6-2-3 Issyk-Ata-2 Site

In Issyk-Ata River, flowing down from the north slope of Kyrgyz Range to Chui Valley, Issyk-Ata-1 SHPP has been constructed in 2008 and now in operation. Issyk-Ata-2 is a new SHPP potential site located upstream of existing Issyk-Ata-1 SHPP.

According to the information provided from KSTC, major features of Issyk-Ata-2 are 3.6 MW in output, 3.4 m^3/s in maximum discharge and 120 m in head.

(1) Conditions on Access to the Site

- There is a trunk road in a good condition between Bishkek and Kant Town, about 23 km east of Bishkek. From Kant to the site, 48 km upstream of Kant, there is a local road, which is paved and in a good condition for travelling of vehicles.
- At the south end of the local road, there is a spa resort. Site around this spa resort seems Issyk-Ata-2 site.
- The route map from Bishkek to the Djardy-Kainda site is shown in Figure 6-2-12.

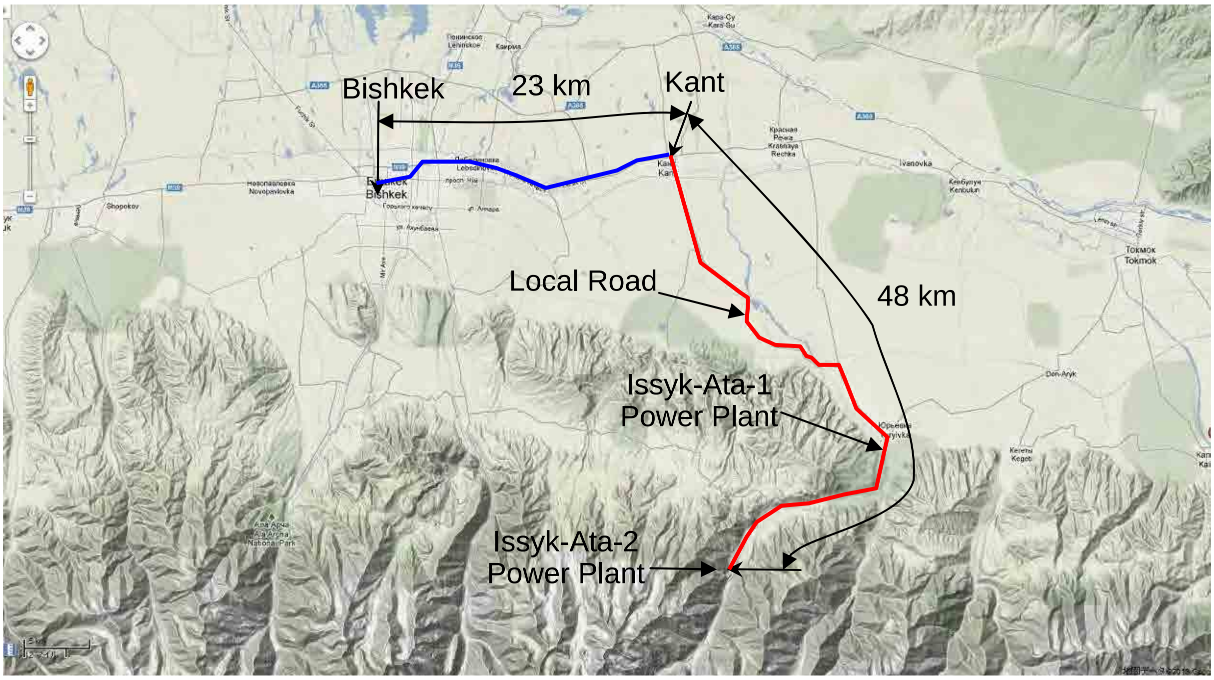


Figure 6-2-12 Route Map to Issyk-Ata site

(2) Findings from Site Survey

1) Conditions around the site

- Site near spa resort areas at the end of the local road seems a Issyk-Ata-2 (new) potential site. A small-scale concrete open-channel is found at upstream end of the spar resort area. This channel is believed to be a headrace of an abolished small-scale hydropower plant with several kWs of an output. At present, a small hotel is built on the abolished powerhouse. (N42° 35'39.0", E74° 54'18.6"/EL.1,906 m)

1) River flow discharge and Route Selection

- The river flow discharge is estimated at 0.5 m^3/s or less. (smaller than that at Kegeti site) The river gradient around the site is about 1/15. (1/10 or less upstream of this point)
- It is better to locate a SHPP more upstream of this site taking into account the spa resort. However, there is no access road upstream of the spa resort.

2) Conditions on Distribution and Transmission Line

- About 6km down the stream of Issyk-Ata River from the candidate power station location, 220kV Ala-Archa - Bystrovka transmission line lies east and west; however, the direct distance to Ala-Archa substation (220/110/10kV), the nearest substation, is more than 30km, and that to Bystrovka substation (220/110/35kV), another terminal substation of the line, is more than 60km. Therefore, it is not practical to connect to the transmission system at either of substations. The location of the nearest 35/10kV distribution substation was not able to be identified during the site investigation although there was existing 10kV and 0.4kV distribution lines to the candidate intake point. According to the information provided by JSC Severelectro; however, there should be a 35/10kV distribution substation close to the candidate power station location.

(3) Longitudinal Profile of River and HPP Layout Plan

Locations of the HPP potential sites identified through the site surveys, and longitudinal profile made by collecting location data from topographical map (Google map) are shown in Figure 6-2-13 and Figure 6-2-14.

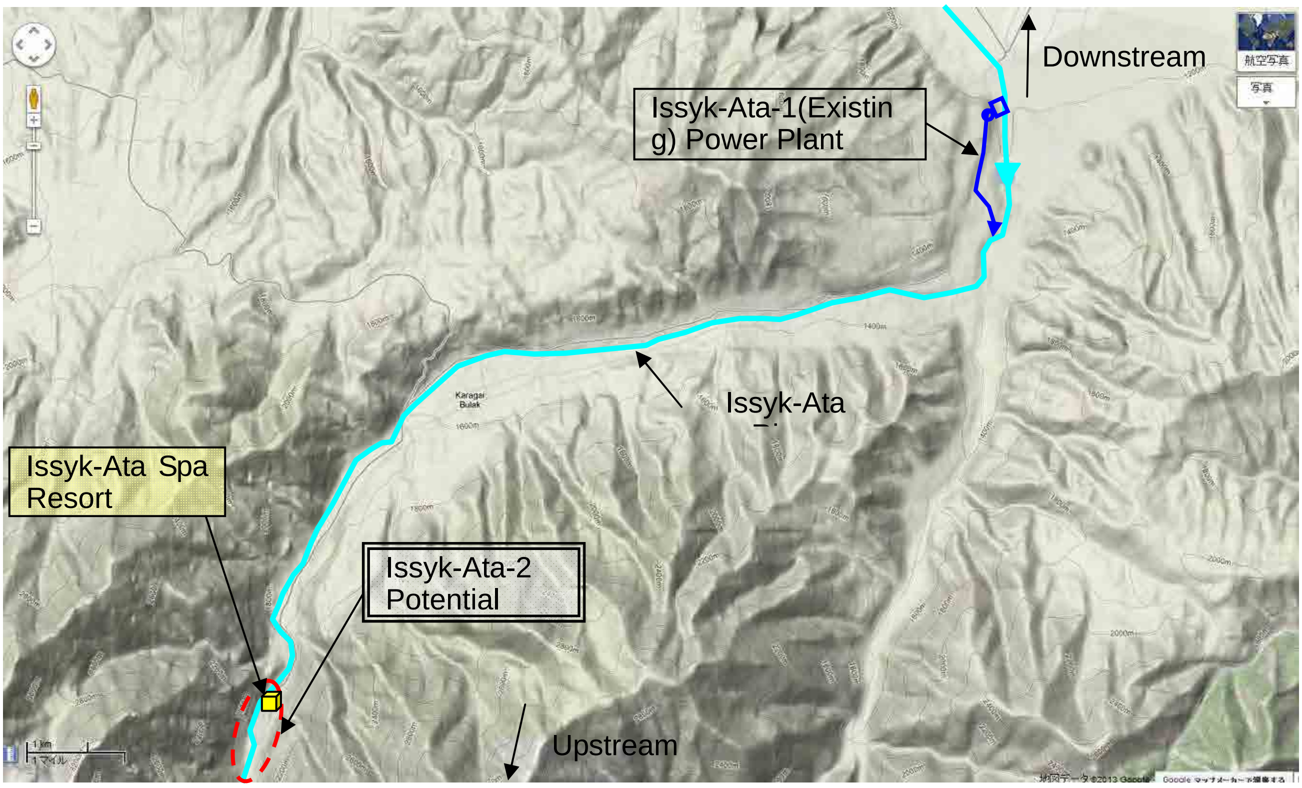


Figure 6-2-13 Location of Issyk-Ata SHPP Potential Site and Existing SHPP

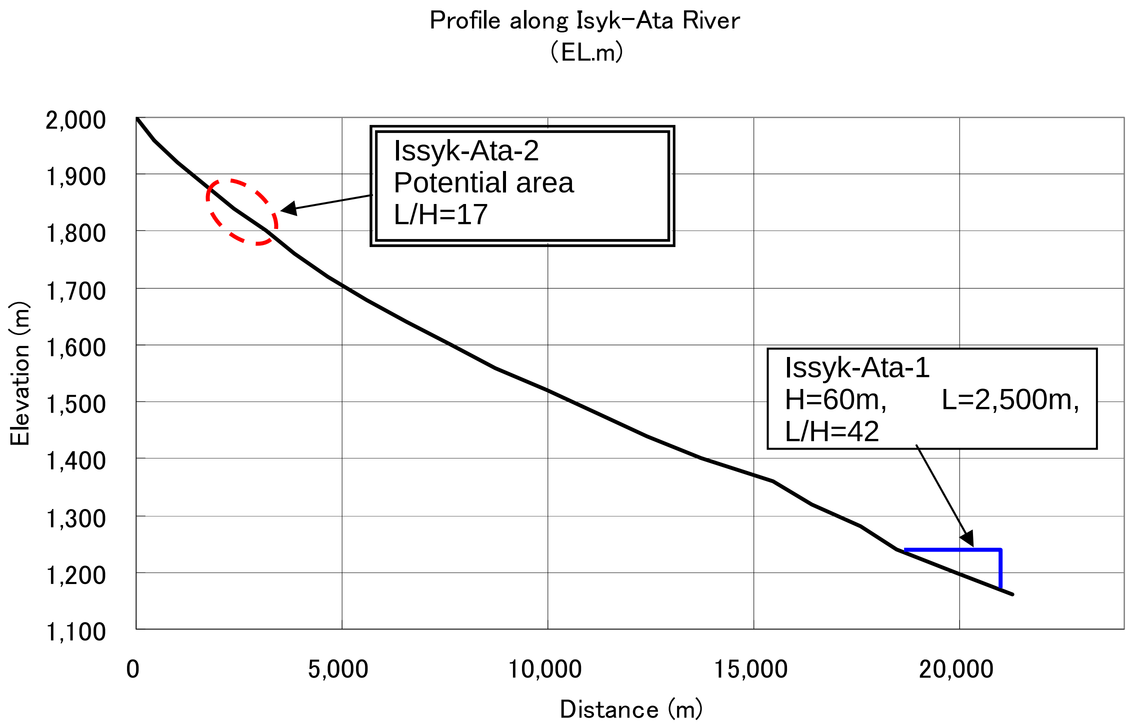


Figure 6-2-14 Longitudinal Profile of Issyk-Ata River

(4) Photographs of Site Conditions

Photo 6-2-48: Rive and Old Headrace of Abolished SHPP


Photo 6-2-49: Cut Slope above Headrace


Photo 6-2-50: Buildings of Spa Resort


Photo 6-2-51 220kV Ala-Archa – Bystrovka Line


Photo 6-2-52 10/0.4kV Transformer located 2km down the stream of Ysyk-Ata River from Candidate Power Station Location


Photo 6-2-53 10kV Distribution Line for Local Power Supply

(5) Bird view for Potential Site

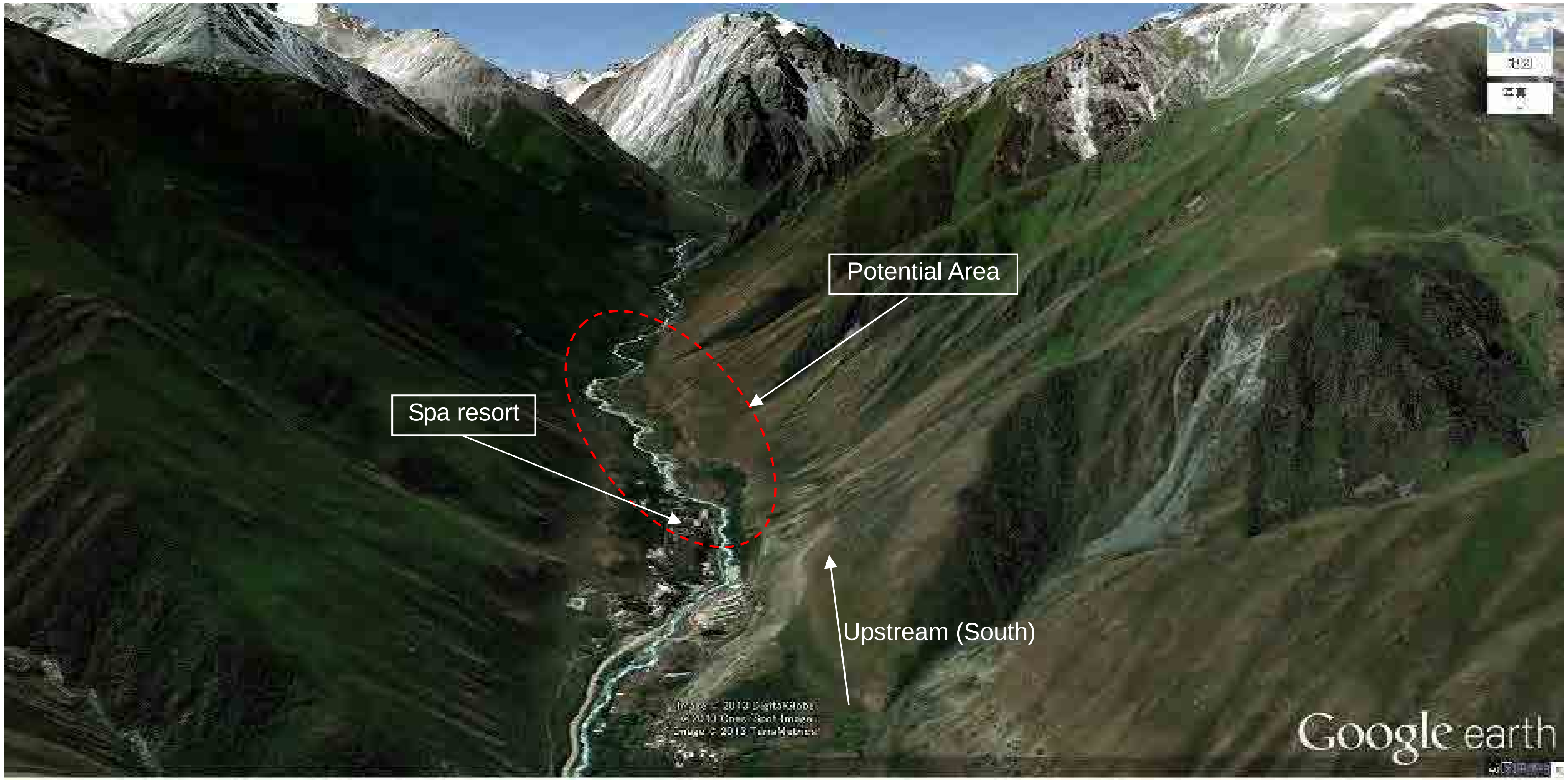


Figure 6-2-15 Bird View for Issyk-Ata-2 SHPP (seen from north to south)

(6) Findings and Evaluation

The river gradient is less 1/20, which is suitable gradient for SHPP development, but since the site is near the spa resort area, the construction works for a SHPP and/or the reduction of river flow discharge caused by a SHPP are likely to have a negative impact on the spa resort area.

In addition, according to the Project Coordinator for small hydropower development at the Bishkek UNDP office, there is a possibility that a private company will develop a SHPP at this site.

Since there are a negative impact on the spa resort area and a possibility of a conflict with a private firm, this site is excluded from promising candidates.

6-2-4 Sokuluk-1 Site

The Sokuluk site is one of 13 SHPP potential sites for reconstruction SHPP on abolished plants, which are approved by the Presidential Decree No. 365 (totally 41 sites, new 28 sites and reconstruction 13). Sokuluk-5 site, selected as the most promising sites in the reports of EBRD's small hydropower muster plan, is located just downstream of Sokuluk-1 site. The features of the abolished Sokuluk-1, reconstruction plan according to the Presidential Decree and Sokuluk-5 site, are shown below.

	Abolished Plant		New Plan	
Name	Installed Capacity	Commission Year	Installed Capacity	Resource
Sokuluk-1	**0.82 MW**	**1960**	**1.98 MW**	Presidential Decree No.365
Sokuluk-2	1.16 MW	1962	1.73 MW	
Sokuluk-5	-		1.50 MW	Small Hydropower Master Plan by EBRD

(1) Conditions on Access to the Site

- There is a trunk road in a good condition between Bishkek and Romanovka Town, about 27 km west of Bishkek. From Romanovka to the site, 17 km upstream of Romanovka, there is a local road in not so bad condition for travelling of vehicles. The site is totally 1 hours and a half ride from Bishkek.
- The intake site is about 5 km upstream (or south) of the powerhouse. There is several hudred meters between the intake site and a vehicle road.
- The route map from Bishkek to Sokuluk site is shown in Figure 6-2-16.

