

Implementation Plan for Hydroelectric Power Plant Shelek River in Almaty region

January, 2020



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Project Overview

Project Overview

 **Project** : Shelek Hydro Power Development Project in Kazakhstan

 **Type** : BOO (Build, Operation and Owning)

 **Location** : Middle reaches of the Shelek river

- Almaty Oblast in Kazakhstan
- Installed Capacity: 143.5 MW (3 Cascades of Hydro Power Plants)
 - HEPP-4 : E78°19'2.83", N43°3'32.12"
 - HEPP-5 : E78°20'53.8", N43°6'45.12"
 - HEPP-6 : E78°28'25.03", N43°16'22.69"
- Estimated Project Costs : 400 Million USD

 **Developer** : Kazgaztekhika LLP (CEO: Asadullin V.A.)

 **PMC** : GSP (Global Solution Partner)

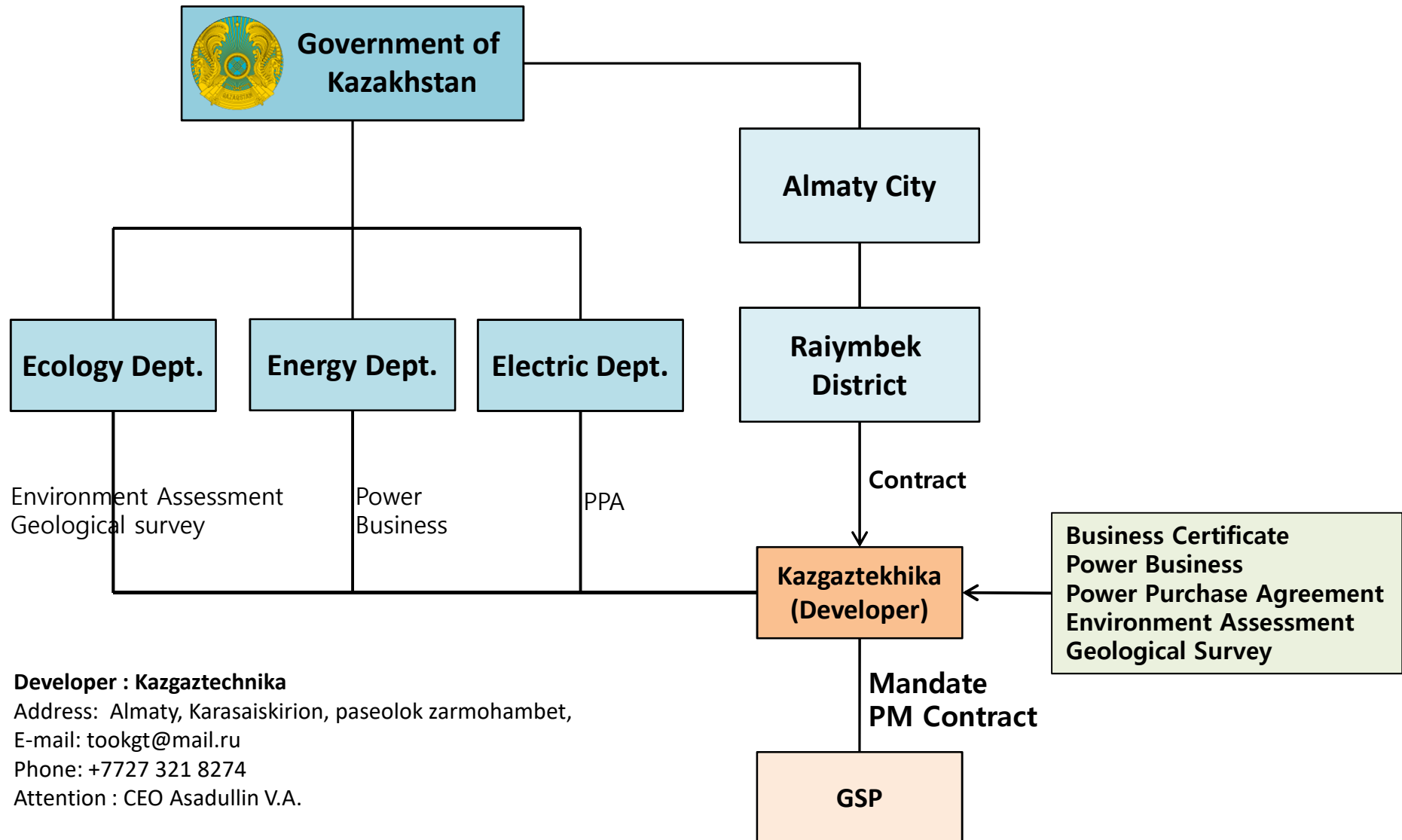
Project History

- '09.4.7: 카작 정부 “신재생 에너지 개발 지원법” Supporting the use of renewable energy sources” 발의
- '10.2.7: 중국 GEZHOUBA Group 사업 검토 및 개발계획 수립
- '10.3.15: Raiymbek시장 Shelek River 개발계획 승인
- '12.4.26: Kazgaztekhika와 중앙정부 에너지부와 전기구매계약 체결
- '13.1.25: 국가 신재생 에너지 개발 촉진화 계획 수립 (Resolution of Government of the Republic of Kazakhstan No.43)
- '13.5.30: Kazgaztekhika와 Almaty Energo Sbyt PPA계약 체결
- 2014 : 예비 타당성 평가 (Business Plan of the Project)
- '16.8.4: 지자체(Raiymbek)가 수력발전소 부지 9.5 Ha 개발제한 해지
- '16.8.4: Almaty Raiymbek 과 Kazgaztekhika LPP signed contract.
- '16.8.17 : Ecology Department가 환경영향 평가 승인

사업 개발 현황

순번	업무	주관	일자	내용	비고
1	사업개발 보고서 (2010)	GEZHOUBA Group	'10.2.7	터널공법 기반	
2	사업개발 보고서 (2014)	Kazgaztekhika LLP	2014	Penstock 공법 기반	
3	사업허가	Department of Energy	'12.4.26	Kazgaztekhika 사업자	
4	지자체 승인	Almaty Raiymbek	'16.8.4	사업부지 규제 해제	
5	환경영향 평가	Ecology Department	'16.8.17	환경영향 없음, 사업승인	
6	PPA 계약	AlmatyEnergoSbyt.	'12.4.26	'19.10.28 갱신, 20단계	
7	GSP PMC 계약	Kazgaztekhika	'19.10.2	Mandate 계약	
8	금융 협의	Castlepine	'19.9	F/S 제출 후 4개월	
9	한국팀 구성	GSP	'19.10.29	GSP, 한수원, 삼안, 평화	
10	현장평가	삼안, 평화	'19.11.11	현장 실사 (1주일)	
11	타당성평가 보고서 (2020)	삼안, 평화	TBD		
12	EPC 선정	GSP	TBD		

Project Developer Scheme



Developer : Kazgaztekhika

Address: Almaty, Karasaiskirion, paseolok zarmohambet,

E-mail: tookgt@mail.ru

Phone: +7727 321 8274

Attention : CEO Asadullin V.A.

