of quantities, sequence of activities and their dependence on the expected hydrological conditions at the site, a construction period of approximately 5 years has been planned. The construction schedule assumes that the construction will be awarded to an experienced and qualified contractor with international experience in similar projects and understanding local conditions.

The construction sections for completing Asrit-Kedam Hydropower Project are largely classified into 3 sections such as the upstream Headworks section, Power Waterway section and the lower Power Station section to be planned for parallel construction.

Structure plan for Asrit-Kedam HPP consists of the following items.

- Weir and Sluiceway, Head Regulator and Desander
- Power Intake, Headrace Tunnel, Surge Tank, Vertical Pressure Shaft, Horizontal Steel Penstock and Wye branches, Tailrace Tunnel and Outlet
- Underground Powerhouse, Access Tunnel and Cable Tunnel etc.

Main concrete and steel structures are as following and once the concrete structure finishes, installation of steel structures begins. After preparing concrete structures, installation of steel structures will start.

- Concrete Structures
- Weir and sluiceway, head regulator and desander
- Power intake and outlet, lining concrete for headrace tunnel, vertical pressure shaft,
- surge tank and tailrace tunnel
- Backfill concrete for horizontal steel penstock and wye branches
- Underground powerhouse and outdoor switchyard

#### Steel Structures

- Penstock for horizontal pressure tunnel and wye branches
- Gates at sluiceway and gantry crane
- Gates at head regulator
- Gates at desander and intake
- Crane for powerhouse and transformer room, draft tube outlet gate
- Gates for tailrace outlet

The estimate of the construction time for each unit process was calculated in consideration of the construction performance of similar projects, and the result of construction period for each unit process is shown:

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
1. Headworks					
Relocation Road		L=430.0m	15.0m/day	1.1	
Dam & Weir	Concrete	H=28.5m (=19lift) W=71.4m	1lift/7day (H=1.5m) 2Team	5.3	
Head Regulator & Desander	Concrete	H=22.5m (=15lift) W=62.957m	1liftt/7day (H=1.5m) 2Team	4.2	
2. Power Waterway					
Intake	Concrete	L=25.0m B,H=7.4m	1Block/1month	2.0	
Work Adit for HRT	Excavation	L=300.0m B,H=10.8m	2.0m/day	5.0	
Headrace Tunnel(Pilot)	Excavation(NATM)	L=100.0m B,H=10.8m	2.0m/day	1.7	

#### Table 0-39 : Construction Period Bifurcation

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
Headrace Tunnel	Excavation(TBM)	L=10,167m D=8.3m	- Good (50%) 500m/month - Fair (30%) 400m/month -Poor (15%) 300m/month -Very Poor(5%) 100m/month	28.1	
Headrace	Excavation(NATM)	L=124.0m D=8.3m	2.0m/day	2.1	
Tunnel	Lining Concrete	L=500.0m D=7.4m (Form length=30.0m)	30.0m³/day	1.7	start pouring from 500m behind TBM
	Excavation(Pilot)	L=108.0m D=3.0m	2.9m/day	1.5	
Surge Tank	Excavation(Enlarge)	L=108.0m D=15.5m	2.5m/day	1.7	
	Lining Concrete	L=108.0m D=14.0m	1.5m/day	2.9	
	Excavation(Pilot)	L=131.5m D=3.0m	2.9m/day	1.8	
Vertical Pressure Shaft	Excavation(Enlarge)	L=131.5m D=8.8m	2.5m/day	2.1	
	Lining Concrete	L=131.5m D=7.4m	1.5m/day	3.5	
Steel popsteelz	Excavation	L=225.5m D=8.8-3.2m	3.0m/day	3.0	
Steel pensiock	Installation & Backfill Conc.	L=237.5m D=7.4-2.2m	1.0m/day	7.9	
Tailrace	Excavation(2Line)	L=300.0m B,H=6.3m	2.0m/day	6.0	
Tunnel	Lining Conc.(2Line)	L=300.0m B,H=5.5m	10.0m/3day	3.6	
Tailrace Outlet	Concrete (2Line)	H=14.0m (=7lift) W=6.5m	11iftt/5day (H=2.0m)	1.4	
3. Power Station					
	Excavation-1 (to Work-Adit Jt.)	L=273.0m B,H=7.7m	2.0m/day	4.6	
Access Tunnel	Excavation-1 (to Work-Adit Jt.)	L=142.7m B,H=7.7m	2.0m/day	2.4	
	Excavation-2 (to TR Room)	L=59.9m B,H=7.7m	2.0m/day	1.0	