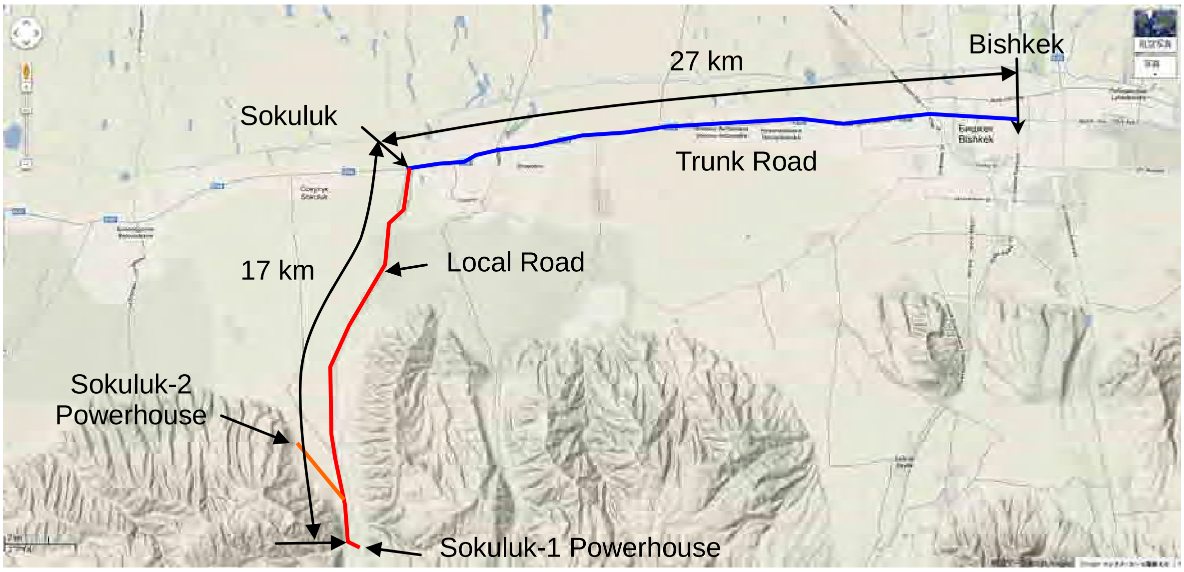


Figure 6-2-16 Route Map to Sokuluk Site

(2) Findings from Site Survey

1) Power house

- The local road which runs along the Djardy-Kainda River ends around the irrigation water intake, but the powerhouse is surrounded by fences. This may indelicate that the powerhouse and its land is owned by some one.

2) Penstock

- The penstock is buried in the ground and fixed with concrete anchor blocks or supports at some intervals. The penstock is buried very shallowly in the ground, and some parts of it have been exposed on the ground surface. The steel pipe of most of the penstock still remains, and is 600 mm in diameter and about 330 m in length. The thickness of the pipe is unknown.
- Since the penstock is buried in the slope of mud flow deposits, the foundations of concrete anchor blocks and supports are likely not to reach firm bedrock.

3) Head tank and Spillway from Head tank

- Height difference between the head tank and the powerhouse is 80 m.
- Most of the concrete structures for the head tank still remain, but their quality is very poor.
- Since there is a 1.5 m wide narrow cross-section just like a channel in front of the inlet of penstock, there is a concern of air entrainment.
- Since the capacity of the remaining head tank seems too small, this structure should not be expected to be utilized for new SHPP.

4) Headrace

- The headrace between the head tank and the intake is about 5.2 km in total length, and constructed with a 150 cm wide cross section which is located near the slope on a about 10 m wide platform created by cutting a hillside slope. (see Figure 6-2-17)

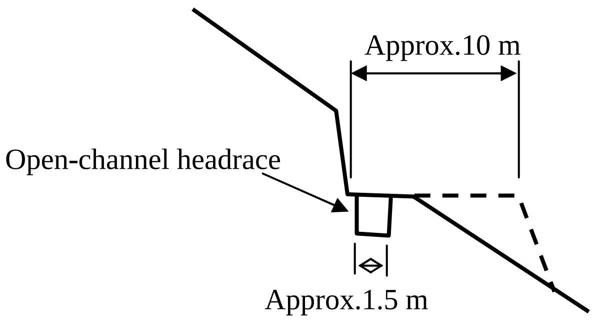


Figure 6-2-17 Cross Section of Headrace for Sokuluk-1

- A part of the headrace channel has a rectangular cross section with concrete lining, but most of the part is non-lining.
- The headrace is constructed on slopes of mud flow sediments containing sand and gravel, which is soft, but the cut slopes have no protection from erosion and/or land slide. Several parts of the slopes are collapsed and about one third of the open channel has been buried by collapsed soil and gravel. However, the 10 m wide platform itself is still stable in most of the sections.
- At 2 km upstream of the head tank, the headrace channel crosses a rather big stream by an concrete aqueduct. (channel width 2 m x height 2 m) However, it is too deteriorated to be reutilized.

5) Intake and Intake Weir

- The intake site is several hundred meters far from the road available for vehicle traffic.
- The intake weir is significantly damaged. The conditions around this weir are now not suitable for intake weir installation because the river width has been very wide maybe due to

large floods. It is recommended to install a new intake weir several hundred upstream of the old weir.

- The river at the site is observed at 1.5 – 2.0 m^3/s in discharge and 1/40 in gradient.
- Any river water usage for irrigation is not found between the intake and the powerhouse, although very small irrigation intake facility is found near the intake site.

6) Conditions around powerhouse

- No houses are found around the powerhouse, while there are some farmhouses in the foot of the slope where the headrace runs and the headrace near the intake are installed adjacent to some houses.
- The land around the headrace, penstock and powerhouse is used for grazing.

7) Conditions on Distribution and Transmission Line

- 220kV Ala-Archa - Frunzenskaya line passes about several hundred meters on the north of the old power station location. It is not realistic to connect to the transmission system at either of the terminal substations since the distance to both of these is several tens of kilometers. Also, the distance to 110kV Sokuluk substation, the nearest substation to the candidate power station location, is about 20km, so it is undesirable for the connection point. Instead, 35/10kV Belogorka substation, located about 6km down the stream of Sokuluk River and placed adjacent to Sokuluk-2 SHPP which is under rehabilitation, is considered the suitable location for grid connection. JSC Severelectro also suggested that the substation is one of the candidate substations for grid connection. The access to the candidate power station location is not paved but almost flat, therefore, there is no obstacle to transport equipment to the construction site. Upon connection to the existing distribution grid, it is necessary to check the space for additional bay and loading condition of the existing transformers and conductors to avoid exceeding the capacity of the equipment.

(3) Longitudinal Profile of River and HPP Layout Plan

Locations of the HPP potential sites identified through the site surveys, and longitudinal profile made by collecting location data are shown in Figure 6-2-18, Table 6-2-3 and Figure 6-2-19.

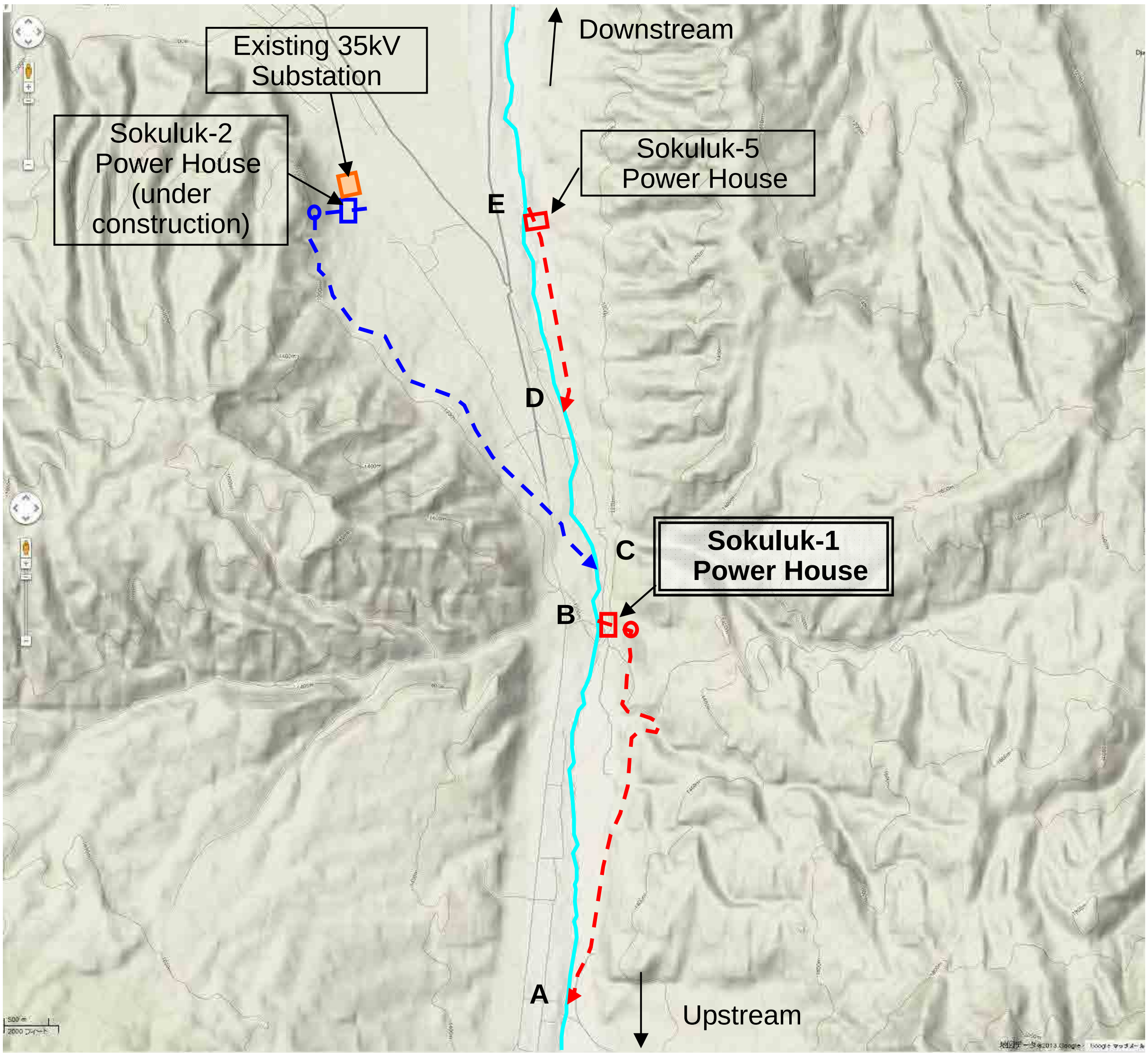


Figure 6-2-18 Location of Sokuluk-1&2 and Sokuluk-5 Site

Table 6-2-3 Location Data for Measure Points along Sokuluk River

	Measure Points	Latitude	Longitude	Altitude (EL.m)	Height difference (m)	Cumulative Distance (m)	Interval Distance (m)	Gradient (L/H)	Estimated Discharge (m³/s)
A	Sokuluk-1 Intake	N42°39'57.0"	E74°14'33.0"	1,290	—	—	—	—	1.5～2.0
B	Sokuluk-1 Powerhouse	N42°42'09.8"	E74°14'53.1"	1,198	-92	3,900	3,900	42	
C	Sokuluk-2 Intake	N42°42'32.5"	E74°14'44.9"	1,177	-21	4,560	660	31	
D	Sokuluk-5 Intake	N42°43'24.6"	E74°14'32.4"	1,130	-47	6,190	1,630	35	
E	Sokuluk-5 Powerhouse	N42°44'17.3"	E74°14'16.2"	1,085	-45	7,840	1,650	37	

Waterway Length

Sokuluk-1 Headrace : 5,200 m

Penstock : 330 m

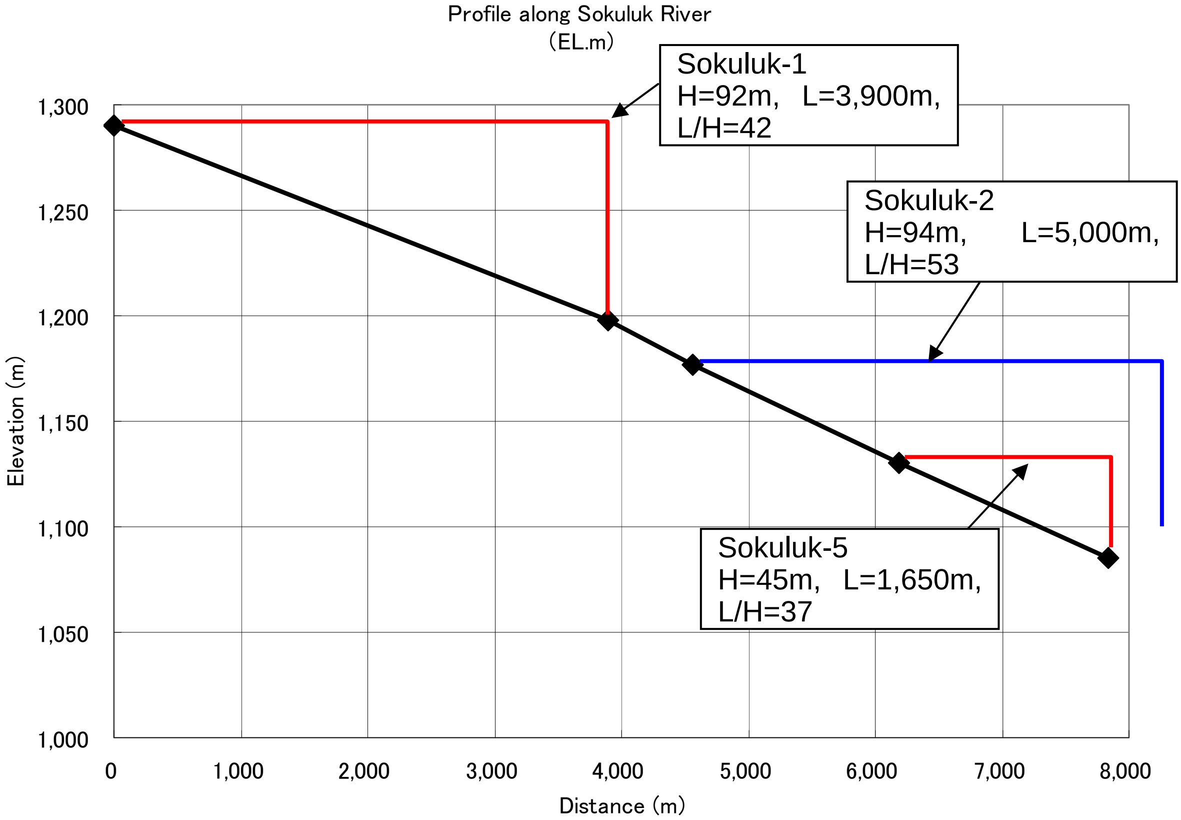


Figure 6-2-19 Longitudinal Profile of Issyk-Ata River

(4) Photographs of Site Conditions

Photo 6-2-54: Powerhouse and
Spillway from Head Tank

Photo 6-2-50: Spillway from Head Tank


Photo 6-2-56: Damaged Spillway from Head Tank


Photo 6-2-57: penstock and Anchor Block


Photo 6-2-58: Head Tank


Photo 6-2-59: Concrete Lined Headrace


Photo 6-2-60: Platform for Headrace (10 m wide)


Photo 6-2-61: Headrace Buried with Soil

Photo 6-2-62: Headrace and Aqueduct

Photo 6-2-63: Aqueduct

Photo 6-2-64: Aqueduct (2 m x 2 m)

Photo 6-2-65: Collapsed Platform


Photo 6-2-66: Damaged Old Intake Weir


Photo 6-2-67: Alternative Intake Site


Photo 6-2-68 220kV Ala-Archa - Frunzenskaya Line


Photo 6-2-69 35kV Distribution Line to Belogorka Substation


Photo 6-2-70 35/10kV Belogorka Substation


Photo 6-2-71 10/0.4kV Transformer in Bululu Village

(5) Bird view for Waterway Route

Figure 6-2-20: Bird View for Sokuluk-1 SHPP

(6) Findings and Evaluation

The abolished Sokuluk-1 SHPP has a waterway layout that consist of a intake taking water from a river flowing down from the north slope of Kyrgyz Range at around the top of a an alluvial fan and a open channel headrace lying on a platform constructed by open-cut on a slope of mud flow sediments. A new SHPP plan utilizing this abolished SHPP has a lot of features in common with existing Issyk-Ata-1 and Sokuluk-2 on-going SHPPs mentioned in the Chapter 5.

River flow discharge at this site is 1.5 - 2.0 m^3/s, which is the largest among the sites surveyed in this study, but as L/H is 42, the SHPP has long waterway (5.2 km) for its head (about 90 m). The construction costs for the headrace is likely to be relatively high.

Although some parts of platform along the headrace are collapsed, the platform as a whole can be used for new headrace without a huge repair. However, since about one third of the open channel has been buried by collapsed soil and gravel due to no protection on the cut slope above the headrace, there should be a need for a huge amount of slope protection costs for a new SHPP.

After the site survey, it was confirmed that the land surrounded by fences has been purchased by the Directorate for the Small and Medium Scale Power Generation Projects (or its affiliated company) for a future development of a SHPP.

In consideration of a possibility of a conflict with a private firm, this site is excluded from promising candidates.

6-2-5 Alamedin Site

Alamedin site, located in the middle part of Alamedin River flowing down from the north slope of Kyrgyz Range to Bishkek City, is one of SHPP potential sites approved by the Presidential Decree No.365, and has a output of 3.2 MW.