Signing between Kazgaztekhika and GSP

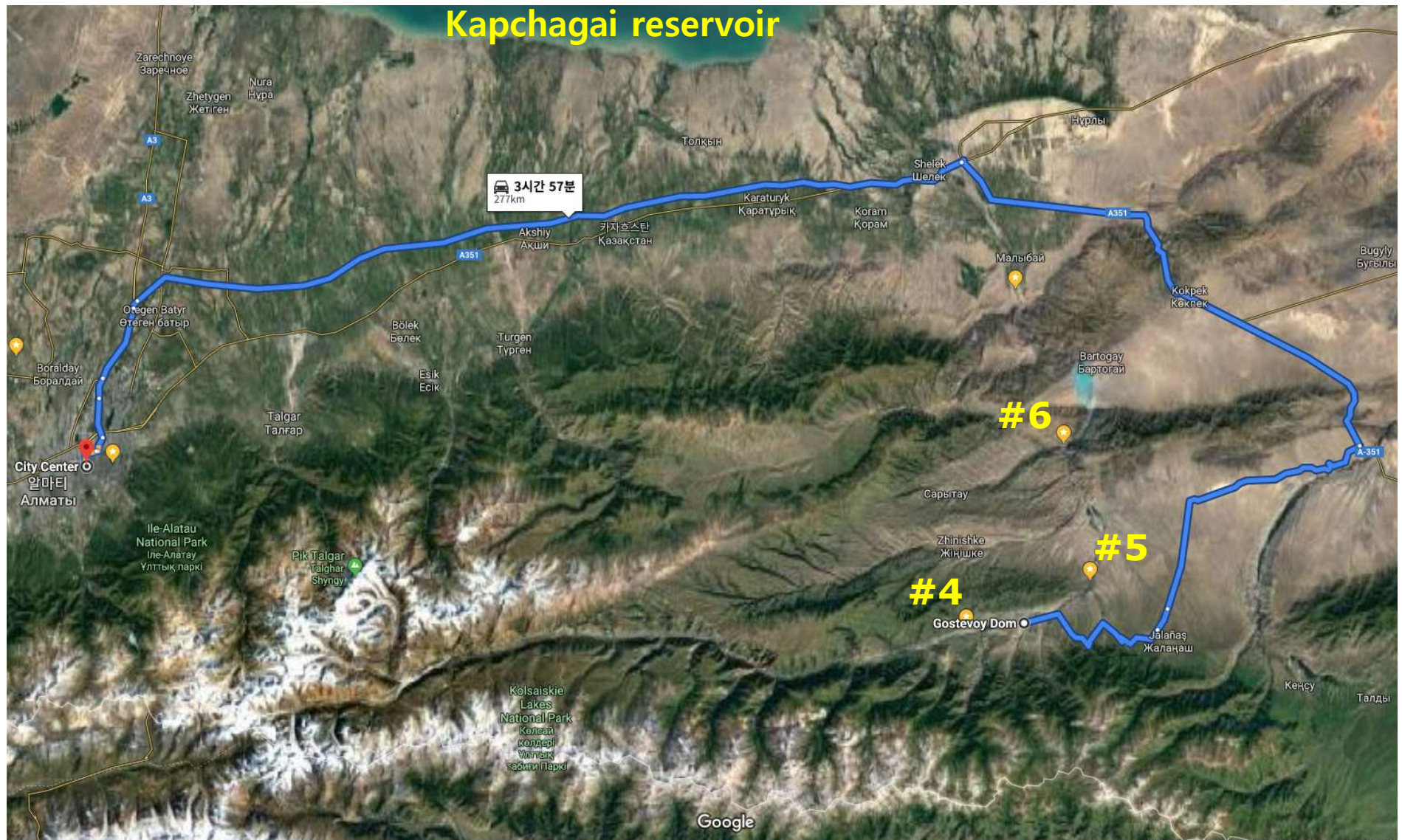


Project History – Korea Team

- '19.8.19: 한수원 협의 및 한수원 참여의향서(LOI) 제출
- '19.9.30~10.6 : Kazgaztekhika 방문 및 GSP와 협약(10.2) 체결
 - 수력발전소 현장 방문 및 실사(10.3)
- '19.10.29: (주)삼안, (주)평화 기술협의 및 참여의향서(LOI) 제출
- '19.11.11~11.16: (주)삼안, (주)평화 현장 실사
- '19.11.18: (주)삼안, (주)평화 기술협의 (출장 결과 중심의 기술협의)
- '19.11.19: 참여기관 1차 통합 기술협의
- '19.11.25: (주)삼안, (주)평화 기술협의 (개발 방안 협의)
- '19.12.9: 참여기관 2차 통합 기술협의
- '19.12.26: Pre-F/S 추진을 위한 협의 (계약, 기술)

참여기관: (주)GSP, (주)삼안, (주)평화, (주)TJG

Location of HEPP on the Shelek River (발전소 위치)



Saty Saty (4호기 부근)



현장



현장

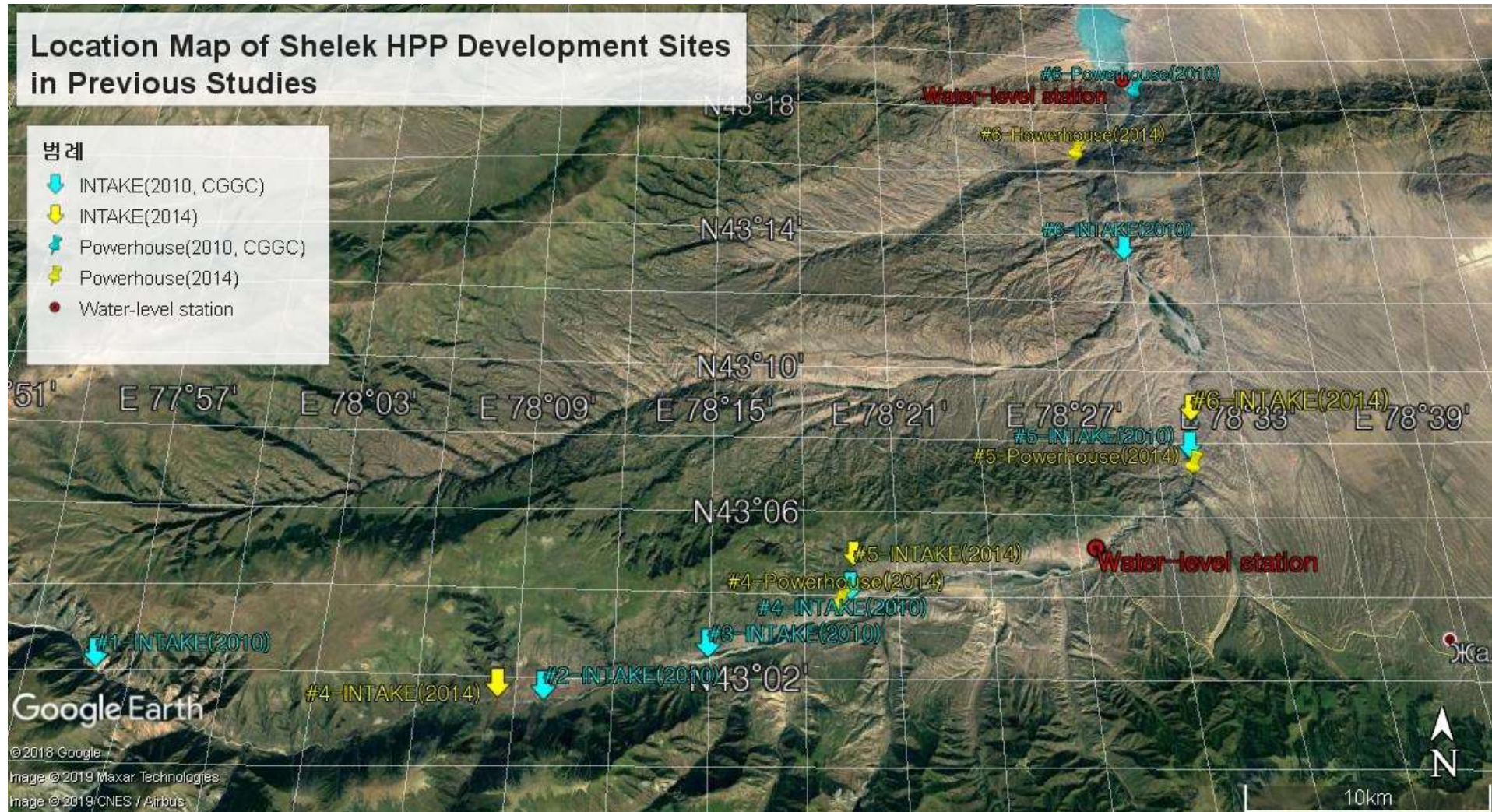


Previous Study

카작 2014

중국 2010

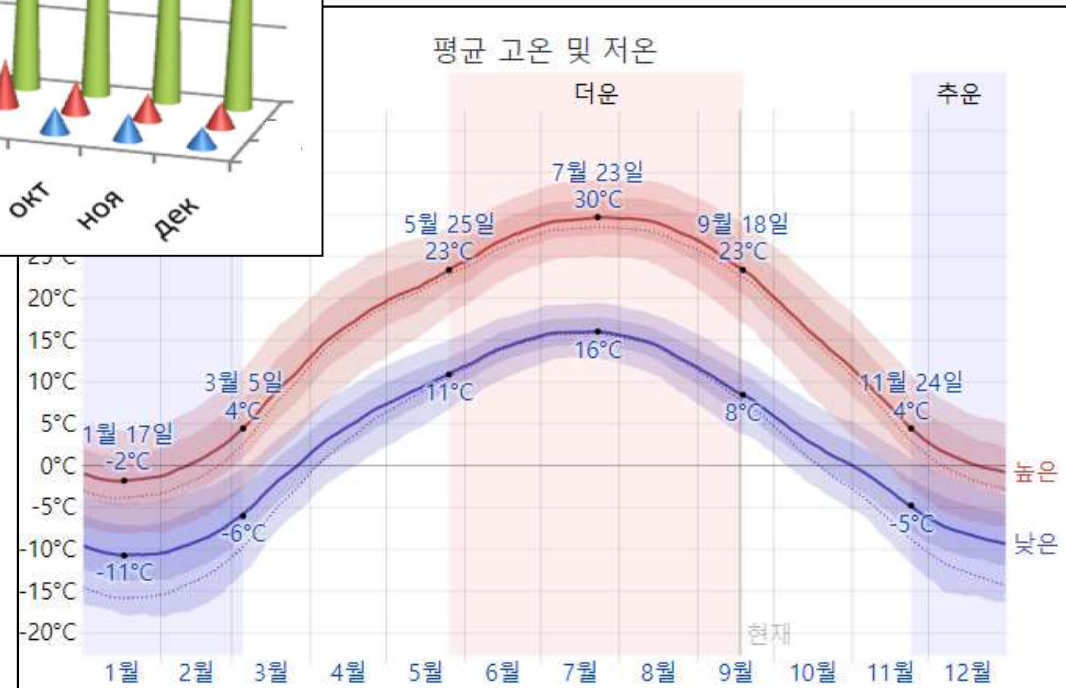
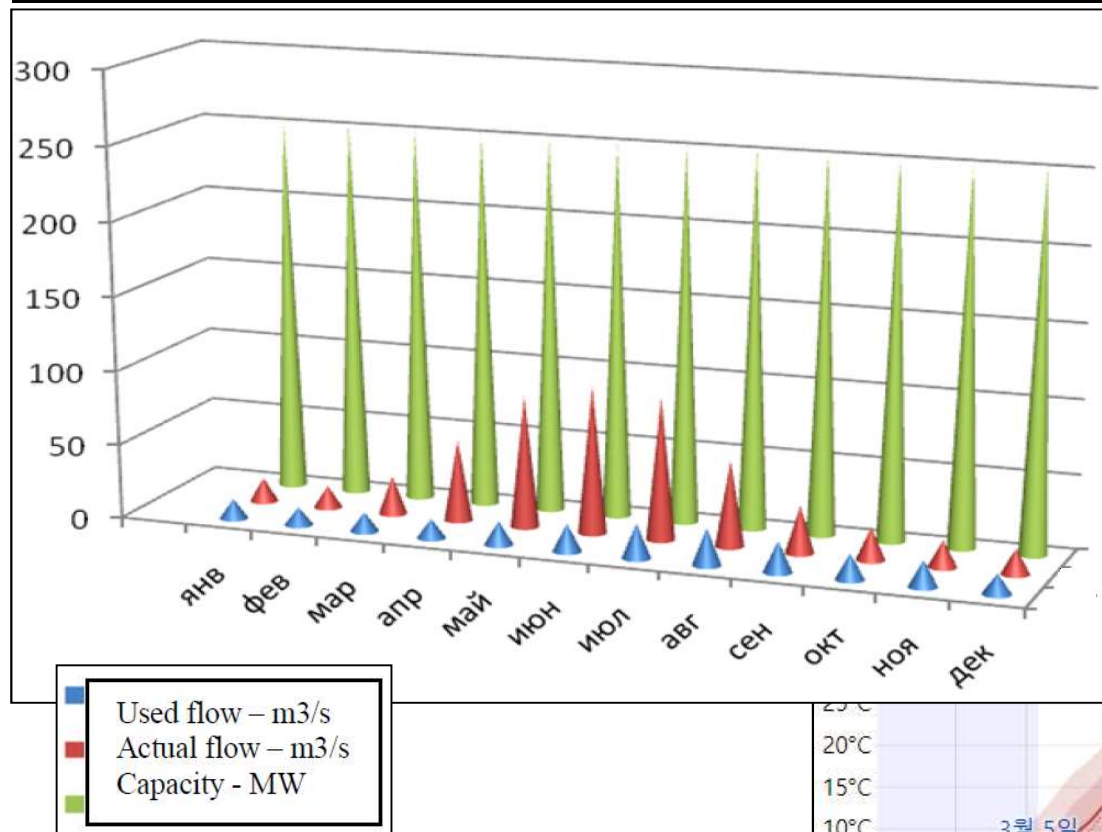
Location Map – Previous Study