Structure	Item	Size	Progress Rates	Construction Period(month)	Remarks
	Excavation-3 (to P/H Room)	L=109.0m B,H=7.7m	2.0m/day	1.8	
Work Adit for	Excavation	L=104.5m B,H=5.7m	3.0m/day	1.2	
Powernouse Cavern Arch	Lining Concrete	L=104.5m B,H=5.0m	10.0m³/day	1.0	
	Excavation-1 (to Work-Adit Jt.)	L=188.0m B,H=5.7m	3.0m/day	2.1	
Cable Tunnel	Excavation-2 (to TR Room)	L=58.5m B,H=5.7m	3.0m/day	0.7	
	Lining Concrete	L=246.5m B,H=5.0m	10.0m³/day	2.5	
Work Adit for	Excavation	L=146.0m B,H=5.7m	3.0m/day	1.6	
Penstock	Lining Concrete	L=146.0m B,H=5.0m	10.0m³/day	1.5	
Powerhouse	Excavation	W=20.0m H=38.8m L=88.0m V=39,000m <sup>3</sup>	220.0m³/day	5.9	
	Frame Conc.(1st)	H=26.2m (=13lift)	1lift(H=2.0m) 2Team	4.3	
Transformer Room	Excavation	W=18.0m H=12.7m L=91.5m V=20,250m <sup>3</sup>	220.0m³/day	3.1	
IPB Tunnel	Excavation	W=6.5m H=6.3-10.1m L=15.0m	3.0m/day	0.2	

# 0.18. Bill of Quantities and Cost Estimation

The following table shows the EPC Cost Estimate.

CODE	DESCRIPTION	Total (PKR)	Total (USD)
А	Civil Works	35,092,134,539	200,526,483
2	Roads	1,026,400,000	5,865,143
3	Diversion Works and Cofferdam	1,832,958,154	10,474,047
4	Spillway	4,004,937,388	22,885,357
5	Desander	6,095,259,168	34,830,052
6	Work Adit to Penstock	203,319,782	1,161,827
7	Work Adit to Powerhouse	142,277,441	813,014

CODE	DESCRIPTION	Total (PKR)	Total (USD)
8	Access Tunnel to TBM	546,451,820	3,122,582
9	Access Tunnel to Cavern	1,061,815,359	6,067,516
10	Headrace Tunnel (TBM)	16,004,012,711	91,451,501
11	Headrace Tunnel (NATM), 7.4 M(D), 152 m	288,588,342	1,649,076
12	Vertical Pressure Tunnel	294,687,316	1,683,928
13, 14, 15	Steel Penstock	842,588,346	4,814,791
16	Surge Tank D=4.5 m	25,176,761	143,867
17	Surge Tank D=14 m	487,541,335	2,785,950
18	Powerhouse (Earth Works)	951,530,981	5,437,320
19	Powerhouse (Earth Works) Transformer Gallery	169,345,168	967,687
18 & 19	Powerhouse & Transformer (Support)	9,388,137	53,646
20	Tailrace Tunnel	1,105,856,330	6,319,179
	Grand Total Cost of Civil Works	35,092,134,539	200,526,483
	Contingency @5% Of Grand Total Civil Works	1,754,606,727	10,026,324
	Total Civil Works Including Contingency	36,846,741,266	210,552,807
В	Total Cost of EMH Works	19,155,403,583	109,459,449
С	Preliminary Works & Other Costs	9,341,565,391	53,380,374
	Total EPC Cost	65,343,710,240	373,392,630

In detail Unit Rate Analysis was done.