(1) Conditions on Access to the Site

- There is a local road in a good condition between Bishkek and the spa resort area near the site , which is about 33 km south of Bishkek.
- There is no road from the end of the local road near the spa resort area.
- The route map from Bishkek to Alamedin site is shown in Figure 6-2-21.

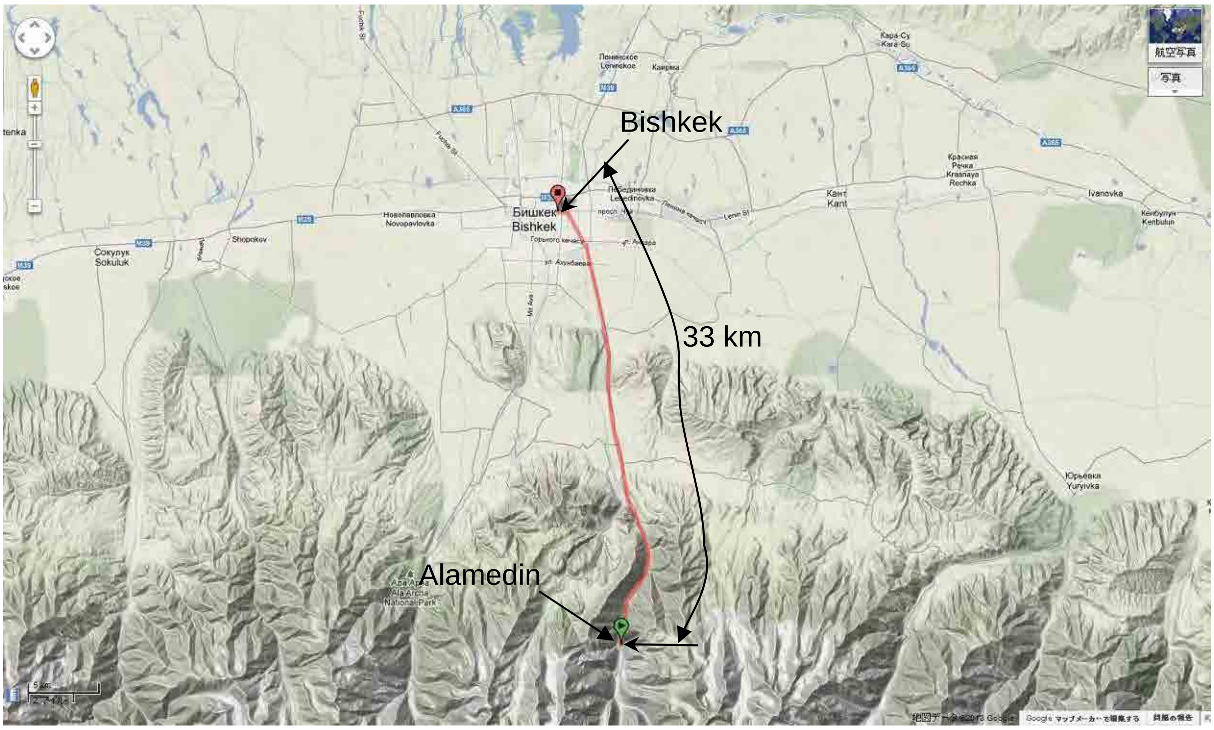


Figure 6-2-21 Route Map to Alamedin Site

(2) Findings from Site Survey

1) Topography

- Due to no detailed location information, the intake and powerhouse sites are not indentified.
- The local ends right after the spa resort accommodation (N42° 36’56.9”, E74° 39’53.3” /EL.1,691m). The place where the road ends (N42° 36’22.9”, E74° 39’46.9”/EL.1,791m) is about 50 m higher than the river bed.
- The valley upstream becomes narrow and the river bed also becomes steeper.

2) River Conditions

- The discharge and the gradient of the river at this site are estimated at 1.0 m^3/s and 1/15～20. (February 2013)
- It is better to locate the intake more upstream of the spa resort accommodation because of the topography as mentioned above. However, it is difficult to approach to the river from the road as the road level becomes higher than river level as altitude increases.

3) Conditions on Waterway Route

- It is difficult to construct open-channel headrace on both the left and right bank slopes, due to the fact that the slopes of the valley are very steep with landslide areas and scree slopes and there is no access road in the left bank. Therefore, it is recommended that the headrace is not conventional open channel constructed on the slopes of valley but pressure pipe to be embedded for all the stretches from the intake to the powerhouse along the road.

4) Social Conditions

- There are a lot of buildings including a spa resort accommodation and villas around the site.

5) Conditions on Distribution and Transmission Line

- There is Severelectro's 35/10kV Sk-Bulak distribution substation near the intake point. The candidate power station location is about 2km down the stream of the Alamedin River from the intake point. It is possible to connect the access distribution line from the candidate power station location to the existing distribution grid at the substation. Thus length of the access distribution line is approximately 2km. It is not practical to connect to the transmission system with the voltage higher than 35kV at a substation considering that the expected output of the SHPP is less than 1-2 MW at most, and that distance to Ala-Archa substation (220/110/10kV), the nearest substation, is more than 20km. The access to the candidate power station location is the gravel road; however, inclination of the road is gentle. Therefore, there is virtually no obstacle to transport equipment to the construction site.

(3) Longitudinal Profile of River and HPP Layout Plan

The longitudinal profile made by collecting location data from topographical map (Google map) are shown in Figure 6-2-22.

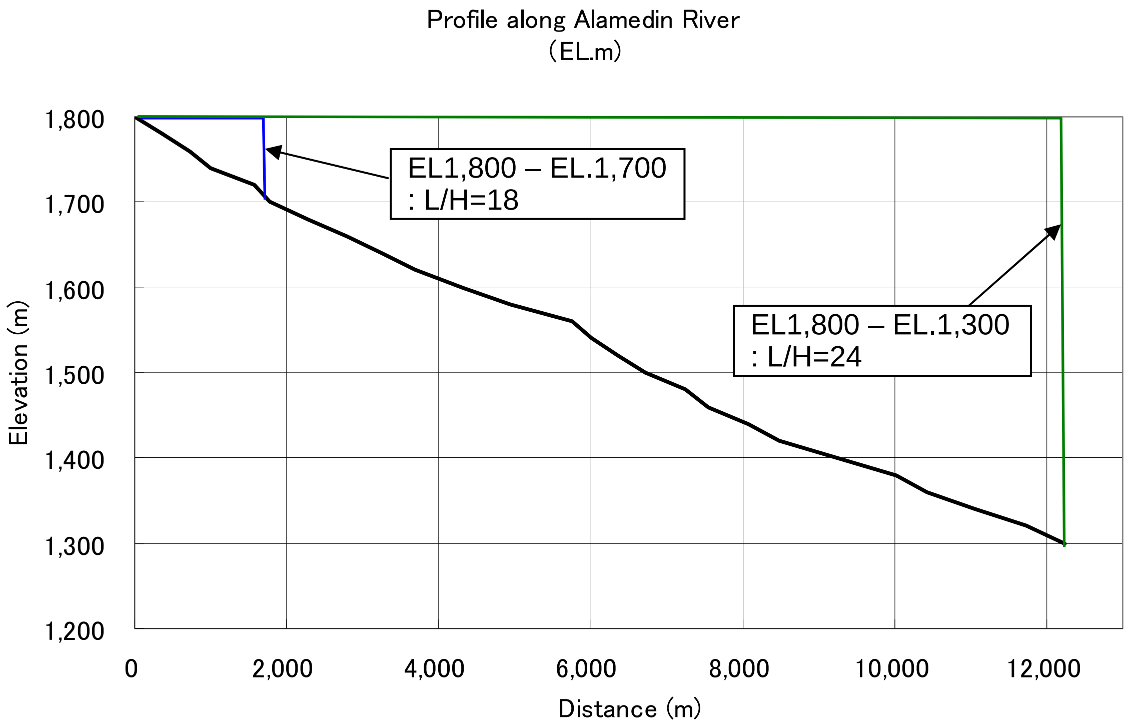


Figure 6-2-22 Longitudinal Profile of Alamedin River

(4) Photographs of Site Conditions

Photo 6-2-72: Upstream of Spa Resort Area

Photo 6-2-73: Downstream of Road End

Photo 6-2-74: Scree Slope near the Site

Photo 6-2-75: Spa Resort Building

Photo 6-2-76: Spa Resort and River

Photo 6-2-77 35kV Distribution Line to Sk-Bulak Substation

Photo 6-2-78 35/10kV Sk-Bulak Substation

Photo 6-2-79 10kV Distribution Line from Sk-Bulak Substation

Photo 6-2-80 10/0.4kV Transformer located near the Intake Point

(6) Findings and Evaluation

The river gradient is less 1/20, which is suitable gradient for SHPP development, but since the site is near the spa resort area, the construction works for a SHPP and/or the reduction of river flow discharge caused by a SHPP are likely to have a negative impact on the spa resort area.

In addition, according to the Project Coordinator for small hydropower development at the Bishkek UNDP office, there is a possibility that a private company will develop a SHPP at this site.

Since there are a negative impact on the spa resort area and a possibility of a conflict with a private firm, this site is excluded from promising candidates.

6-2-6 Shamsi Site

Shamsi site, located in the Shamsi River flowing down from the north slope of Kyrgyz Range towards Tokmok City, 60 km east of Bishkek, is one of SHPP potential sites approved by the Presidential Decree No.365. In response to a request from MEI, Norconsult AS, a consultant in Norway, carried out a pre-feasibility study on this site in 2012. (name of report: Small Hydropower Assessment, Shamsi Hydropower Project -Assessment of Feasibility – Draft Report, October 2012)

According to the information provided by KSTC, the features of the site is P=2.4 MW, Q=1.6 m^3/s、and H=150 m, while Norconsult proposed P=10 MW, Q=8.5 m3/s and H=139 m for Shamsi No.2 SHPP.

(1) Conditions on Access to the Site

- There is a trunk road in a good condition between Bishkek and Tokmok City, which is about 65 km south of Bishkek. The intake site for No.1 SHPP candidate, 35 km upstream of Tokmok., is located near a confluence of two streams.
- The local road is paved until 5 km downstream of the above-mentioned No.1 intake site.
- The No.1 intake site is totally about 100 km far and 2 hours and a half ride from Bishkek.
- The route map from Bishkek to Alamedin site is shown in Figure 6-2-21.

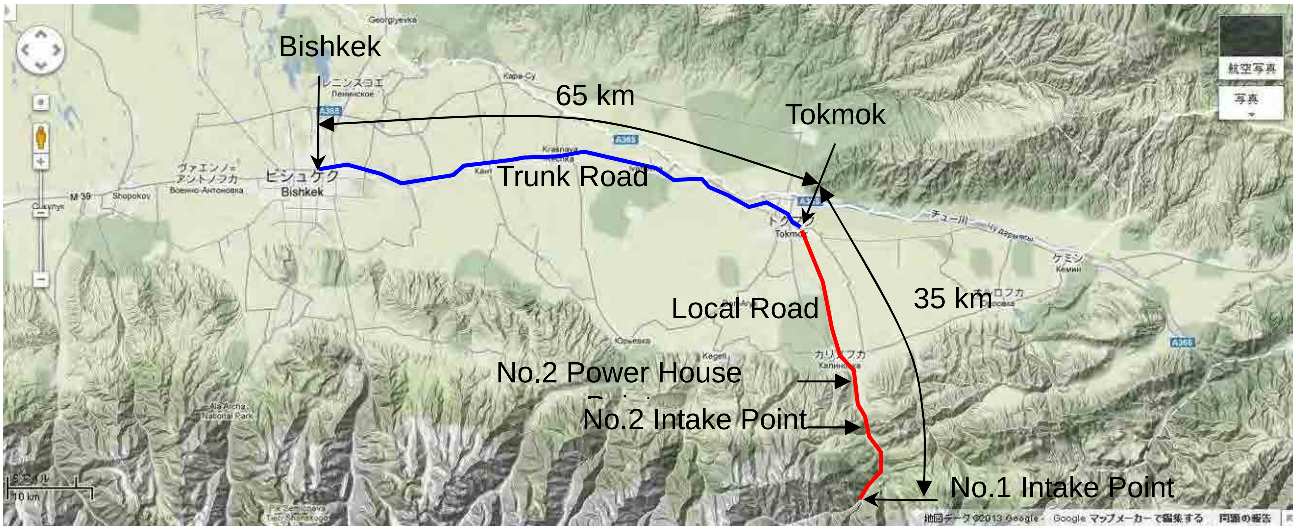


Figure 6-2-23 Route Map to Shamsi Site

(2) Findings from Site Survey

In the pre-feasibility by Norconsult AS, two (2) intake sites (No.1 C.A=254 km^2, No.2 C.A.=462 km^2) were studied and then No.2 intake was selected as a better potential site than No.1. However, No.1 intake site was also surveyed in this site survey.

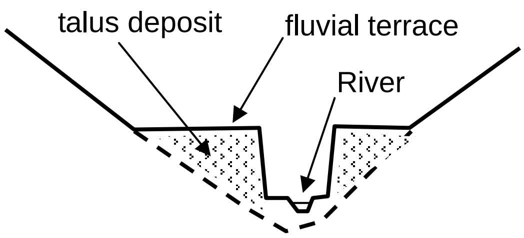
1) No.1 Intake Point (N42°32’07.9”, E75°23’32.0”/EL.1,802m)

- There is a confluence of streams about 35 km upstream of Tokmok. This confluence is No.1 intake point. (C.A=254 km^2)
- The river at this site is estimated at 5 m in width, 0.4 m^3/s in discharge（right side stream 0.1 m3/s＋left side stream 0.3 m^3/s） and 1/20 in gradient.
- The valley at this site is relatively-wide. The river bed is covered widely with thick sediments. The mountain slopes consists mainly of granite rock and talus.

2) No.1 Intake – No.2 Intake

- The distance and the height difference between No.1 and No.2 intake points are about 10 km and 291 m respectively. The gradient of this section is 1/34, which is gentle as a SHPP gradient.

- There is no house around No.1 intake point, while there is one house about 450 m downstream and a rather big stable about 2.9 km downstream of the No.1 intake point.
- A rather large stream flows into the Shamsi River from east downstream about 5 km of the No.1 intake point. The river discharge after this confluence is estimated at 0.5～0.6 m^3/s.
- The river around the confluence is covered with very thick and wide sediments maybe due to its gentle gradient, and fluvial terrace with a height of 10 – 50 m are well developed on the both river side. Because of that, the road along the river has an up and down profile. Such road profile makes it difficult to adopt the pressure pipe to be buried along the road.



Cross Section of Shamsi River

- At around this confluence a distribution line (6 kV or 10 kV) from the downstream is extended to upstream of the stream on the left bank, not extended to the direction of No.1 intake point.

3) No.2 Intake Point （N42° 36’43.0”/E75° 23’59.1”/EL.1,511m）

- The site (C.A.=462 $km^{2)}$ is located at the lower end of the valley, and at about 1 km downstream of the this site, the alluvial fan of Shamsi River starts to be distributed.
- As mentioned at 2), the river in most of parts of the valley is covered with thick and wide sediments, but at this intake site, the valley is very narrow and V-shaped, and the river is not covered with thick sediments. In addition, the river is close to the road. Therefore, this site is very suitable for a intake.

4) No.2 Intake Point – No.2 Powerhouse

- The river runs in the very narrow and steep valley until about 500 m downstream from No.2 intake point. The river also has a very steep gradient like a water fall. After this steep site, the river flows down on alluvial fan with a gentle gradient to the north.
- Around the top of the alluvial fan, there is a large-scale intake facility for irrigation, taking a large amount of the river water. the ere is no house around No.1 intake point, while there are one house about 450 m downstream and a rather big stable about 2.9 km downstream of the No.1 intake point.
- There are roads, settlements and farmlands on the taluses, while the river flows 30 -50 m below the taluses. However, in the river there is quite a few water because of a high permeability of fan deposits.
- According to the report by Norconsult AS, the water way between the intake and the powerhouse is pressure pipe with a length of 5,350 m, a head of 130 m and a gradient of 1/41.

5) No.2 Powerhouse

- According to the report by Norconsult AS, the detailed location of the powerhouse is not mentioned. However, as the length of the pressure pipe is 5,350 m, it is estimated that the powerhouse (N42.661626, E75.382476) is located at a river side near Shamsi Village, which is 5,300 m downstream of the intake. The altitude of the center at the end of penstock is EL.1,374 m.
- Since there is another irrigation canal around this site, there is a need for a consideration not

to give negative impact on that irrigation facility.

6) Distribution and transmission line around powerhouse

- There is a 35 kV Shamsi substation about 3.5 km of the powerhouse..

(3) Longitudinal Profile of River and HPP Layout Plan

The longitudinal profile made by collecting location data from topographical map (Google map) are shown in Figure 6-2-24.