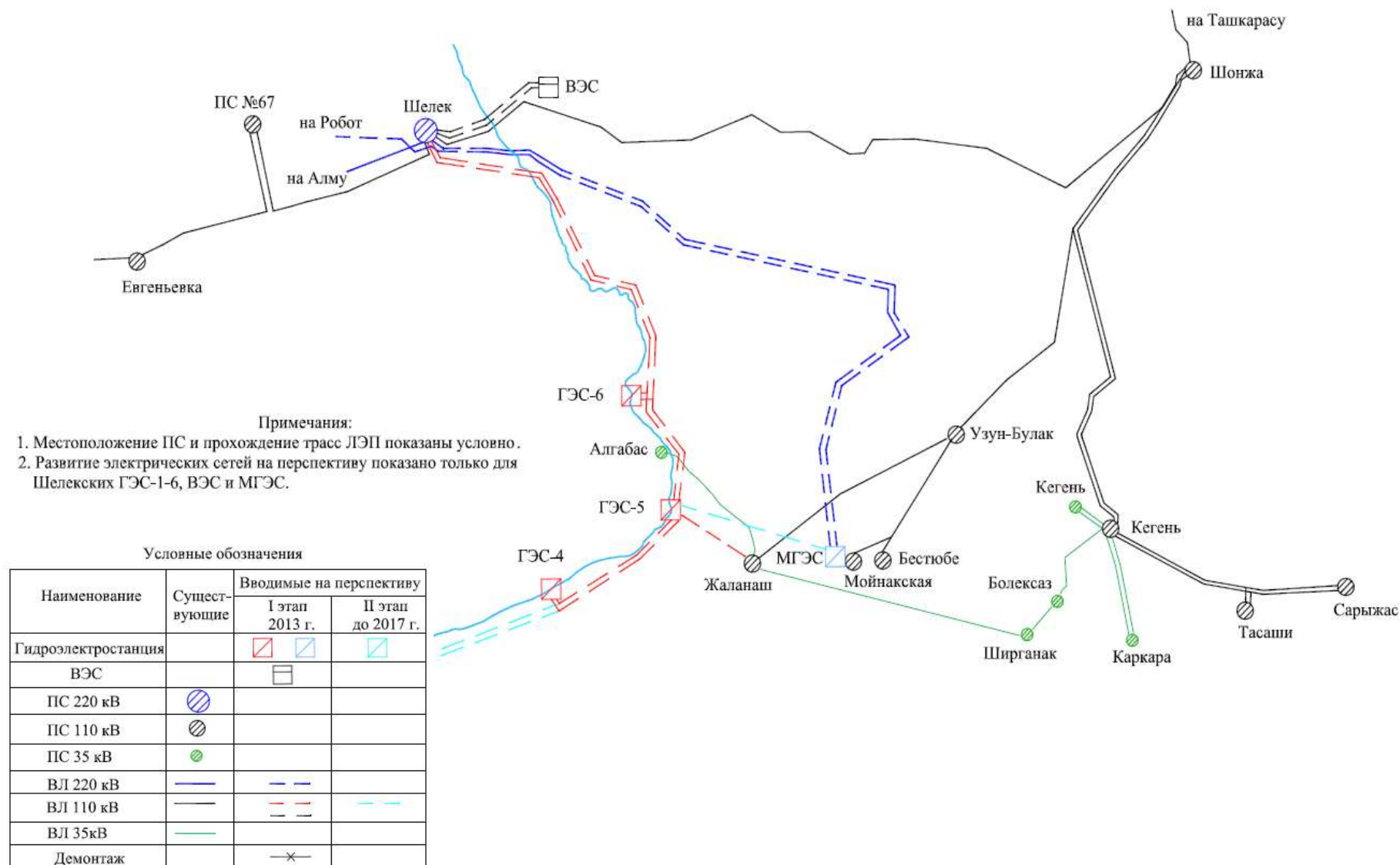
Installed Capacity

HPP		Catchment Area (km ²)	Design Turbine Flow (m ³ /sec)	Turbine Head (m)	Installed Capacity (MW)	Firm Power (MW)	Plant Factor (%)	Annual Energy (GWh/yr)	Annual Operation hour (hrs/yr)	Q _{25%} Flow	Optimum Installed Capacity ^(*1) (MW)
# 1	China	1,156	25	307	63.5	23.8	52	291	4,583	16.4	41.5
# 2	China	1,601	32	96	26.5	10.3	54	126	4,755	22.7	19.0
# 3	China	1,639	34	77.6	20.5	8.5	58	104	5,073	23.3	14.0
Total					110.5	42.6	53	521			
# 4	China	1,639	34	162	44.0	17.8	56	217	4,932		
	Kazak		29.5	180	46.0		89	361			
# 5	China	1,639	34	81.7	23.5	9.0	53	110	4,681		
	Kazak		29.8	180	46.0		89	361			
# 6	China		82	113	76.0	27.4	51	342	4,500	51.3	47.5
	Kazak	3,612	34	180	51.5		89	404			
Total	China				143.5	54.2	53	669			
	Kazak				143.5	-	89	1,126			

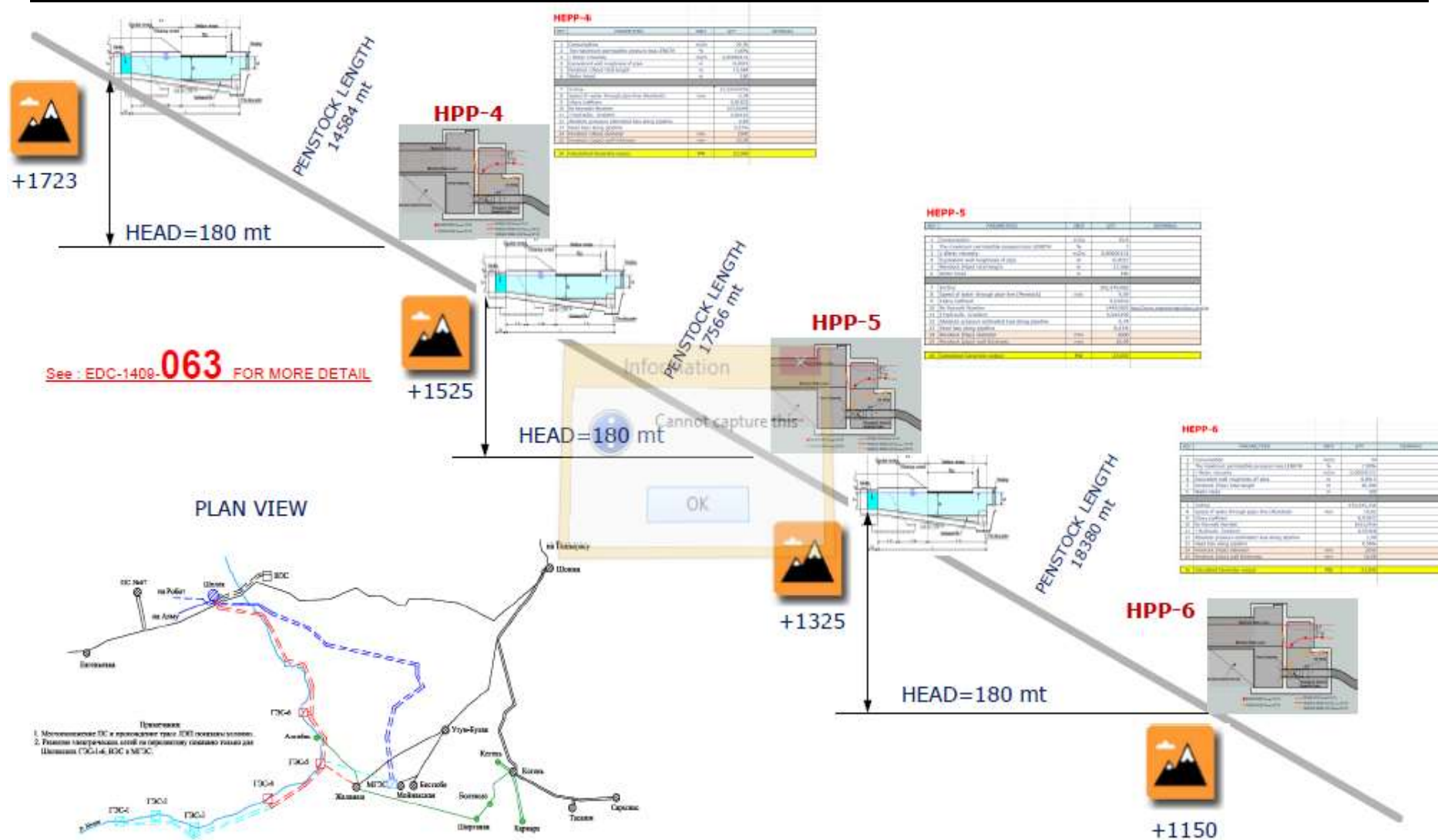
Water flow & Temperature Annual time



Grid Connection



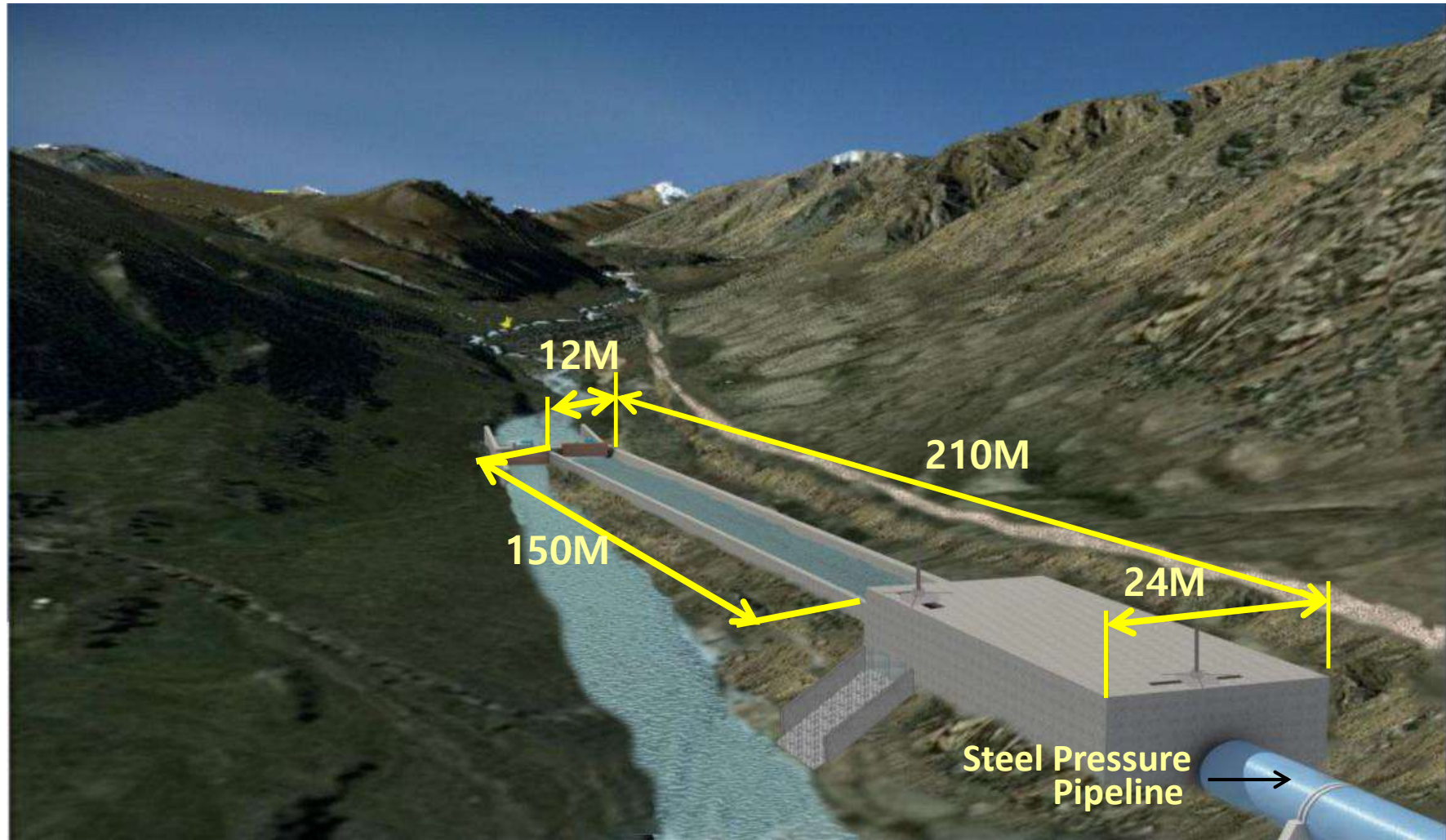
(Business Plan, 2014)