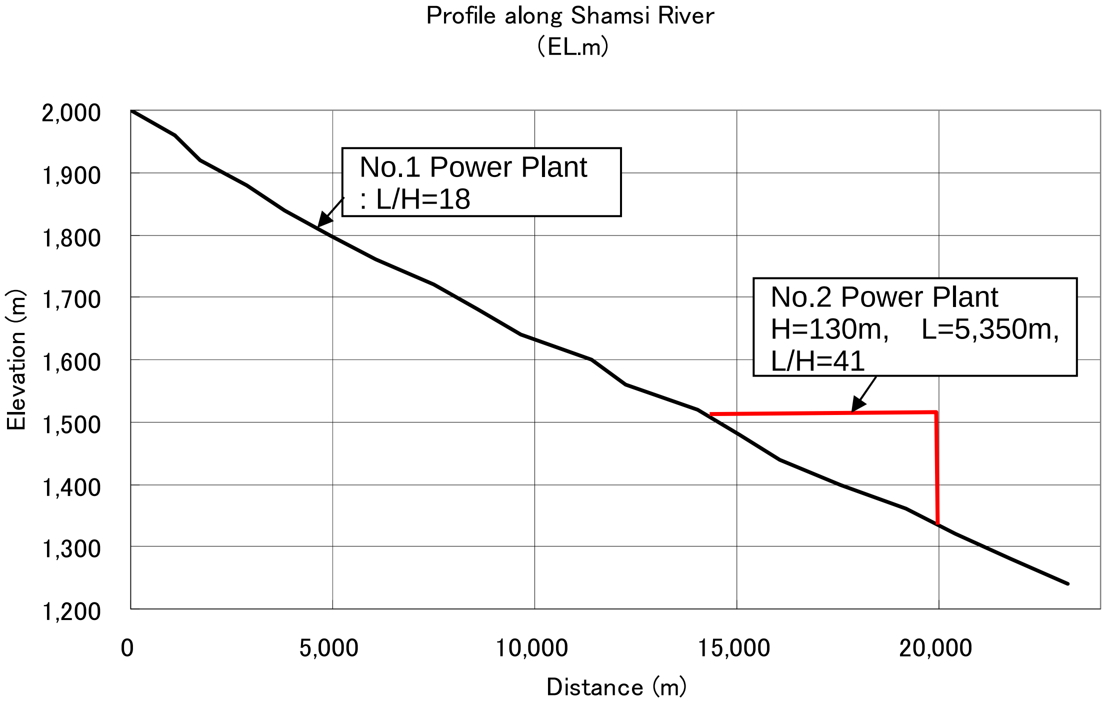


Figure 6-2-24 Longitudinal Profile of Shamsi River

(4) Photographs of Site Conditions

Photo 6-2-81: No. Intake Site (C.A.:254 km²)

Photo 6-2-82: No.1 Intake Site and Road

Photo 6-2-83: Intake water for Agriculture downstream of No.1 Intake Site

Photo 6-2-84: Confluence 5 km downstream of No.1 Intake

Photo 6-2-85: No.2 Intake Site (upstream)

Photo 6-2-86: No.2 Intake (downstream)

Photo 6-2-87: Narrow River Section 500 m downstream of No.2 Intake

Photo 6-2-88: Downstream of Narrow River Section (Intake for Irrigation can be seen)

Photo 6-2-89: Irrigation Canal near No.2 Site

Photo 6-2-90: 35kV Shamsi Substation

Photo 6-2-91: Shamsi River (no water)

Photo 6-2-92: 220kV Transmission Line near No.2 Powerhouse

(5) Bird view for Waterway Route

Figure 6-2-25: Bird View around Intake for Shamsi site (seen from north to south)

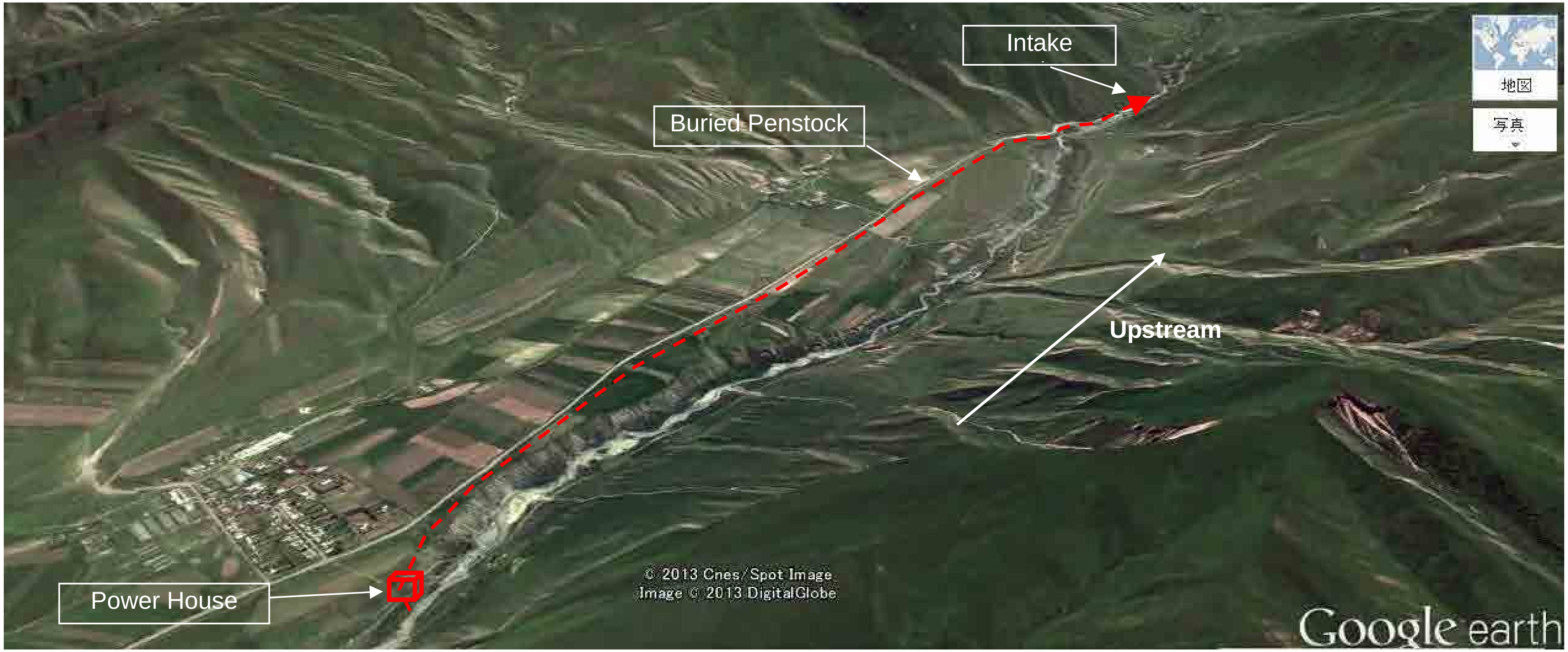


Figure 6-2-26: Bird View of Overall Layout for Shamsi Site (seen from northwest to southeast)

(6) Findings and Evaluation

According to the report by Norconsult AS, the maximum discharge is estimated at 8.5 m^3/s, but only 0.6 m^3/s was observed as the river flow discharge at the No.2 intake site during this site survey. The maximum discharge of 8.5 m^3 is evaluated as too big. As for the headrace, the gradient between the intake and powerhouse is 1/41, which is very gentle as a gradient for a SHPP. The indicator showing ratio between waterway length and head: L/H is 41 (= slope: 1/41). The gradient is too gentle as that for a SHPP, and the headrace length is 5,350 m, which is relatively long. Therefore, this SHPP plan would be economically unfeasible due to the high construction costs for the long waterway.

In Chui Valley, irrigation intake facilities are usually installed at around tops of alluvial fans about 1,300 m above sea level or mouths of river flowing down from the north slope of Kyrgyz Range. There is also a large intake facility for irrigation on the top of alluvial fan, where is just located between the intake and powerhouse for Shamsi SHPP. There is a big concern that the SHPP would be unable to operate as planned because the amount of the intake water should be limited for the irrigation.

In conclusion, it is difficult to evaluate this site as a promising SHPP potential site, and this site is excluded from promising candidates.

6-2-7 Chon-Kemin-1, 2 & 3 Sites

Chon-Kemin River is the biggest tributary with a catchment area of about 1,800 km^2 of Chu River, flowing down to west through the elongated valley (Chon-Kemin Valley) located in the east end of Chui Oblast and flowing into Chu River at the east end of Kyrgyz Range. Chon-Kemin 1, 2 and 3 sits are three sites of 28 new SHPP sites approved by the Presidential Decree No.365. According to the list in the Presidential Decree No. 365, each output of these three sites is the same, 5 MW, but other than the output, no basic information including their locations, heads, discharges, etc. is shown.

Chon-Kemin-1 is also one of 20 promising sites selected in the SHPP mater plan by EBRD, “STRATEGIC PLANNING FOR SMALL AND MEDIUM-SIZED HYDROPOWER DEVELOPMENT”. The output in the master plan is different from that shown in the Presidential Decree No.365 as below.

Output	P: 4.2 MW
Discharge	Q: 13.3 m^3/s
Head	H: 41 m

(1) Conditions on Access to the Site

- At the junction 116 km east of Bishkek, the local road begins to run to Chon-Kemin Valley. The intake site for Chon-Kemin-1 is 35 far from the junction. The road from Bishkek to the site is in a good condition..
- The route map from Bishkek to the sites is shown in Figure 6-2-27.

Figure 6-2-27 Route Map to Chon-Kemin Sites

(2) Findings from Site Survey

1) Chon-Kemin-1

- This site is located in the most upstream of the river among the three sites. Since the river gradient is very gentle with a slope of 1/40 – 1/50, this site is likely to be economically unfeasible.
- The river flows down through mud flow deposits, and on the both river sides there are talus with a height of about 20 m.
- A 10kV existing distribution line passes near the candidate power station location, where the access distribution line can be connected to the JSC Severelectro's grid. In case of constructing the access distribution line to the existing distribution substation, it is considered possible to connect to JSC Severelectro's grid at Shabdan substation (110/35/10kV) located about 16km down the stream of Chon-Kemin River from the candidate power station location. With either case, the access to the candidate power station location is the gravel road; however, inclination of the road is gentle. Therefore, there is virtually no obstacle to transport equipment to the construction site. Shabdan substation is owned and maintained by JSC NEGK; however, 10kV system, the secondary side of the transformer, is owned by Severelectro. The local offices of both companies are located close to each other. The maximum load of the transformer is at most 30-35% of its rated capacity even in wintertime, so the local staff of JSC Severelectro explained that load shedding due to heavy load has not occurred and that outages occur only when equipment breakdown happens because of heavy weather. In regard to connection to the transmission system, it is totally unpractical considering the distance to the terminal substation of the transmission line passes closest to the candidate power station location. 220kV Bystrovka - Issyk-Kul line passes about 19km down the stream of Chon-Kemin River from Shabdan, but the distance to the terminal substation is several tens of kilometers.

2) Chon-Kemin-2

- Since this site is located downstream of the above-mentioned Chon-Kemin-1 site, the river gradient is 1/60 or less, more gentle than that at Chon-Kemin-1. Therefore, this site also is likely to be economically unfeasible.
- Since an irrigation intake takes water from the river between Chon-Kemin-1 powerhouse and Chon-Kemin-2 intake sites, there is a concern that the amount of discharge available for intake would decrease.

2) Chon-Kemin-3

- The intake site is just downstream a confluence of Chon-Kemin River and Chu River.
- There is a narrow gorge covered with rock exposures around the site, where it is possible to construct a dam and waterway type hydropower plant with a 20 -30 m high concrete dam.
- Chu River is an international river flowing through the border of Kazakhstan and Kyrgyzstan. In the case that this site is developed, consultations between the two countries are required.

(3) Longitudinal Profile of River and HPP Layout Plan

The location of the sites identified by the site survey and the longitudinal profile made by collecting location data from topographical map (Google map) are shown in Figure 6-2-28, Table 6-2-4 and Figure 6-2-29.

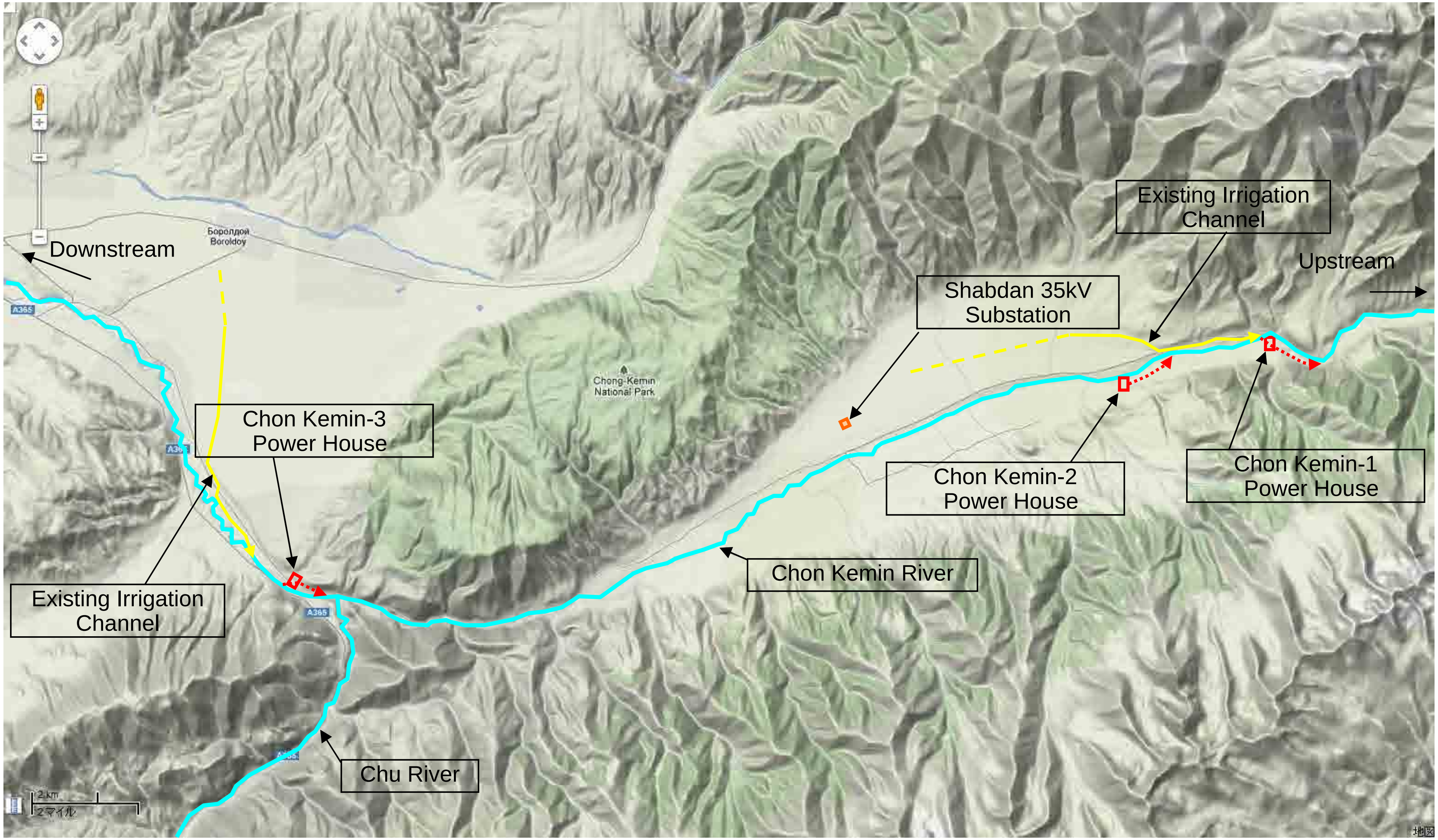


Figure 6-2-28 Location of Chon-Kemin-1&2 and 3 Sites

Table 6-2-4 Location Data for Measure Points along Chon-Kemin River

	Measure Points	Latitude	Longitude	Altitude (EL.m)	Gradient (L/H)	Estimated Discharge (m^3/s)
A	Chon-Kemin-1Intake	N42°45'18.8"	E76°15'20.9"	1,760	-	5.0
B	Chon-Kemin-1 Powerhouse	N42°45'45.1"	E76°14'11.8"	1,710	45	5.0
C	Chon-Kemin-2 Powerhouse	N42°45'06.5"	E76°11'09.6"	1,640	65	5.0
E	Chon-Kemin-3 Powerhouse	N42°41'32.1"	E75°52'25.0"	1,300	90	25

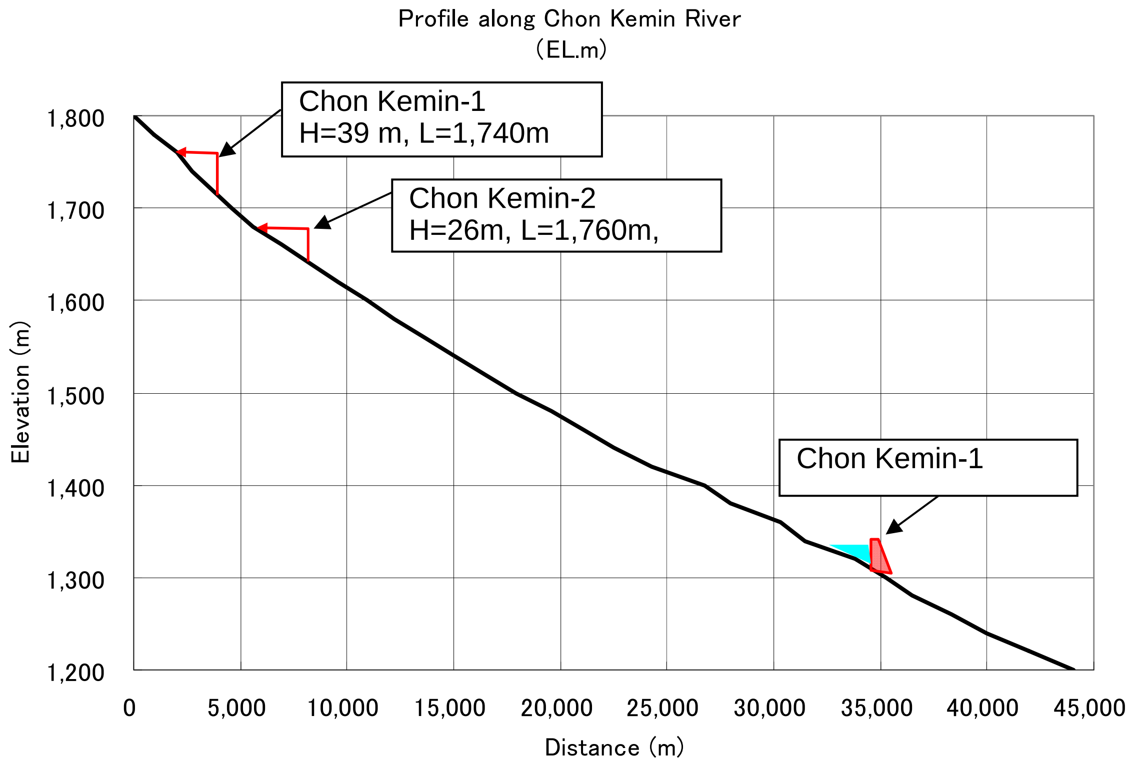


Figure 6-2-29 Longitudinal Profile of Chon-Kemin River

Waterway Length

Chon-Kemin-1 Pressure Pipe : 1,400 m

Chon-Kemin-1 Pressure Pipe : 1,400 m

Chon-Kemin-1 Dam & Waterway :

(Dam: 25 m in height, Waterway: 500 m in length, Intake Water Level: EL.1,320 m, Outlet Water Level: EL. 1,295 m)

(4) Photographs of Site Conditions

Photo 6-2-93: Chon-Kemin-1 Intake Site

Photo 6-2-94: Downstream of Chon-Kemin-1 Intake Site

Photo 6-2-95: Confluence of Chu River and Chon-Kemin River

Photo 6-2-96: Chon-Kemin-3 Intake Site

Photo 6-2-97: Road Bridge downstream of Chon-Kemin-3 Intake Site

Photo 6-2-98 220kV Bystrovka – Issyk-Kul Line

Photo 6-2-99 10kV Distribution Line passes near the Candidate Intake Point

Photo 6-2-100 110/35/10kV Shabdan Substation

(5) Bird view for Potential Sites

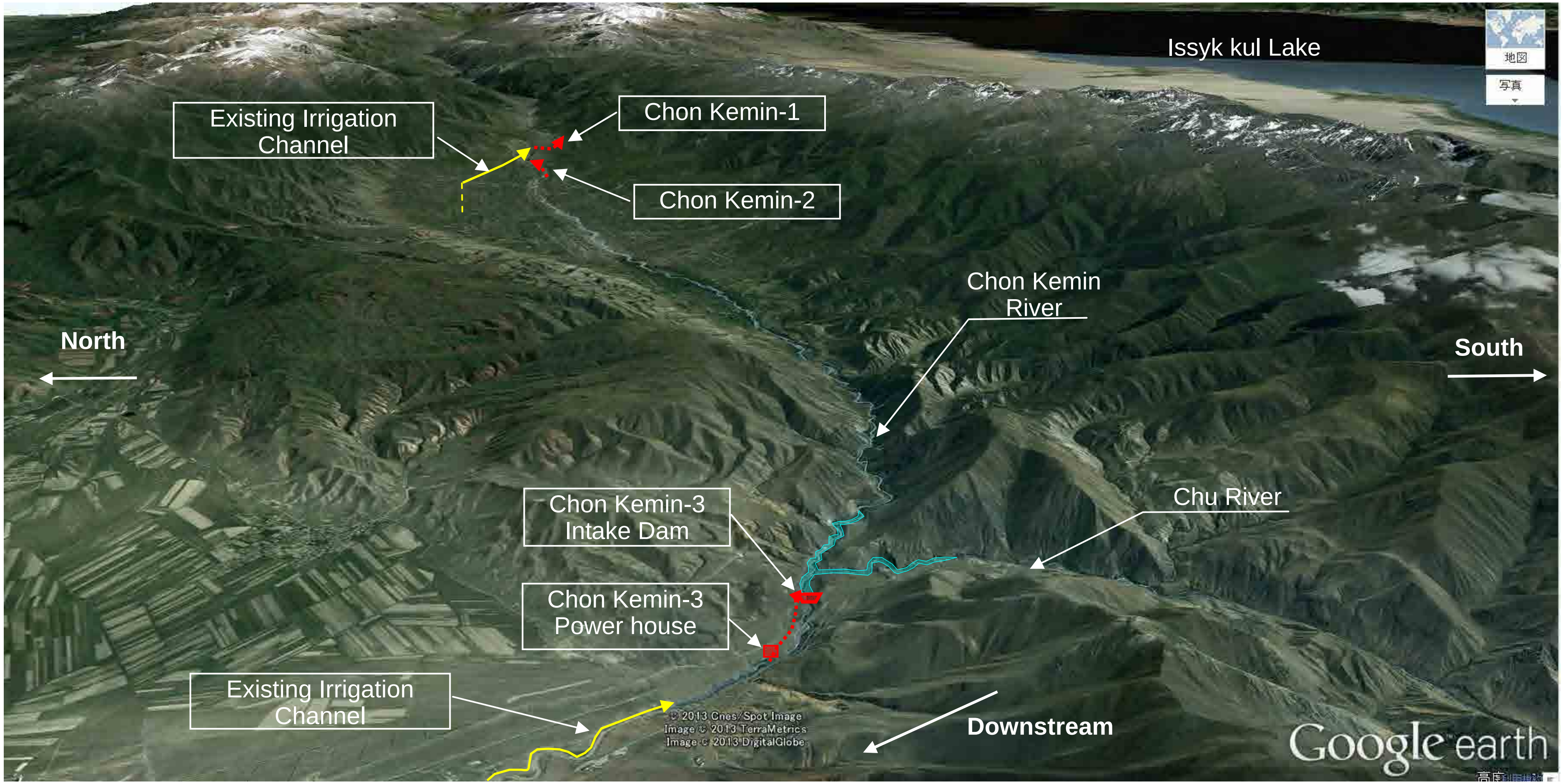


Figure 6-2-30: Bird View of Chon-Kemin Sites (seen from west to east)

(6) Findings and Evaluation

Chon-kemin-1 and 2 sites are likely to be economically unfeasible due to the gentle river gradient for a SHPP.

Since Chu River is an international river flowing through the border of Kazakhstan and Kyrgyzstan, for the development of Chon-Kemin-3, the consultations with the two countries are required. However, the site has topographical features suitable for a dam construction, and there is a possibility that the SHPP at the site will fully utilize a large amount of river flow discharge as a dam type or dam an waterway type hydropower plant.

In conclusion, of the three sits, Chon-Kemin-1 and 2 are excluded from promising candidates, while Chon-Kemin-3 site is evaluated as one of promising candidates and subsequently calculations on power generation features and estimation of their construction costs will be carried out in the next stage.

6-2-8 Ak Suu-1 & 2 Sites

Ak Suu-1 and 2 sites are located in Ak Suu River, flowing down from the north slope of Kyrgyz Range to Belovodskoe, which is a town about 46 km west of Bishkek. The sites are the old Ak Suu-1 and 2 SHPPs which were constructed in the 1960s and abolished after starting operation of large-scale hydropower plants including Toktogul hydropower plant in the 1970s. According to KSTC, the features of these sites for the abolished power plant are shown below.

Name	Installed Capacity	Commission Year
Ak Suu-1	0.2 MW	1941
Ak Suu-2	1.4 MW	1964

These sites are also listed up as 20 promising sites in the SHPP master plan by EBRD. The major features of these sites described in the reports of the master plan are shown below.

Name	Installed Capacity	Total Investment Costs (Mil. USD)
Ak Suu-1	1.98 MW	6.12
Ak Suu-2	1.73 MW	7.72

(1) Conditions on Access to the Site

- There is a trunk road in a good condition between Bishkek and Belovodskoe, which is about 46 km south of Bishkek. The intake site for Ak Suu-1 is 21 km upstream of Belovodskoe.
- The local road is also paved and in a good condition.
- The route map from Bishkek to Alamedin site is shown in Figure 6-2-21.

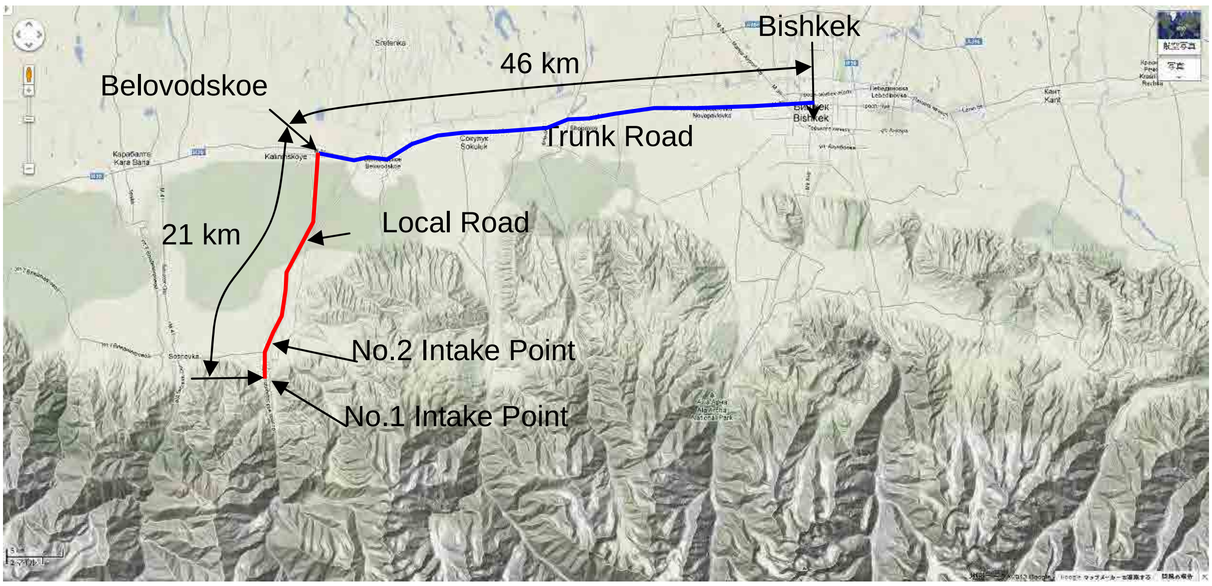


Figure 6-2-31 Route Map to Ak Suu 1 & 2 Sites

(2) Findings from Site Survey

- Ak Suu-1 and 2 sites were surveyed based on the information shown in the reports of the EBRD's master plan, but no trace of the old SHPPs was found during the site survey.
- As shown in Figure 6-2-31, a captive SHPP is found between Ak Suu-1 and 2 sites. According to a operator at the SHPP, this captive power is owned by a milk factory. Detailed information on this plant could not be confirmed from the operator. However, it is estimated that this plant has a two units of turbine and generators with a capacity of 300 kW x 2 = 600 kW and a maximum discharge of about 2.0 m^3/s estimated from a output (600 kW) and the head of 38 m. Since the building of powerhouse looks still new and the generator was made in April 2009 in China, but the penstock looks to be more than 10 years old, this captive power seems a power plant which was reconstructed on the abolished Ak Suu-2 (p=1.4 MW).
- Therefore, Ak Suu-2 site shown in the reports of the EBRD's master plan seems not a reconstruction SHPP on a abolished SHPP, but just a new development plan.
- According to the EBRD's maser plan, the both intake weirs will be installed at or near existing intake weirs for irrigation. The both SHPP will have no choice but to reduce the amount of taking water during the irrigation period.
- Since the river around the sites flows through an alluvial fan, some portion of river water must go to underground. The river gradient is very gentle with a slope of about 1/50 for SHPP site.
- As shown in Figure &-2-31, there is a 35 kV substation in the middle of Ak Suu-1 and Ak Suu-2. The substation is 1.6 km and 3.7 km far from Ak Suu-1 and Ak Suu-2 powerhouses respectively.

(3) Longitudinal Profile of River and HPP Layout Plan

The location of the sites identified by the site survey and the longitudinal profile made by collecting location data are shown in Figure 6-2-32, Table 6-2-5 and Figure 6-2-33.

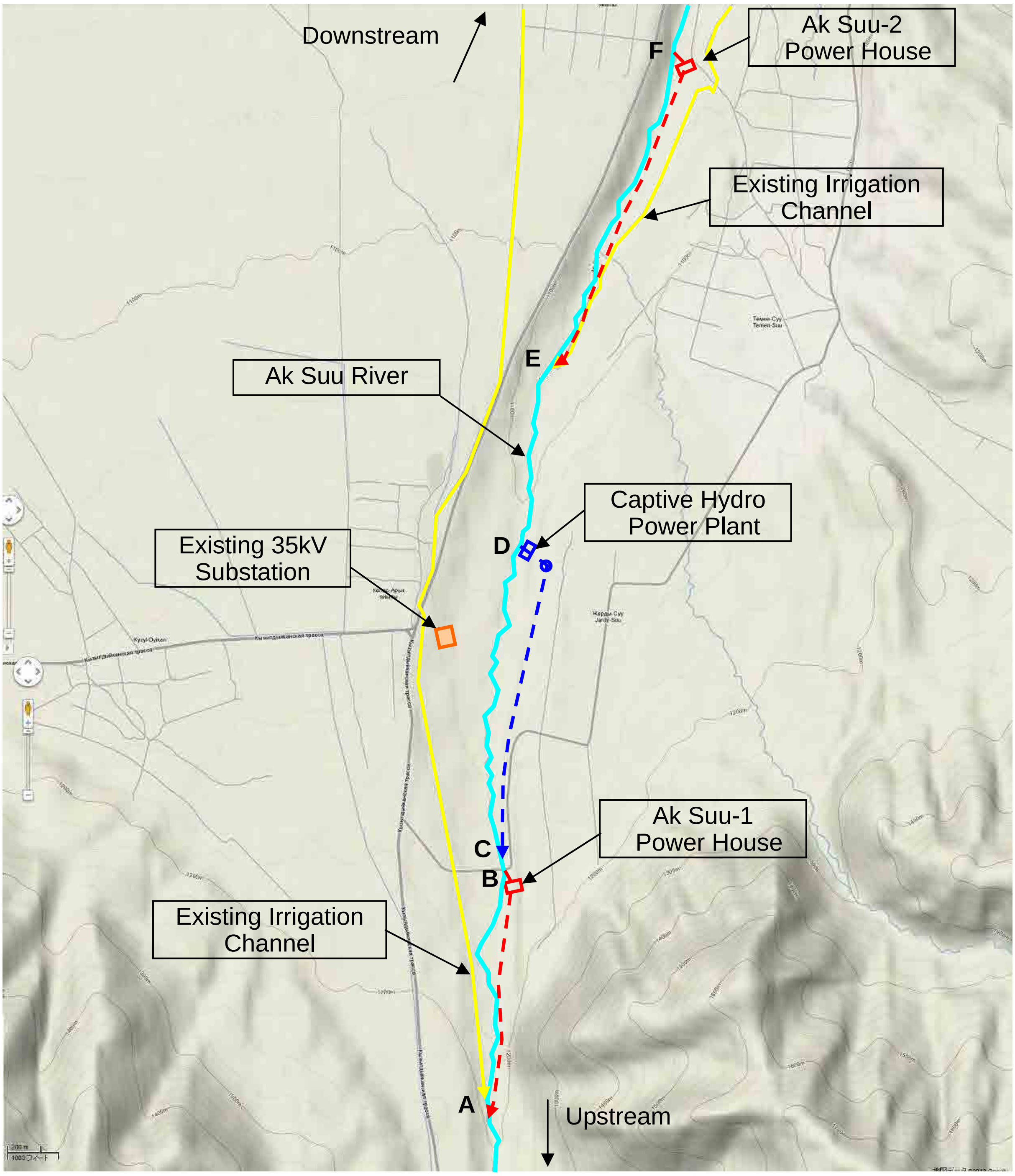


Figure 6-2-32 Location of Ak Suu-1&2 and Existing Captive SHPP

Table 6-2-5 Location Data for Measure Points along Ak Suu River

	Measure Points	Latitude	Longitude	Altitude (EL.m)	Height difference (m)	Cumulative Distance (m)	Interval Distance (m)	Gradient (L/H)	Estimated Discharge (m^3/s)
A	Ak Suu-1 Intake	N42°39'10.8"	E74°00'01.5"	1,186	–	–	–	–	1.0～1.5
B	Ak Suu-1 powerhouse	N42°39'53.0"	E74°00'08.6"	1,150	-36	1,370	1,370	38	1.5
C	Captive Intake	N42°40'01.9"	E74°00'05.4"	1,145	-5	1,610	240	48	1.2
E	Captive Powerhouse	N42°40'57.4"	E74°00'12.7"	1,107	-38	3,330	1,720	45	
F	Ak Suu-2 Intake	N42°41'34.6"	E74°00'19.0"	1,085	-22	4,500	1,170	53	0.5
G	Ak Suu-2 Powerhouse	N42°42'33.7"	E74°00'52.8"	1,042	-43	6,490	1,990	46	0.5～0.8