Hydropower Plant Whole View



Intake Structure



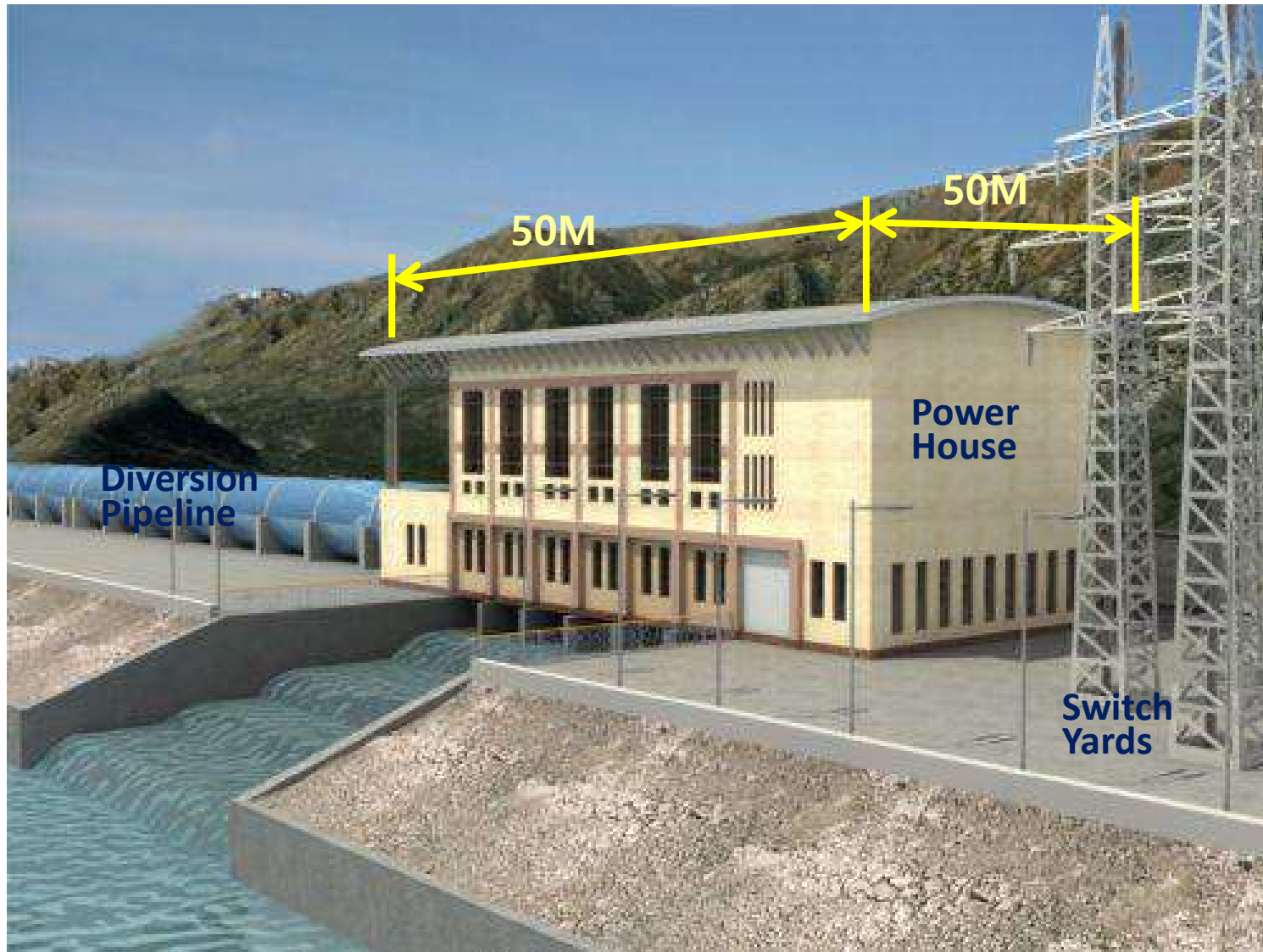
Closure Dam



HEPP Buildings



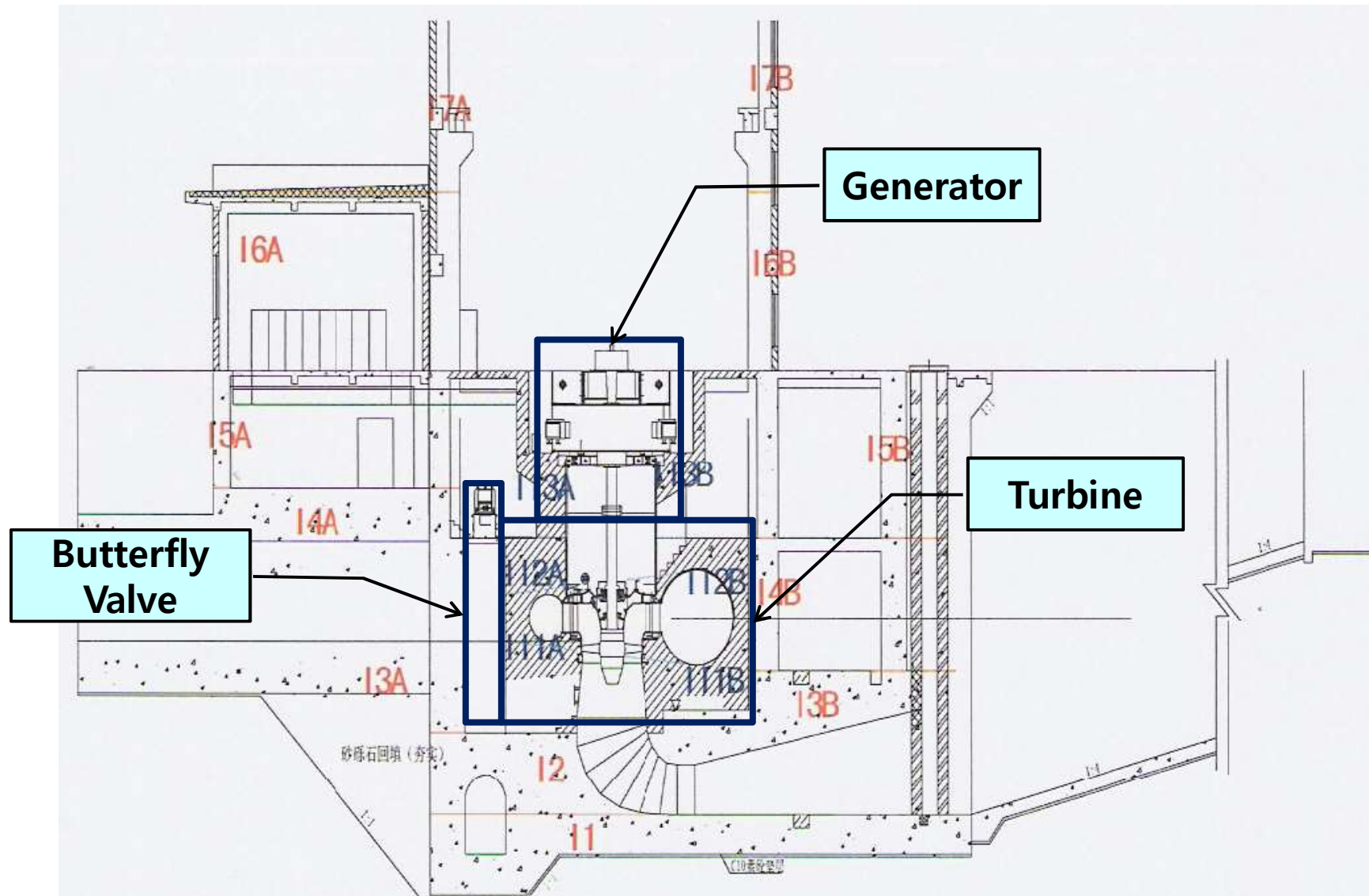
HEPP Buildings



Mechanical Equipment

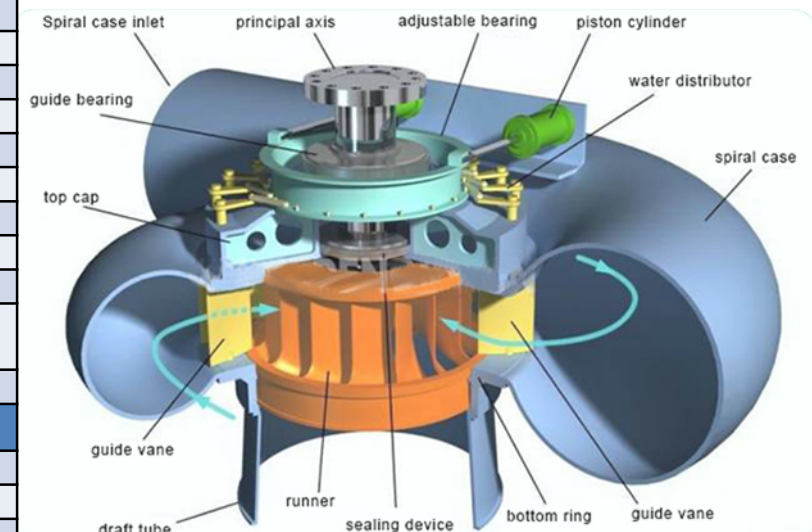
- WATER SUPPLY EQUIPMENT
- TURBINE
- SPIRAL CAMERA DRAINAGE EQUIPMENT
- WATER COOLING EQUIPMENT
- HYDRAULIC ADJUSTMENT EQUIPMENT
- GENERATOR
- ELECTRICAL EQUIPMENT

Concept for Francis Turbine Design



Francis Turbine

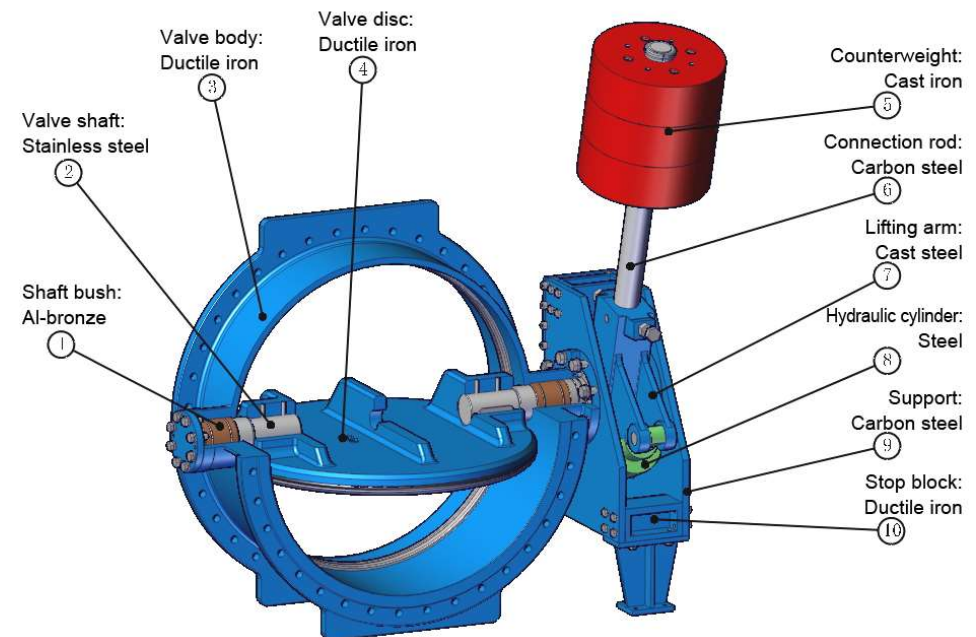
Type	Vertical Radial Axial (Francis, Francis) turbine with spiral chamber from steel sheets and suction pipe FSV1600F4
Number of units	2
Rated flow	15,0 м ³ с ⁻¹
Net head	170,77 м
Turbine power	22 490 кВт
Impeller diameter	1600 мм
Rated speed	600 мин ⁻¹
Acceleration Speed	940 мин ⁻¹
Suction lift	-5,60 м
Turbine Guide Bearing	
Type of	plain bearing
Number of units	1
Lubricant	Oil
Cooling	with water cooler immersed in an oil bath
Turbine servo motor	
Type of	Double Acting Servo Motor
Number of units	2
Piston diameter	Will be specified in the technological project
Piston rod diameter	Will be specified in the technological project
Full speed	Will be specified in the technological project
Volume (total)	2x 6 dm ³
Working stroke	Will be specified in the technological project
Operating pressure	11 ÷ 13 MPa
Position Sensor Type	induction linear
Manufacturer	Balluff GmbH - Germany
Positional sensor	
Position Sensor Type	BTL5E10
Turbine stuffing box	
Type of	mechanical radial
Seal Type & Materials	Graphite rings
Cooling method	using filtered water



Water Supply Equipment Butterfly Valve



Type	Hydraulic actuated butterfly valve with counterweight
Number of units	2
Nominal Diameter	DN 2000
Pressure Rating	PN 25
Bypass	
Nominal Diameter	DN 150
Pressure Rating	PN 25
Servomotor	
Type of	single side hydraulic servo motor actions
Maximum Pressure	25 MPa
Operating Pressure	10 MPa



Generator

Type of	vertical, synchronous, 3-phase, with external thyristor excitation
Number of units	2
Rated voltage	10 500V $\pm$ 5%
Rated apparent power	26 458 kVA
Power factor	0.85 main
Active power	22 490 kW
Rated frequency	50 Hz $\pm$ 1%
Rated speed	600 rpm ⁻¹
Acceleration Speed	940 min ⁻¹
Acceleration Period	Max. 10 min
Stator wiring	6 wire star
Class	S1
Insulation class	F
Class pace. windings	B
Insulation	IP 44 (23)
Cooling	closed air circuit through water coolers (IC8A1W7)
The form	IM 8421
Moment of inertia	Will be specified in the technological project
Total weight	Will be specified in the technological project
Type of arousal	external static thyristor kit with AVR, etc.
Top bearing	
Type of	Combined angular contact and directional plain bearings
amount	one
Grease	Oil
Cooling	by immersion water cooler in the oil bath of the oil tank
Lower bearing	
Type of	plain bearing
amount	one
Grease	Oil
Cooling	by immersion water cooler in the oil bath of the oil tank



Overview of Pre-F/S

업무 개요

■ 수압철관(Penstock)과 수로터널(Tunnel) 방식 병행 비교 분석

- 구 소련 데이터 (1928~1985) 분석과 현장 실사 결과 경제성 있음
- Case I : 수압철관 방식 (2014 Business Plan 기준)
- Case II : 수로터널 방식 (한국팀 제안)

■ 현장 실측자료 분석을 토대로 발전량 재 검증

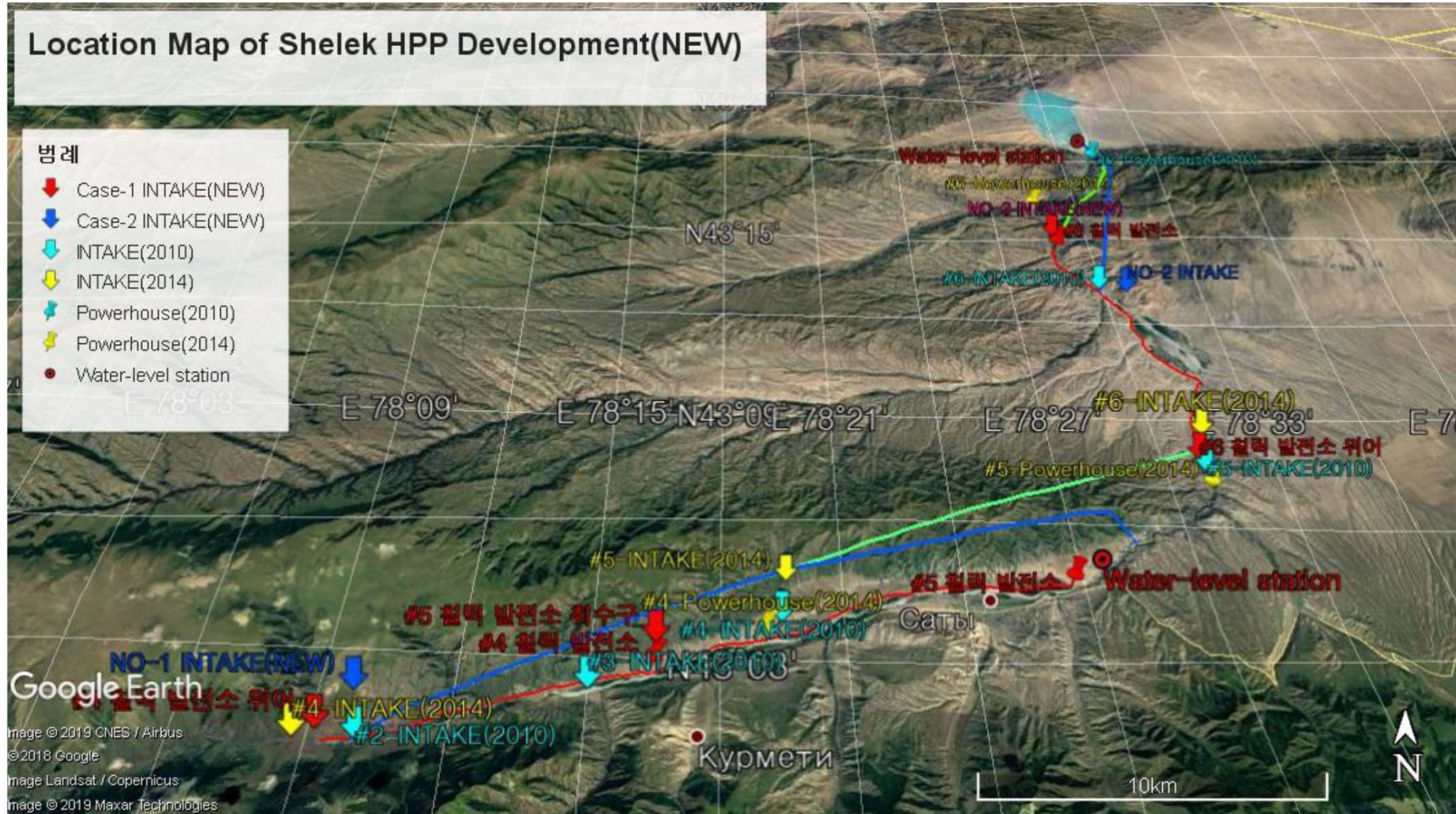
- 수압철관 방식은 2014년 Business Plan 검토를 기준으로 평가
- 수압철관 방식에 소요되는 자재 구매, 제작, 운반 및 설치 비용을 고려
- 6호기는 지형 구조상 터널 방식이 적합 (40MW)

■ 6호기는 터널 방식으로 개발

- 터널 길이 및 댐 설계에 대한 경제성 평가
 - 1안: 터널 5Km, 댐 40~50M, 환경영향평가
 - 2안: 터널 10km, 댐 10~15M

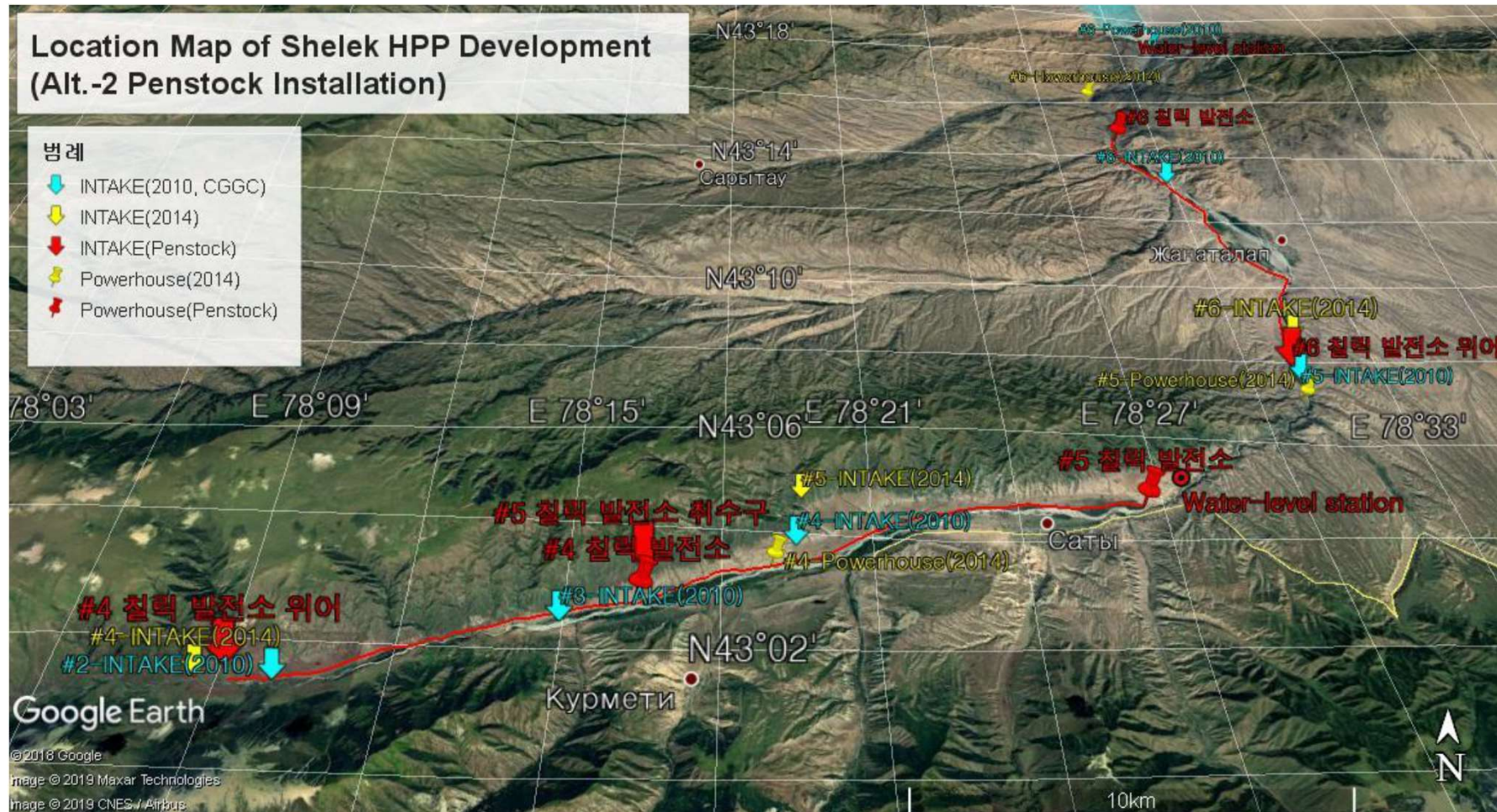
추진 방향

공사비 비교를 통해 수로형식 비교 검토: 제1안(수압철관), 제2안(수로터널)



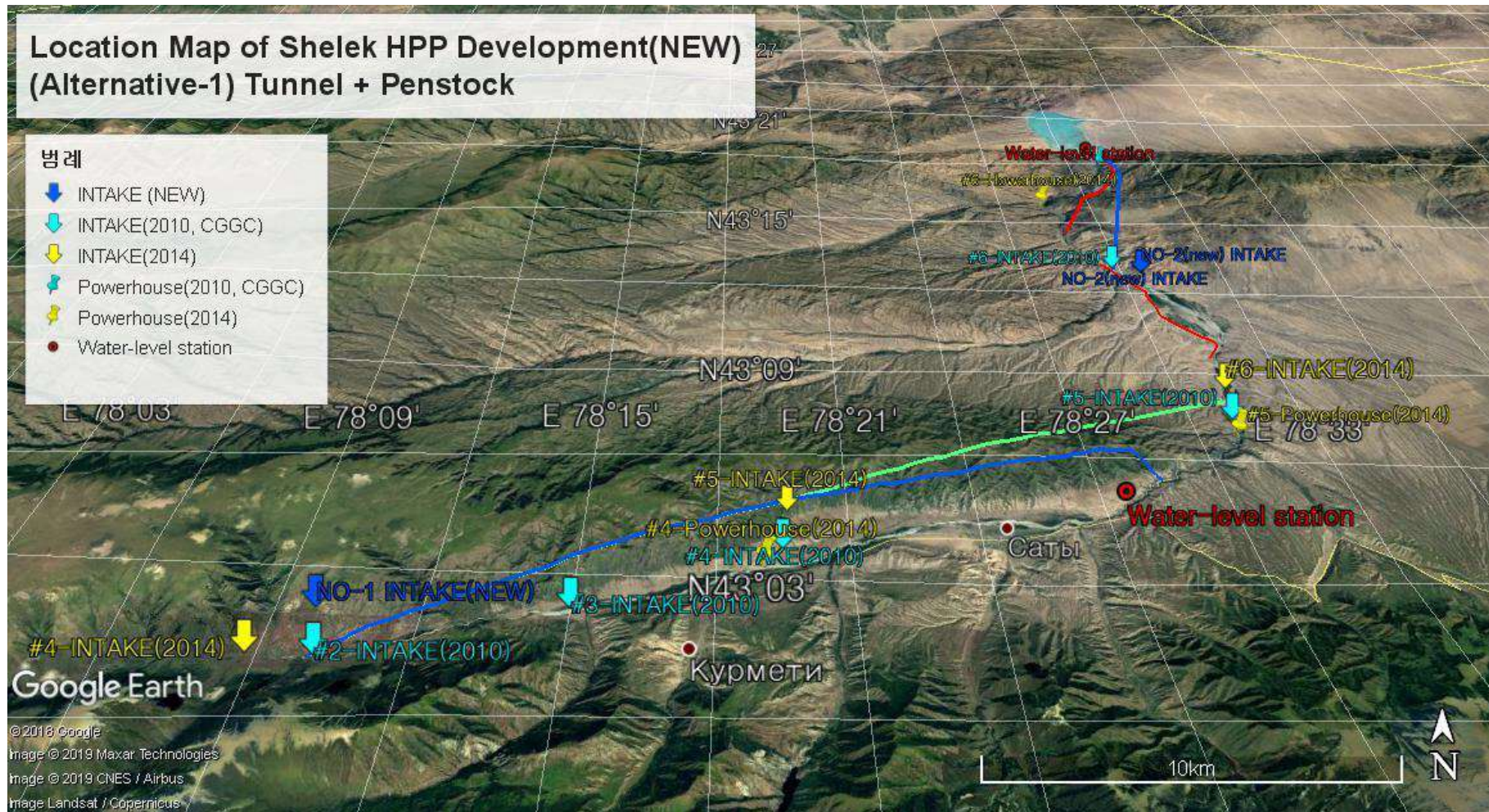
제1안 (수압철관)