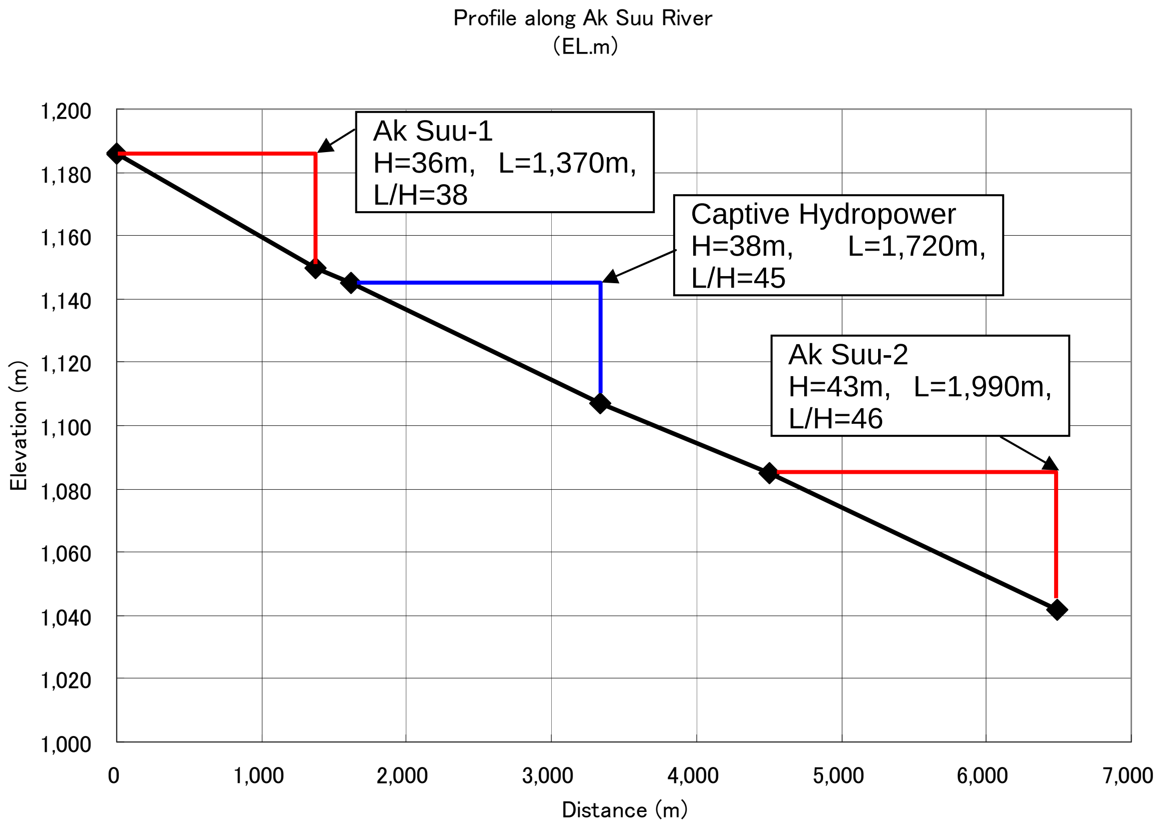


Figure 6-2-33 Longitudinal Profile of Ak Suu River (Intake – Powerhouse)

Waterway Length

Ak Suu-1	Pressure Pipe	: 1,400 m
Captive Power	Pressure Pipe	: 1,660 m
	Penstock	: 120 m
Ak Suu-2	Pressure Pipe	: 2,000 m

(4) Photographs of Site Conditions

Photo 6-2-101: Existing Intake for Irrigation near Ak Suu-1 Intake

Photo 6-2-102: Existing Intake for Irrigation near Ak Suu-1 Intake

Photo 6-2-103: Ak Suu-1 Powerhouse

Photo 6-2-104: Intake for Captive Power

Photo 6-2-105: Headrace for Captive Power

Photo 6-2-106: Head for Captive Power

Photo 6-2-107: Headtank for Captive Power

Photo 6-2-108: Penstock for Captive Power

Photo 6-2-109: Powerhouse for Captive Power

Photo 6-2-110: Generator for Captive Power

Photo 6-2-111: Generator Nameplate for Captive Power

Photo 6-2-112: 35 kV Substation near the Site

Photo 6-2-113: Existing Intake for Irrigation at Ak Suu-2 Intake (Q=0.5 m^3/s)

Photo 6-2-114: Irrigation Channel from Existing Intake

Photo 6-2-115: Powerhouse for Ak Suu-2

(5) Bird view for Waterway Routes

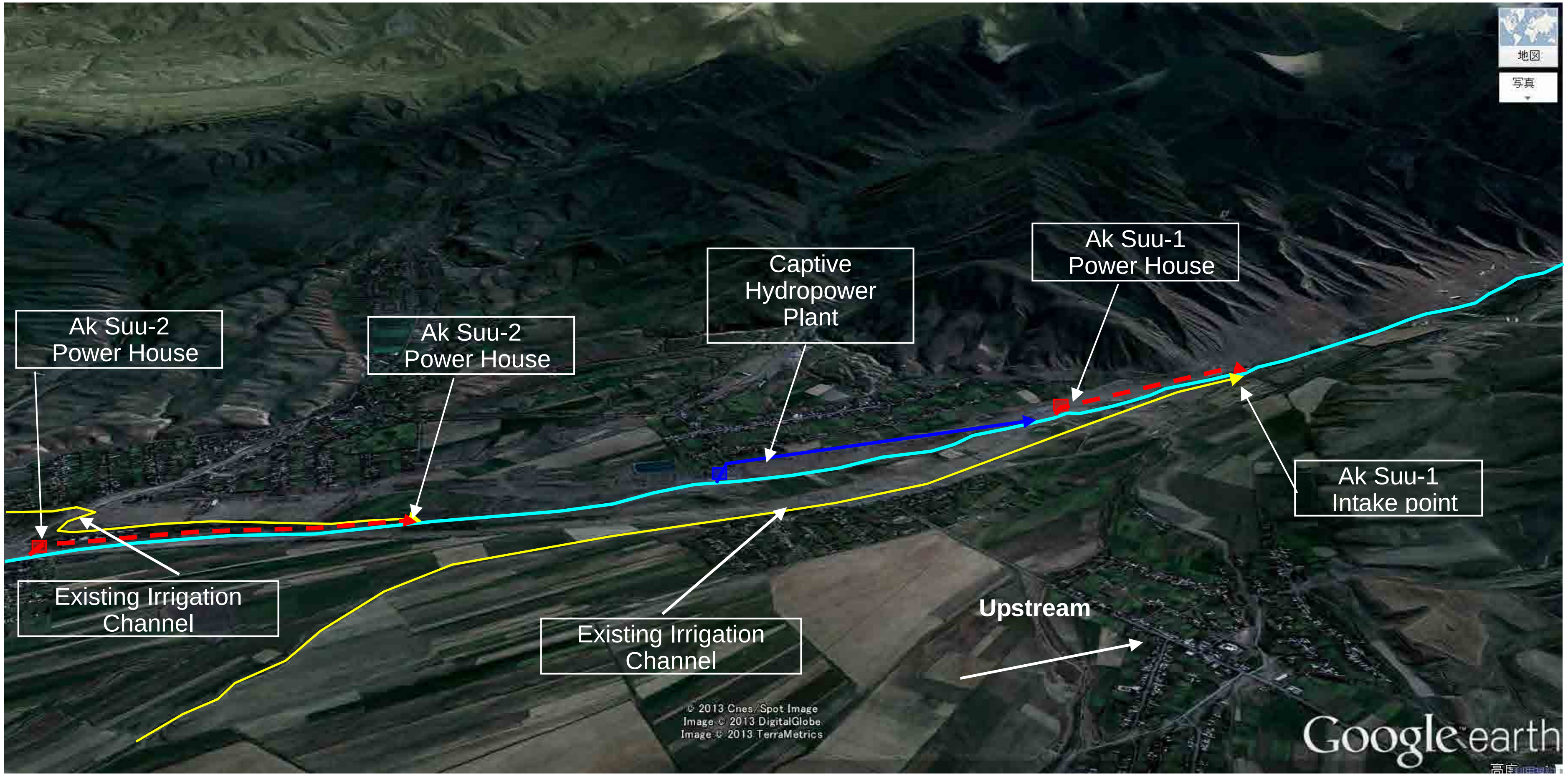


Figure 6-2-34: Bird View for Ak Suu Sites

(6) Findings and Evaluation

In EBRD’s SHPP master plan, Ak Suu-1 and 2 are classified as sites for reconstruction on abolished SHPP, but there is no trace of the abolished SHPPs. These sites should, therefore, be regarded just as new sites.

Since there are intake facilities at or near the intake sites for these SHPP sites, there is a big concern that the SHPPs will be unable to intake sufficient water from the river during the irrigation period. In addition to very gentle river gradient, the headrace is designed as pressure pipe which requires higher construction costs than that of conventional type. These conditions lead to relatively high construction costs and then the two sites are evaluated to be economically unfeasible.

In conclusion, both Ak Suu-1 and 2 sites are excluded from promising candidates.

6-2-9 Lebedinovka Site

Lebedinovka HPP is a candidate site for the renovation project of existing HPPs. Lebedinovka HPP is one of the oldest HPPs of nine (9) HPPs which are owned, operated and maintained by a stated-owned enterprise, JSC Chakan GES.

Lebedinovka HPP is located at the most upstream of Alamedin Cascade small HPP group which utilizes the water flow of the irrigation main canal near the capital Bishkek.

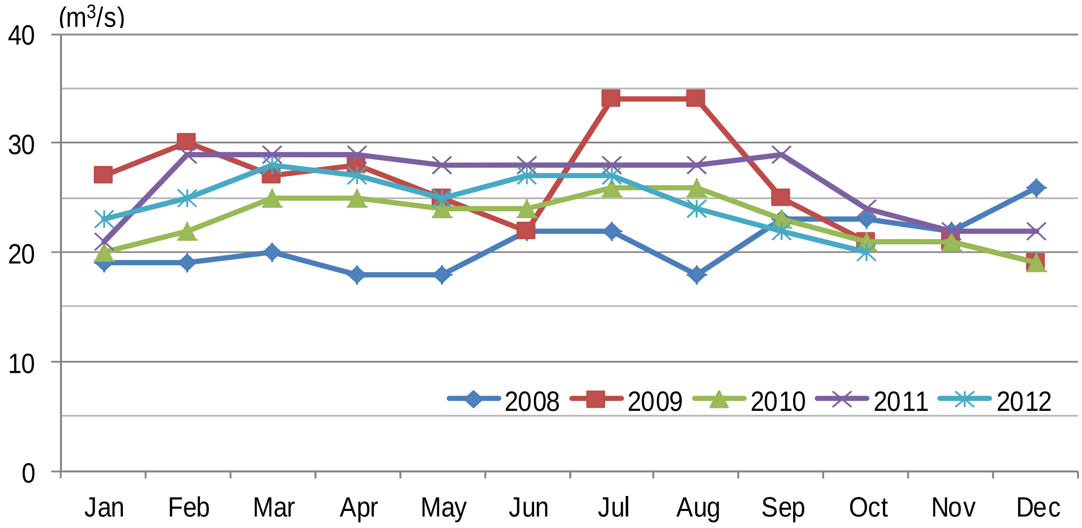
Lebedinovka HPP is one of the most important HPPs for JSC Chakan GES since it has the largest capacity of eight Cascade HPPs. The location, the output and the commissioning year of Lebedinovka HPP are shown in Figure 5-7-10 and Table 5-7-3 respectively.

Lebedinovka HPP is composed of two water turbine generators. Main features of equipment are shown in Table 6-2-6. Both water turbine generators has passed over sixty years since the commissioning year, and it supposed that the efficiency of equipment is not high compared to the current design technology and is further decreased due to aged deterioration.

Table 6-2-6 Main Equipment Specification of Lebedinovka HPP

	Unit No.1	Unit No.2
Commissioning Year	1948	1943
Country of Manufacturing	United States of America	Sweden
Effective Head	26.8 m	26.8 m
Maximum Designed Discharge	19.0 m^3/s	21.0 m^3/s
Turbine Type	Vertical Francis	Horizontal Francis
Rated Rotation Speed	250 min^{-1}	375 min^{-1}
Diameter of Turbine Runner	1,840 mm	1,200 mm
Rated Generation Capacity	5,000 kVA	4,750 kVA
Rated Power Factor	0.8	0.75
Rated Generation Output	4,000 kW	3,600 kW
Rated Generation Voltage	6 kV	6 kV
Rated Frequency	50 Hz	50 Hz

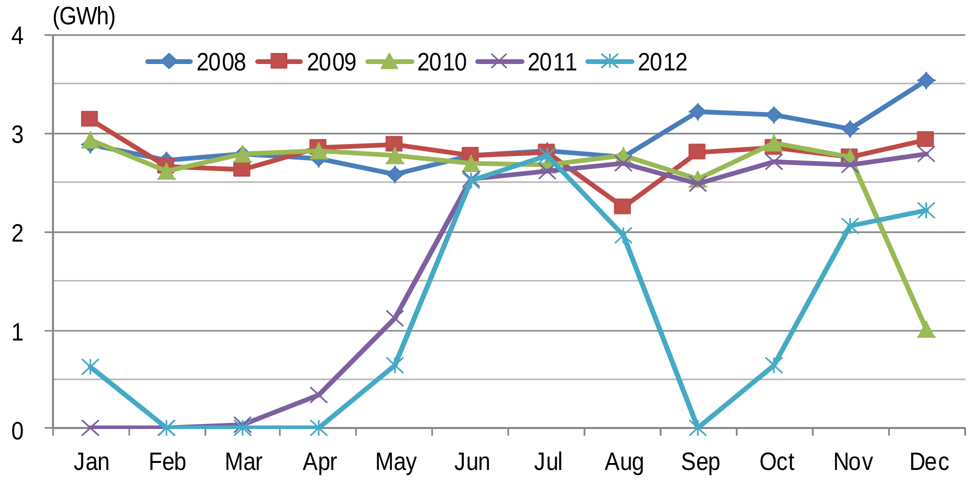
According to the Interview with JSC Chakan GES, the amount of the total inflow into Lebedinovka HPP at the time it was designed and constructed was up to 40 m^3/s. After construction, a new water intake facility for supplying irrigation water to another region was built in the channel on the upstream side from the power plant, and the current amount of the inflow was reduced to about 30 m^3/s at maximum. Monthly average inflow of Lebedinovka HPP from October 2008 to January 2012 is shown in Figure 6-2-35. Annual average inflow from 2008 to 2011 is 24.1 m^3/s. Maximum value of the monthly average inflow has recorded 34 m^3/s in July and August of 2009. The others of monthly average values are less than 30 m^3/s. In addition, seasonal variation of inflow is not so large, the minimum monthly average inflow of 21.5 m^3/s in December (average value from 2008 to 2011) against the maximum monthly average inflow of 27.4 m^3/s in July (average from 2008 to 2012) has decreased only about 22%. This shows that Lebedinovka HPP has an enough inflow to play an important role as a power supplier in winter when the value of the power supply is insufficient.



(Source: JSC Chakan GES)

Figure 6-2-35 Monthly Average Inflow of Lebedinovka HPP (2008 – 2012)

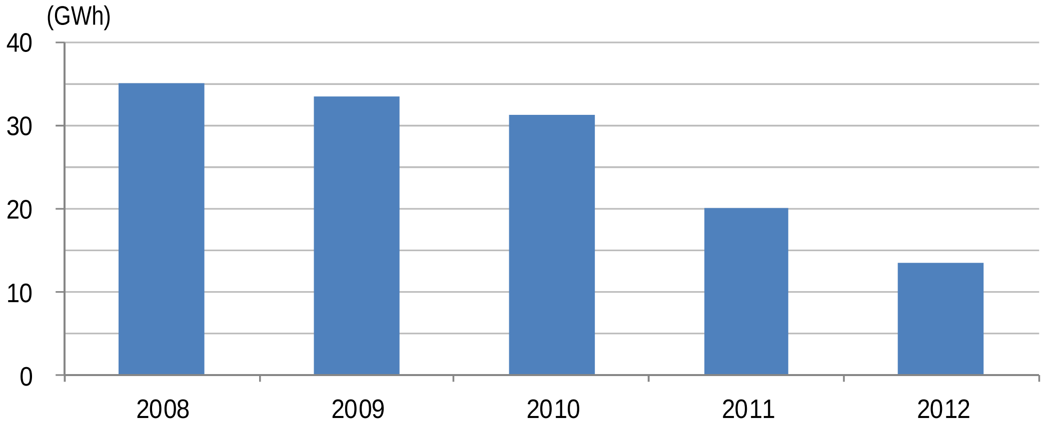
Then, monthly power generation of Lebedinovka HPP is shown in Figure 6-2-36. There are no large changes between seasons same as inflow data mentioned above, but the extreme reduction of the power generation can be observed from December 2010. According to the interview with JSC Chakan GES, Unit No.2 of Lebedinovka HPP is no longer able to operate by the trouble of main shaft a few years ago, and the cause of the reduction in power generation is estimated to be due to this trouble.



(Source: JSC Chakan GES)

Figure 6-2-36 Monthly Power Generation of Lebedinovka HPP (2008 – 2012)

Annual power generation from 2008 to 2012 is shown in Figure 6-2-37. The amount in 2011 and 2012 decreased largely compared to the others. This cause is estimated to be due to the stoppage of Unit No.2 by the equipment trouble.



(Source: JSC Chakan GES)

Figure 6-2-37 Annual Power Generation of Lebedinovka HPP (2008 – 2012)

The trouble of the main shaft has happened in Unit No.1 of water turbine generator same as Unit No.2, and Unit No.1 (rated generator output of 4.0 MW) can be operated only at the output of up to 2.9 MW. For this reason, currently, under the supervision of a Russian engineer invited, JSC Chakan GES has formulated the renovation plan of Unit No.2 as well as the repair plan of Unit No.1 and Unit No.2.

1st STEP：
Of two troubled units, Unit No.2 (rated generator output of 3.6 MW) will be repaired to be able to operate at the output of 1.1 to 1.5 MW in this summer first. After repairs of Unit No.2, the total power generation of Lebedinovka HPP will reach to 4.0 to 4.4 MW compared to the total value of 2.9 MW (only Unit No.1) before repairs.

2nd STEP：
After Unit No.2 starts operation, Unit No.1 whose available generation output has reduced to 2.9MW will be repaired to be able to operate at rated generation output of 4.0 MW by this winter. During the repair work of Unit No.1, only Unit No.2 will be operated and the total power generation of Lebedinovka HPP will be 1.1 to 1.5 MW. After the repair work of Unit No.1, Unit No.1 will first operate at the rated generation output of 4.0 MW and Unit No.2 will operate at 1.1 to 1.5 MW with inflow of the rest. As a result of this, the total power output will reach to 5.1 to 5.5 MW.

3rd STEP：
Unit No.1 (rated generation output of 3.6MW) will be repaired on 1st STEP. However, the available generation output will be recovered to only 1.1 to 1.5 MW after the repair. In addition, it is assumed that Unit No.2 will stop the operation again due to the equipment trouble in several years since the aged deterioration of Unit No.2 has been serious already.
Therefore, JSC Chakan GES is planning the renovation work of the existing Unit No.2 with the aim to improve the reliability and recover the power output. The water turbine generator was commissioned 70 years ago and it is assumed that its efficiency has decreased significantly due to aged deterioration. Since the design of high efficiency thanks to technological progress can be applied to new equipment, it is expected that the values of power output and the power generation after the renovation work will increase largely, even if the same amount of the discharge is used.

If the entire above plan is realized, Lebedinovka HPP will contribute significantly to the power supply to the capital Bishkek. However, JSC Chakan GES is being in a difficult financial condition. JSC Chakan GES has the policy that only 1st STEP (small scale) will be carried out in its own funds. For the finds of the 2nd STEP and 3rd STEP (large funds is required), the financing is not prepared. From this, it seems that there is difficulty in the feasibility that the renovation plan of Unit No.2 and the repair plan of Unit No.1 will be done by JSC Chakan GES.

As mentioned above, the equipment trouble has occurred in Unit No.2 of Lebedinovka HPP which started the operation over seventy years ago and both the capacity of the power output and reliability of the equipment has been decreasing. On the other hand, the discharge of the irrigation channel which is utilized by Lebedinovka HPP is stable through the year and it is expected that the renovation work of Unit No.2 will lead to the large increase in recovery of the power output and the power generation. Furthermore, this renovation work will have economic advantages compared to a new construction work since most existing civil facilities are in good conditions and don’t need to be replaced with new ones in the renovation work.

On condition that all equipment including auxiliary equipment will be replaced in the renovation work of Unit No.2, a major problem in designing and constructing cannot be found if a manufacturer who is different from the original manufacturer supplies new equipment. However, it is necessary to pay careful consideration such as conducting the prior site investigation thoroughly, for the design of the interface with the existing facilities of Unit No.1 and the construction work regarding removal, installation and connection of control cables and piping.

There is no possibility that any competition for water use will occurs since Lebedinovka HPP is located on the existing irrigation channel. And the renovation plan does not include the large-scale civil work such as replacement of water way. From these, it seems that there are not any problems regarding environmental and social considerations. Furthermore, it can be said that this renovation work is an appropriate one as a public financing and technical cooperation project as the owner of Lebedinovka HPP is a stated-owned enterprise, JSC Chakan GES.

As mentioned above, since any large problems are not confirmed at this stage, the renovation plan on Unit No.2 of Lebedinovka HPP can be considered as one of the promising candidates. Therefore, the examination of the main specifications and the calculation of the construction cost regarding the renovation work will be conducted.

6-2-10 Summary of Findings from Site Surveys

As a result of the site surveys carried out on a total of 13 sites selected in 6-1-1, 8 sites are excluded from promising candidates because major issues to development were confirmed at this stage, while the other 5 sites with added Kegeti-2 during the site survey are evaluated as promising candidates and subsequently calculations on power generation features and estimation of their construction costs will be carried out in the next stage.

Table 6-2-6 Evaluation of Surveyed Potential Sites

No	Name of Site	Source	Output (MW)	Type	Candidates for Promising Sites	Major Issues for exclusion
1	**Kegeti-1**	KSTC	2.4	New	○	
2	**Kegeti-2**	Survey Team		New	○	
3	**Djardy-Kainda**	KSTC	1.2	Reconstruction	○	
4	**Chon-Kemin-3**	Presidential Decree No.365	5.0	New	○	
5	**Lebedinovka**	JSC Chakan GES	7.6	Renovation of Existing	○	
6	Issyk-Ata-2	KSTC	3.6	New	×	Possibility of Conflict with Private/ Negative Impact on Spa Resort
7	Sokuluk-1	Presidential Decree No.365	2.0	Reconstruction	×	Possibility of Conflict with Private
8	Alamedin	Presidential Decree No.365	3.2	New	×	Possibility of Conflict with Private/ Negative Impact on Spa Resort
9	Shamsi	EBRD 20 promising site	2.4	New	×	Conflict with Existing Irrigation Channel/ Economically inefficient (long pressure headrace)
10	Chon-Kemin-1	Presidential Decree No.365 /EBRD 20 promising site	5.0	New	×	Economically inefficient (large L/H*)
11	Chon-Kemin-2	Presidential Decree No.365	5.0	Reconstruction	×	Economically inefficient (large L/H*)
12	Ak Suu-1	EBRD 20 promising site	1.98	Reconstruction	×	Conflict with Existing Irrigation Channel/ Economically inefficient (large L/H*)
13	Ak Suu-2	EBRD 20 promising site	1.73	Reconstruction	×	Conflict with Existing Irrigation Channel/ Economically inefficient (large L/H*)

Note *: L/H = Waterway length / Height deference

6-3 Hydropower Planning

6-3-1 Analysis of Hydrological Data

Except for Lebedinovka site, hydrological data for the four (4) candidate sites remaining in the previous section 6-2 are analyzed to determine maximum discharge for each site.

(1) Catchment Areas

Catchment areas for the four sites are measured based on the topographical maps on a scale of 1:200,000, as shown below. Catchment area for each site is shown in Figure 6-3-1, 2 and 3.

Kegeti-1 : 127 km^2
Kegeti-2 : 108 km^2
Djardy-Kainda : 181 km^2
Chon-Kemin-3 : 1,891 km^2

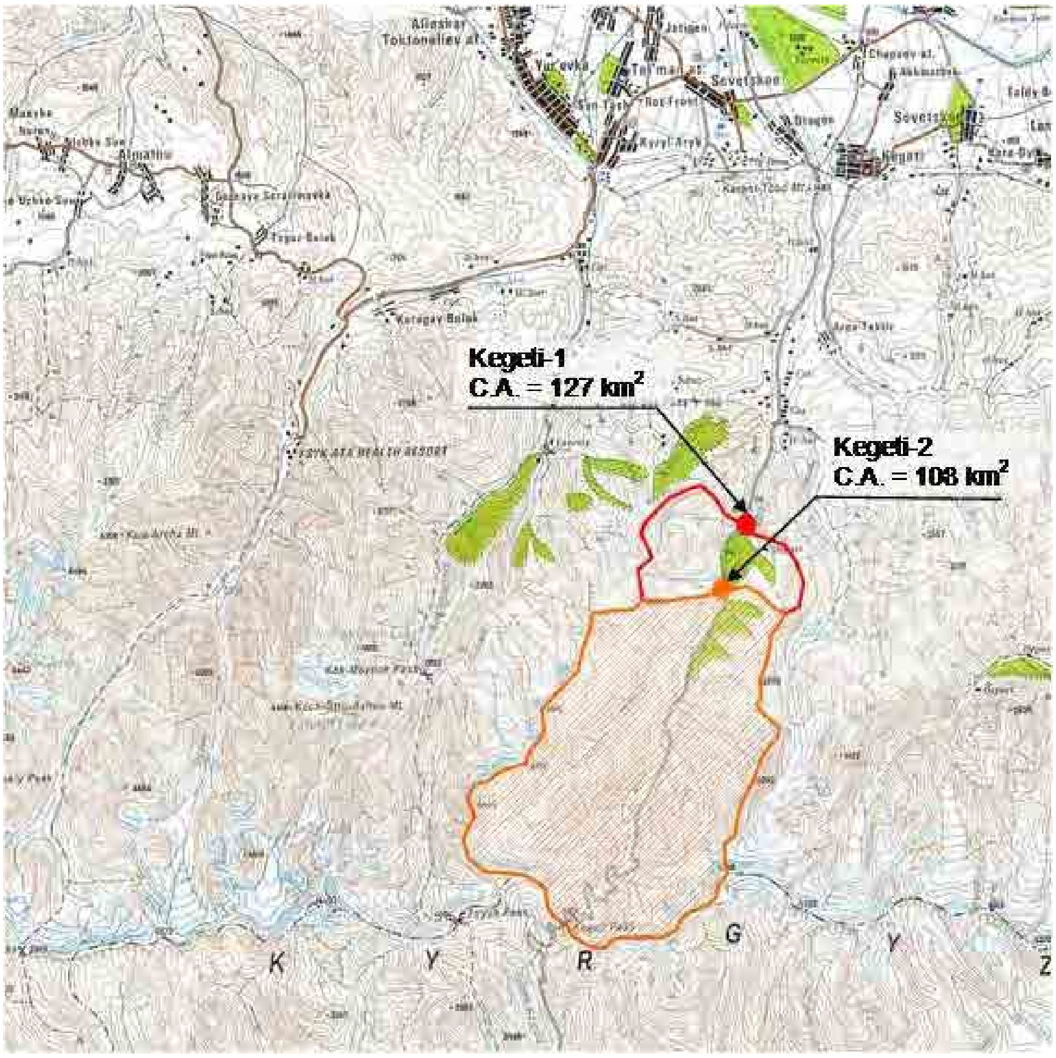


Figure 6-3-1 Catchment Areas for Kegeti-1and 2

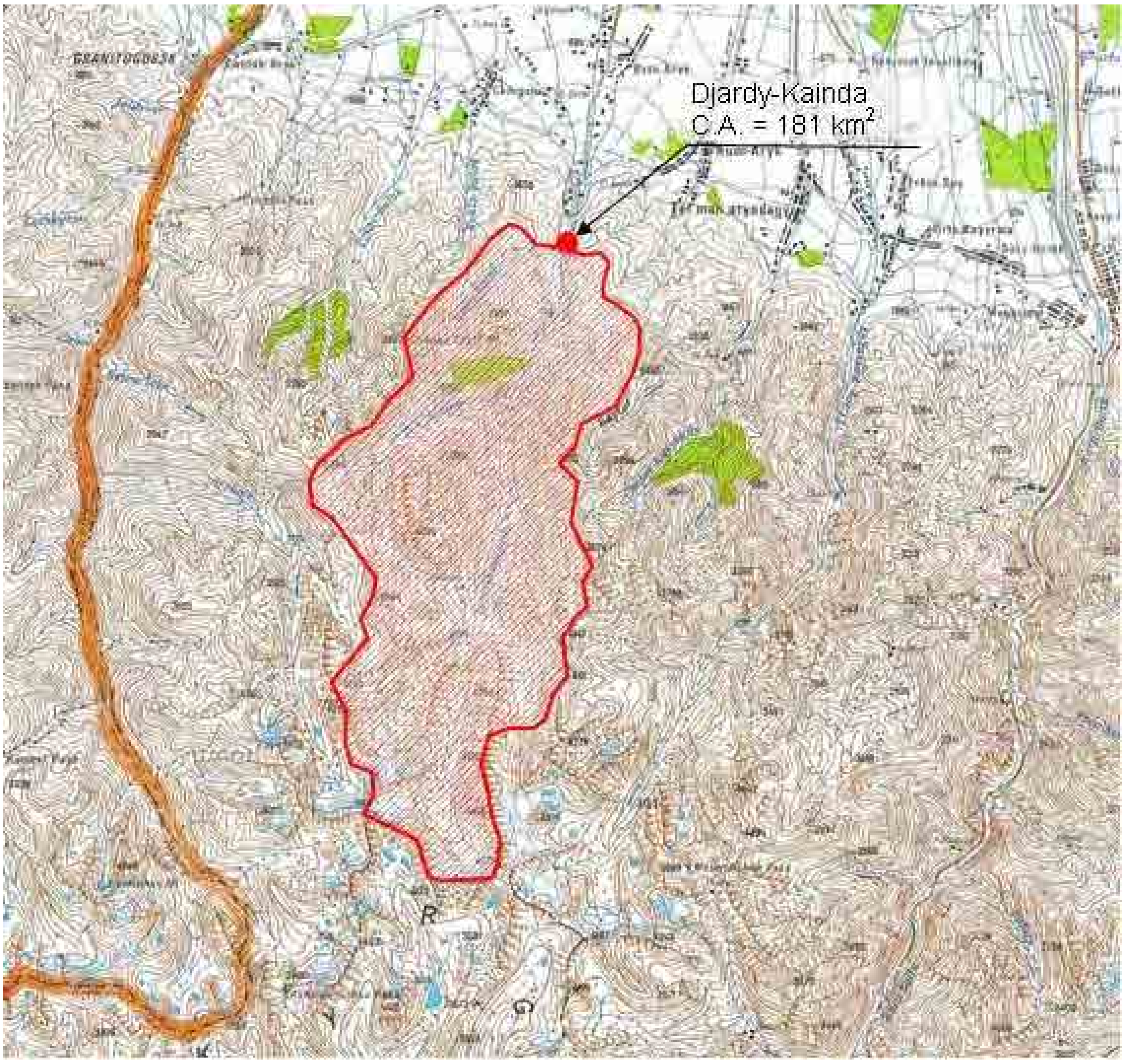


Figure 6-3-2 Catchment Area for Djardy-Kainda

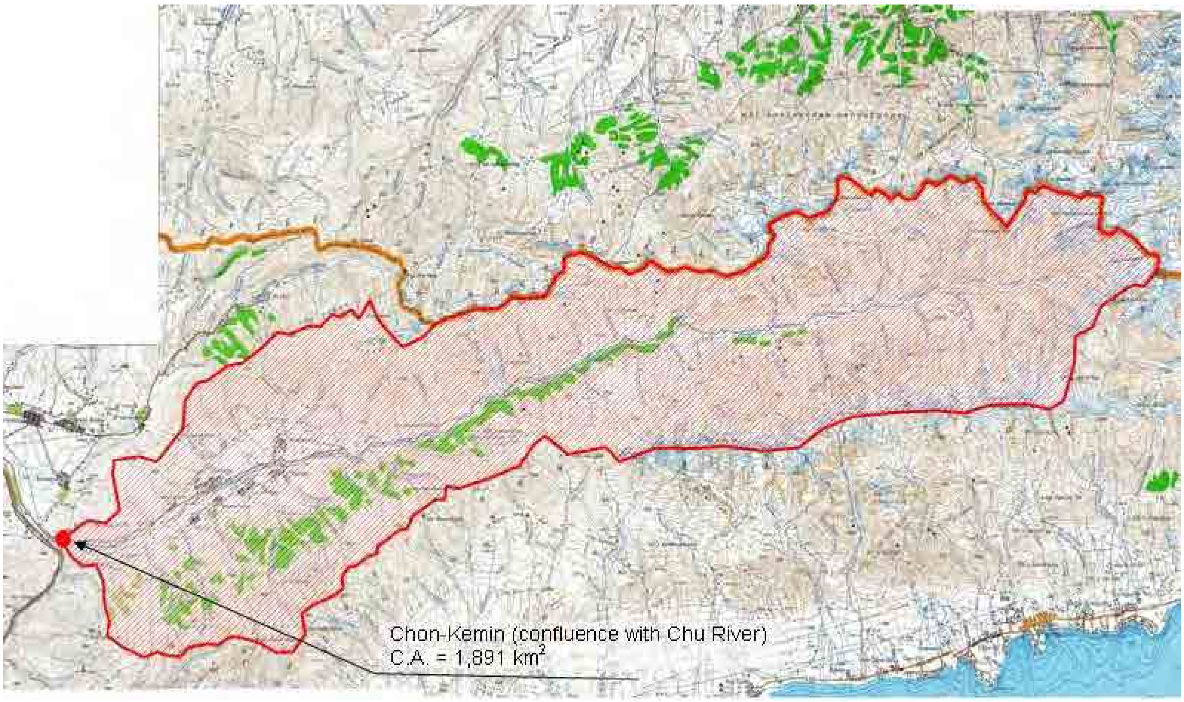


Figure 6-3-3 Catchment Area for Chon-Kemin-3

(2) Calculation of Flow Duration Curve

In the Kegeti river, a gauging station (Hydropost) (hereinafter referred as to Kegeti gauging station, catchment area: 256 km^2) has been installed and discharge data has been recorded for a long time. However, discharge data after 2002 has not been recorded for some reasons. Therefore, the daily discharge data are collected for the eleven years period from 1992 to 2002.

Due to the fact that there is no gauging station in the Djardy-Kainda River, flow duration data of Kegeti gauging station is used for Djardy-Kainda site. Since the specific discharges measured at Kegeti River are smaller than that at other rivers, the discharges calculated using the specific discharges at Kegeti River are conservative (small) discharge. Since there is a reservoir for irrigation upstream of Chon-Kemin-3, flow duration at Chon-Kemin-3 site is not similar to general rivers. Therefore, the maximum discharge is determined not using flow duration curve.

In general, discharge for a planning site is calculated based on discharge data measured at a gauging station near the site and catchment area ratio of the gauging station and the site. However, as mentioned in Chapter 5, 5-2-1, river discharges in Chui Valley are strongly influenced by snow melting in high mountain areas, and it is desirable to estimate discharges at the targeted site taking into account the influence of melting snow, when conducting more detailed planning.

Calculated flow duration curves for Kegeti-1, Kegeti-2 and Djardy-Kainda are shown in Figure 6-3-4, 5 and 6. In the flow duration curves, curves of discharge plant factor and river flow utilization are also added.