- 기계설비를 통한 수격압 저감방안 검토 (MAVEL 기술협력)
- 수로터널과 조합도 다능



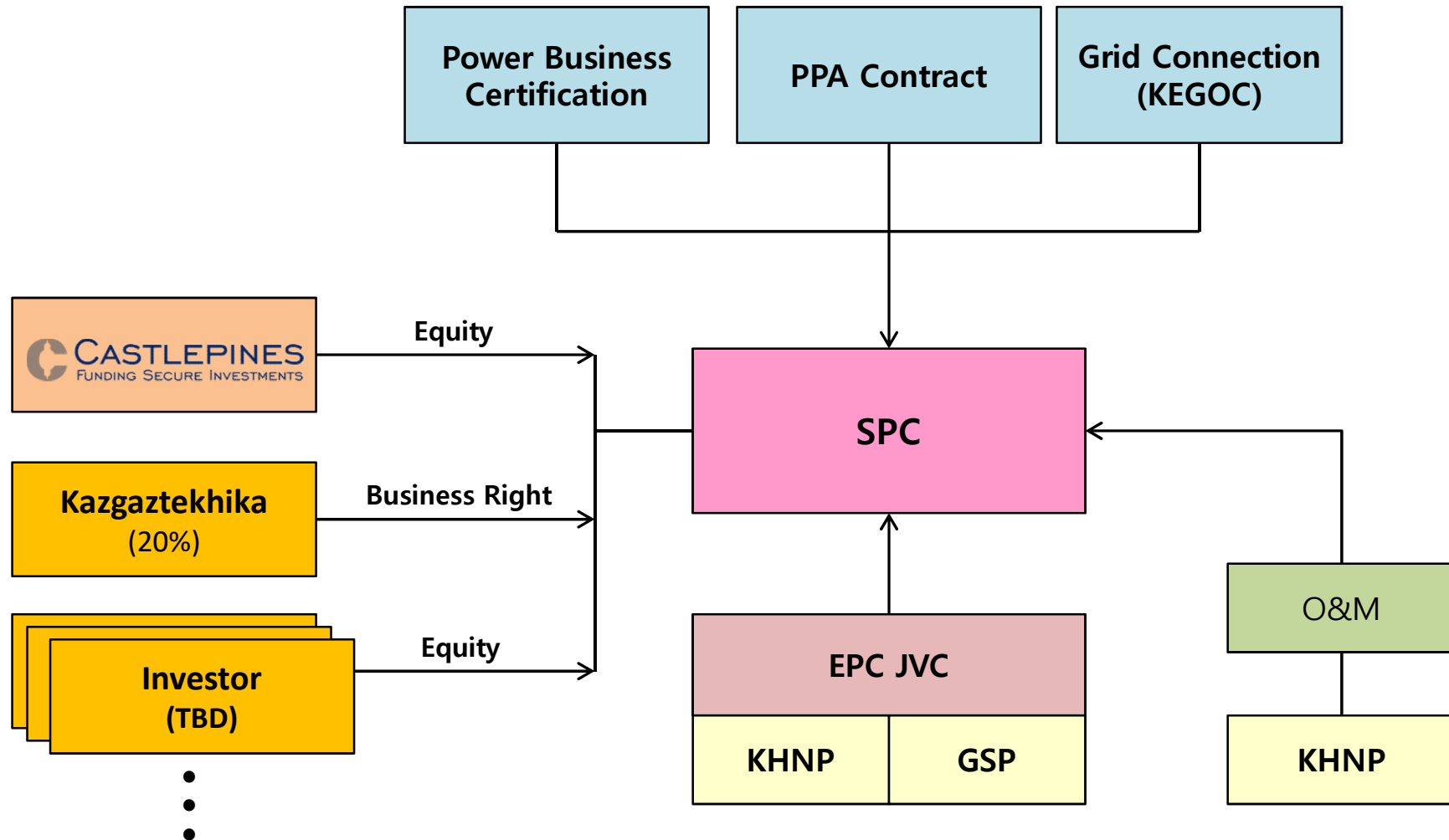
제2안 (수로터널)

- 수압철관, 수로터널 건설비용에 따라 조합도 가능
- 재무분석 결과에 따라 일부 호기만 개발 가능



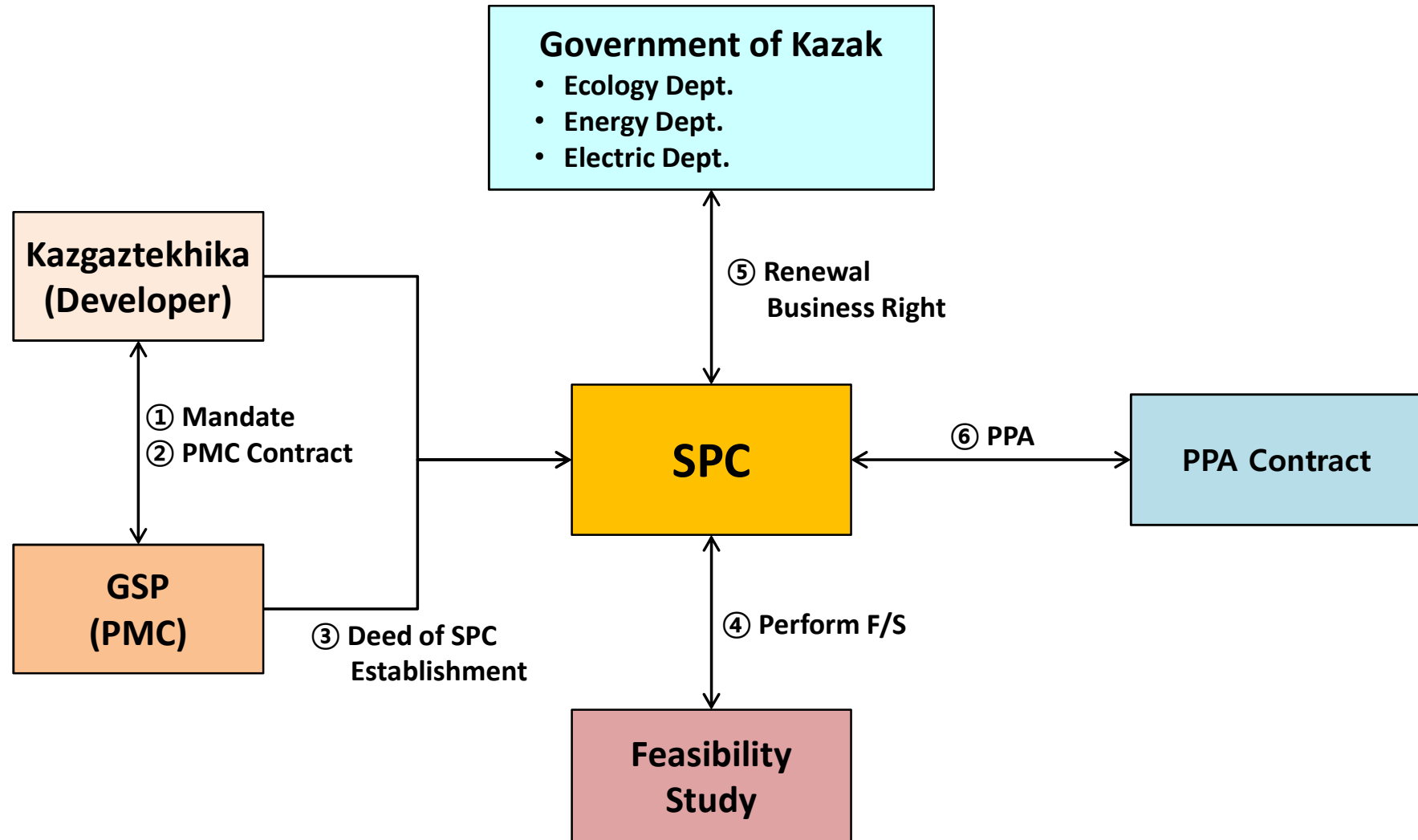
Project Execution Strategy

Project Stakeholder Structure



KEGOC: Kazakhstan Electricity Grid Operating Company

IPP Implementation Scheme

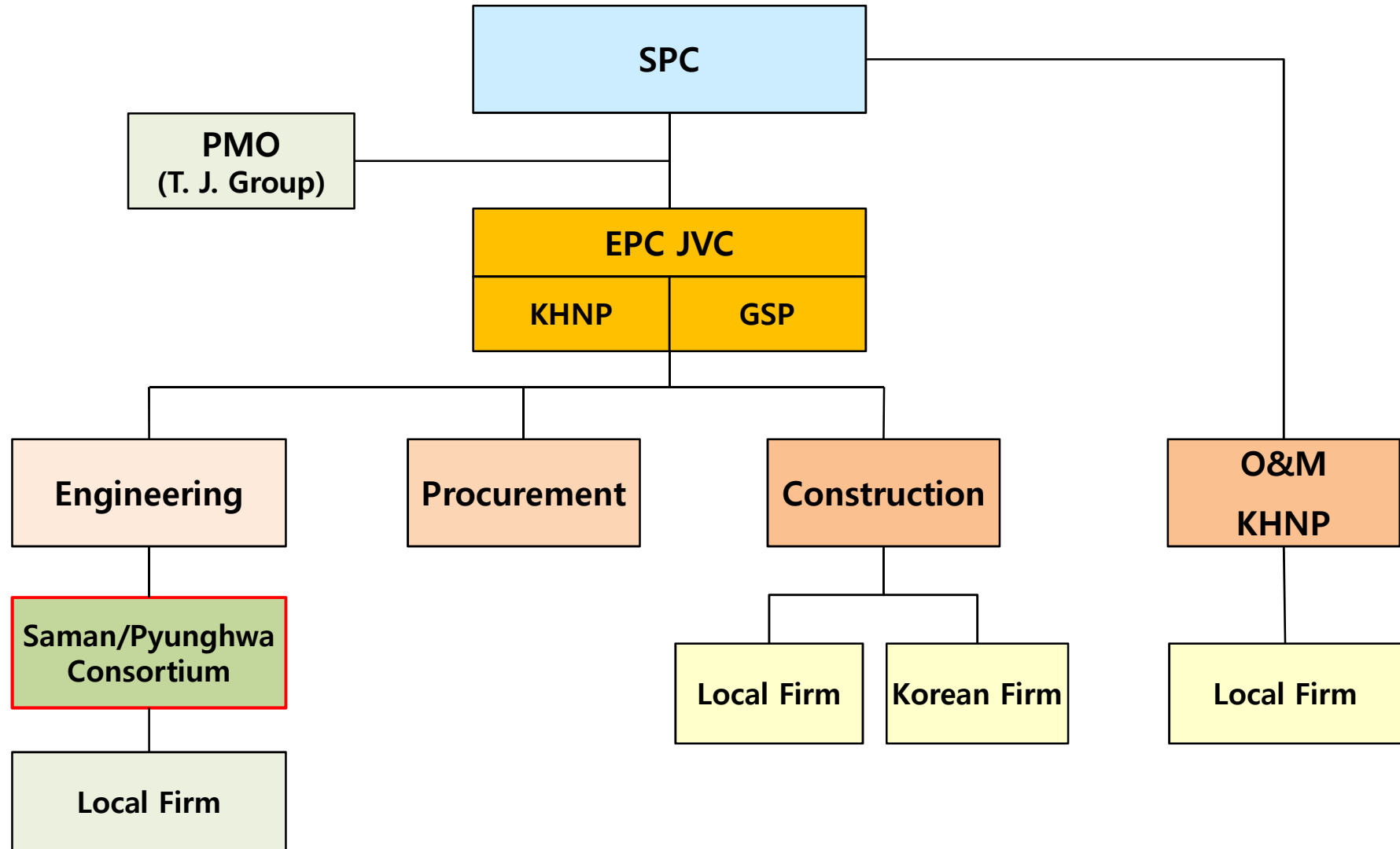


Project Overall Time Schedule

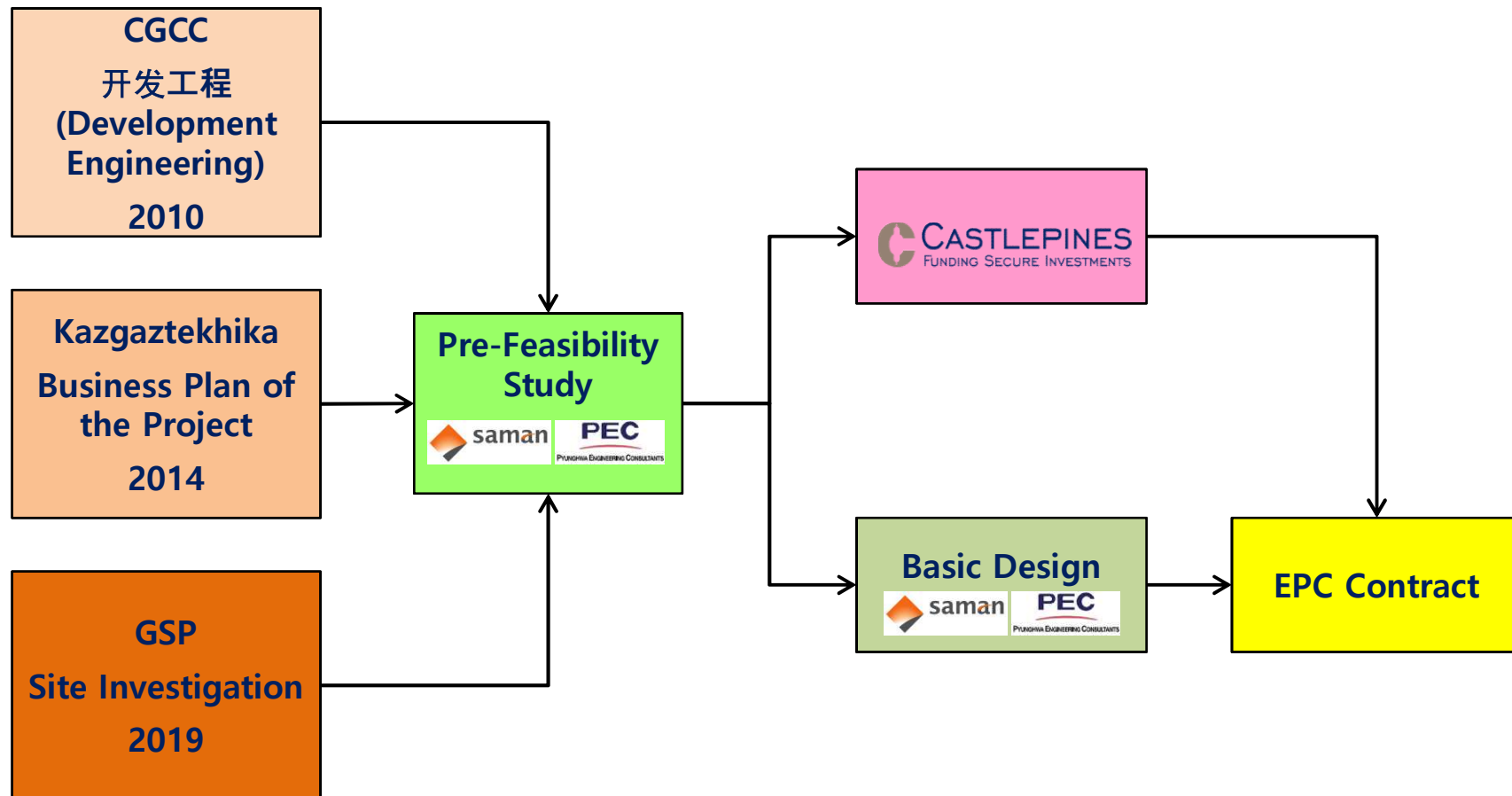
#	Work Activity	Duration (Mon.)	Scope	Remark
1	Mandate and PMC Contract (협약체결)	1 week	GSP/KZKA	Finish
2	Deed of Special Purpose Company Establishment (SPC설립)	1 week	GSP/KZKA	
3	Perform Feasibility Study (타당성 조사)	TBD	SPC	O
4	Renewal Business Right for Ecology Dept. (사업권 갱신)	N/A	SPC	
5	Power Purchase Agreement with Energy Dept. (PPA체결)	1 week	SPC	
6	Financial Closing (Credit Agreement) (투자자금 투입)	4 month	SPC/GCE	
7	Perform Basic Engineering for EPC Bidding	TBD	SPC	O
8	Bidding EPC and Contract	1~2 weeks	SPC	
9	Start Construction (EPC)	36 month	EPC	
10	Finish and Commercial Operation	3 month	SPC	

KZKA: Kazgaztekhika, GCE: Global Castlepine Equity

Project Organization



Project Development Process



Financial Analysis

(Developer's Data)

Plant Basic Data

No.	ITEM	Data	Unit	Remark
1	Operation Year	25	Year	TBD
2	Plant Location HEPP-4	E78°19'2.83", N43°3'32.12"	-	
3	Plant Location HEPP-5	E78°20'53.8", N43°6'45.12"		
4	Plant Location HEPP-6	E78°28'25.03", N43°16'22.69"		
5	Electricity Tariff	0.079	USD/kwh	
6	Estimate Interest Rate for Loan	3.5	%	
7	Estimate Discount Rate for Loan	5.5	%	
8	Local Government Invest to SPC	NONE	-	IPP
9	Cooperate Tax	20%	%	
10	Depreciation Year	20	Year	
11	Payback Period	10	Year	

Costs by Types of Work

(업무별 사업예산)

#	Work Activity	HEPP4	HEPP5	HEPP6	Total	Ratio
1	Preparation Works	68,877	63,856	69,547	202,280	50.6%
2	Derivation channels and tunnels, Water-fencing Structures			20,662	20,662	5.2%
3	Water-intake tunnel and Regulating facility	75,280	30,420	5,090	110,790	27.7%
4	Intake Chamber and Closure Dam	6,644	5,372		12,016	3.0%
5	Front Basin				0	0.0%
6	Surface Building	11,067	12,538		23,605	5.9%
7	Underground Building			30,647	30,647	7.7%
Total (1000USD)		161,868	112,186	125,946	400,000	100.0%
원화 (억원)		1,942	1,346	1,511	4,800	1,200원
Share of costs on each HEPP in the total volume		40.5%	28.0%	31.5%	100.0%	

Source of Income

No.	Facility	Capacity (MW/h)	Normal Power (MW)		Internal Consumption (MW)		Power Loss (MW)		Electric Power for Sale (MW)		PPA	Revenue (USD'000) (Excluding VAT)	
			Month	Annual	Month	Annual	Month	Annual	Month	Annual		Month	Annual
1	HEPP-4	46.0	33,580	402,960	79.759	957.11	3,358	40,296	28,394	361,706.9	0.071	2,127	25,519
2	HEPP-5	46.0	33,580	402,960	79.759	957.11	3,358	40,296	30,142	361,706.9	0.071	2,127	25,519
3	HEPP-6	51.5	37,595	451,140	89.296	1,071.55	3,759.5	45,114	30,142	404,954.5	0.071	2,381	28,571
Total		143500	104,755	1,257,060	248.814	2,985.76	10,475.5	125,706	88,678	1,128,368	-	6,634	79,609

Financial Analysis

No.	ITEM	Value	Remark
1	Total Investment	\$400,000,000	
2	Discount Rate	5.5%	at the level of refinancing rate of NB RK
3	Net Present Value (NPV)	645,273	
4	Internal Rate of Return (IRR)	18%	
5	Investment Profitability Index (PI)	2.61	
6	Discounted Payback Period (PP)	8.3 Years	
7	Payback Period (PP)	6.9 Years	
8	Net Profit Margin	79%	
9	Annual Payments to the Treasury	46,717,000	In average