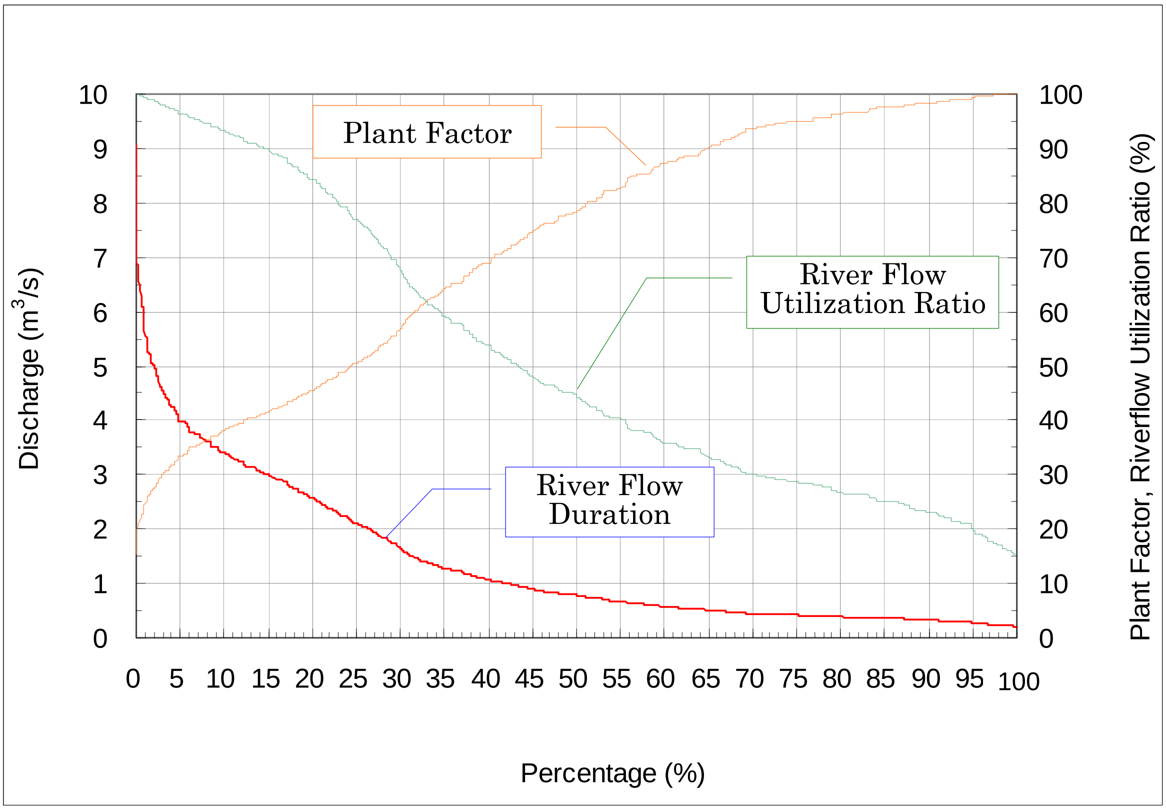


Figure 6-3-4 Flow Duration Curve for Kegeti-1 (C.A.: 127 km^2)

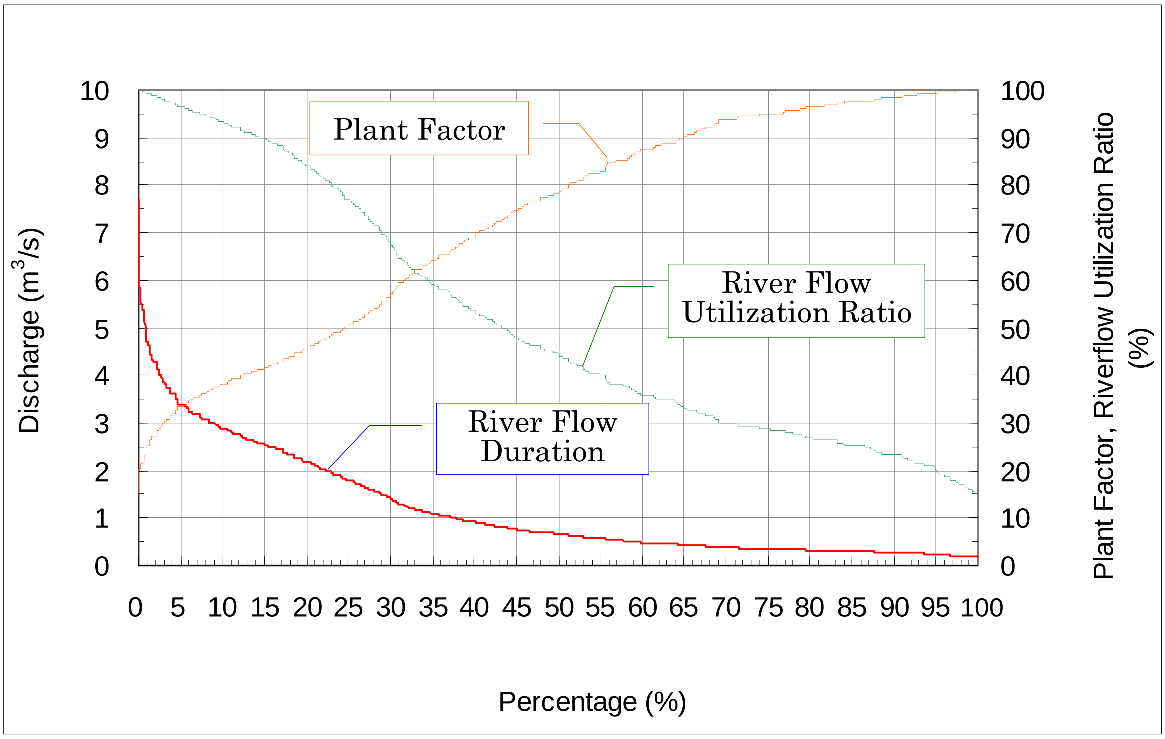


Figure 6-3-5 Flow Duration Curve for Kegeti-2 (C.A.: 108 km^2)

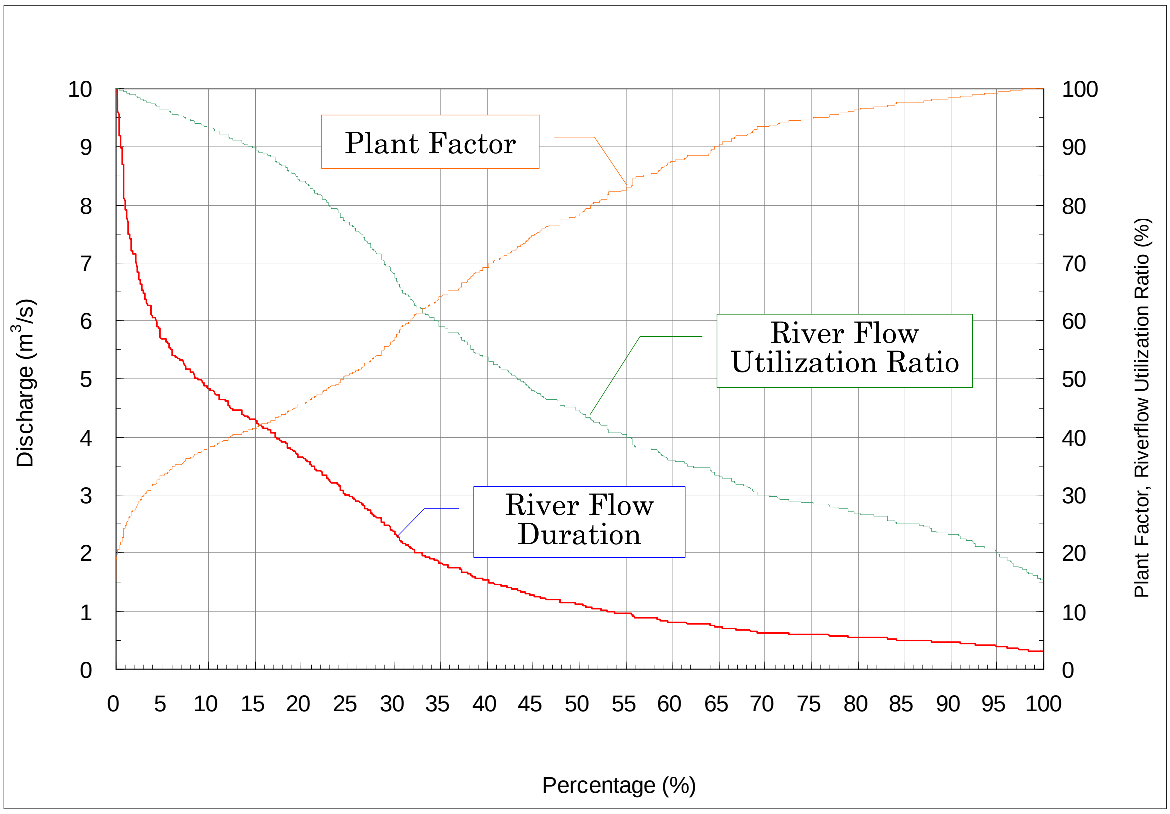


Figure 6-3-6 Flow Duration Curve for Djardy-Kainda (C.A.: 181 km^2)

(3) Maximum Discharge

Maximum discharges of the sites are determined to be a discharge when a discharge plant factor is 70% in consideration of the past SHPP developments.

As a result, the maximum discharges are as follows:

Kegeti-1	: 1.05 m^3/s
Kegeti-2	: 0.90 m^3/s
Djardy-Kainda	: 1.50 m^3/s
Chon-Kemin-3*	: 30.0 m^3/s

*: Since there is a reservoir for irrigation upstream of Chon-Kemin-3, flow duration at Chon-Kemin-3 site is not similar to general rivers, and no discharge data could not be obtained during the survey, the maximum discharge is determined at 30 m^3/s that is two third of 45 m^3/s, the maximum discharge at Bystrovka hydropower plant located 13 km downstream of the Chon-Kemin-3 site.

6-3-2 Renovation Plan of Lebedinovka Site

The main generating specification and the construction cost determined with the method shown in "the Guidebook for the Development of Small and Middle Scale Hydropower Plants (3rd revised edition)" published by NEF is shown in Table 6-3-1 in case that the renovation work on Unit No.2 of Lebedinovka HPP is conducted by Japanese financing and technology.

Based on the average annual inflow from 2008 to 2011 of 24.1 m^3/s, the maximum available inflow for Lebedinovka HPP is assumed to be 25.0 m^3/s. The maximum inflow for Unit No.1 whose available output has been decreased to 2.9 MW due to the equipment trouble is assumed to be 14.7 m^3/s, calculated with the measurement of the relationship between the discharge and the power output recorded by JSC Chakan GES. For the renovation plan on Unit No.2 of Lebedinovka HPP under the conditions mentioned above, the following two patterns of the largest and smallest scale are investigated the patterns of two of the largest and smallest size shown below.

Case 1:
10.3 m^3/s is the value of the maximum designed discharge for renovated Unit No.2 obtained by subtracting the value of the maximum available discharge of 14.7 m^3/s from the value of the maximum designed discharge for Lebedinovka HPP of 25.0 m^3/s. New Unit No.2 whose efficiency will be increased by the renovation work is operated at maximum power output on a priority basis. The existing Unit No.1 is operated with the discharge of the rest.

Case 2:
New Unit No.2 is operated with the maximum designed discharge for Lebedinovka HPP of 25.0 m^3/s. The only new Unit 2 is usually operated and the existing Unit No.1 is treated as a spare unit.

Table 6-3-1 Main Generating Specification and Construction Cost of Lebedinovka HPP

Items		Case 1 (Smallest Size)	Case 2 (Largest Size)
Specification	Maximum Output of Unit No.1, P_1 (MW)	2.90	(2.90)
	Maximum Output of Unit No.2, P_2 (MW)	2.22	5.67
	Total Maximum Output, P (MW)	5.12	5.67
	Maximum Designed Discharge of Unit No.1, Q_1 (m^3/s)	14.7	(14.7)
	Maximum Designed Discharge of Unit No.2, Q_2 (m^3/s)	10.3	25.0
	Total Designed Discharge, Q (m^3/s)	25.0	25.0
	Effective Head, He (m)	26.8	26.8
	Annual Available Power Generation of Unit No.1 (GWh/year)	21.87	0
	Annual Available Power Generation of Unit No.2 (GWh/year)	19.45	47.11
	Total Annual Available Power Generation (GWh/year)	41.32	47.11
Equipment	Turbine Type	Horizontal Francis	Vertical Kaplan
	Maximum Combined Efficiency of Unit No.1 (%)	74.3	(74.3)
	Maximum Combined Efficiency of Unit No.2 (%)	82.2	86.4
Cost	Renovation Cost (mil. JPY)	1,271.7	2,407.5

Table 6-3-1 shows obviously that the maximum power output and annual available power generation of Lebedinovka HPP in Case 1 are larger than those in Case 2. This is because the entire discharge of Lebedinovka HPP is used for New Unit No.2 whose efficiency is 12.1% higher than that of Unit No.1 in Case 2 although the value of the maximum designed discharge for Lebedinovka HPP of 25.0 m^3/s is the same in both Case 1 and Case 2. The cost for the renovation works in Case 2 whose capacity of equipment is larger than that of Case 1 is 2,407.5 mil. JPY. The cost of Case 2 is about 1.9 times higher than that of Case 1. The cost of the renovation work includes not only the construction costs for water intake, penstock, outlet, foundation for equipment, electrical-mechanical equipment, temporary facilities and so on, but also transportation costs and contingency.

Evaluation of economic efficiency and benefit effect are summarized in Table 6-3-2, divided into three following cases.

Case 1-1:
Unit No.2 is replaced with New equipment whose capacity is 2.22 MW on condition that both existing Unit No.1 (2.9 MW) and Unit No.2 (1.5 MW) repaired by JSC Chakan GES are able to operate after the renovation work.

Case 1-2:
Unit No.2 is replaced with New equipment whose capacity is 2.22 MW on condition that the only existing Unit No.1 (2.9 MW) is able to operate, but Unit No.2 (1.5 MW) repaired by JSC Chakan GES is not able to operate after the renovation work.

Case 2:
Unit No.2 is replaced with New equipment whose capacity is 5.67 MW on condition that the neither existing Unit No.1 (2.9 MW) nor Unit No.2 (1.5 MW) repaired by JSC Chakan GES is able to operate after the renovation work.

Table 6-3-2 Evaluation of Economic Efficiency and Benefit Effect of Renovation Plan on Lebedinovka HPP Unit No.2

Items		Case 1-1	Case 1-2	Case 2
Output	1. Maximum Output of Existing Unit No.1 (MW)	2.90	2.90	0
	2. Maximum Output of Existing Unit No.2 (MW)	(1.50)	0	0
	3. Maximum Output of Renovated Unit No.2 (MW)	2.22	2.22	5.67
	4. Total Maximum Output (MW)	5.12	5.12	5.67
	5. Increment of Total Maximum Output by Unit No.2 Renovation (MW)	0.72	2.22	5.67
Cost	Cost of Renovation Work for Unit No.2 (mil. JPY)	1,271.7	1,271.7	2,407.5
Benefit 1 (MW)	1. Winter Maximum Output of Existing Unit No.1 (MW)	1.96	1.96	0
	2. Winter Maximum Output of Existing Unit No.2 (MW)	(1.50)	0	0
	3. Winter Maximum Output of Renovated Unit No.2 (MW)	2.22	2.22	4.88
	4. Total Winter Maximum Output (MW)	4.18	4.18	4.88
	5. Increment of Total Winter Maximum Output by Unit No.2 Renovation (MW)	0.72	2.22	4.88
Benefit 2 (GWh/year)	1. Annual Available Power Generation of Existing Unit No.1 (GWh/year)	21.87	21.87	0
	2. Annual Available Power Generation of Existing Unit No.2 (GWh/year)	(13.14)	0	0
	3. Annual Available Power Generation of Renovated Unit No.2 (GWh/year)	19.45	19.45	47.11
	4. Total Annual Available Power Generation (GWh/year)	41.32	41.32	47.11
	5. Increment of Total Available Power Generation by Unit No.2Renovation (GWh/year)	6.31	19.45	47.11
Economy	Cost per kW (Thousand JPY/kW)	1,766	572	425
	Cost per kWh (JPY/kWh)	202	65	51

As an indicator of benefit effect, first, winter maximum power output is took up. As Maximum monthly available inflow in winter, 21.5 m^3/s of the monthly average inflow in December (average from 2008 to 2011) is chosen since that in December is the minimum value throughout the year. As shown in Table 6-3-3, in Case 1, Unit No.2 operates at maximum designed discharge of 10.3 m^3/s and existing Unit No.1 whose efficiency is low operates with 11.2 m^3/s, the discharge of the rest. On the other hand, in Case 2, Unit No.2 whose efficiency is high can operate with the entire inflow in winter since maximum designed discharge of Unit No.2 is 25.0 m^3/s. As a result of this, the maximum power output of Lebedinovka HPP in Case 2 of 4.88 MW is 17% larger than that in Case 1, and 63% larger than that of the existing Unit No.1. It means that Case 2 contributes significantly to the resolution of the power shortage in winter. Since the existing Unit No.2 is assumed to be able to continue to operate in Case 1-1, increment of winter maximum power by Unit No.2 renovation work is 0.72 kW obtained by subtracting the existing Unit No.2's maximum power output in winter of 1.50 kW from renovated Unit No.2's maximum power output in winter of 2.22 kW.

Table 6-3-3 Breakdown of Winter Maximum Output of Renovation Plan on Lebedinovka HPP Unit No.2

	Case 1 (Maximum Designed Discharge of Unit No.2: 10.3 m^3/s)			Case 2 (Maximum Designed Discharge of Unit No.2: 25.0 m^3/s)		
	Discharge (m^3/s)	Combined Efficiency (%)	Maximum Output (MW)	Discharge (m^3/s)	Combined Efficiency (%)	Maximum Output (MW)
Unit No.1	11.2	66.8	1.96	—	—	—
Unit No.2	10.3	82.2	2.22	21.5	86.4	4.88
Total	21.5	—	4.18	21.5	—	4.88

Annual power generation of another indicator is the same condition as power output in winter of the former indicator. Case 2 in which renovated Unit No.2 can use almost all inflow supplies 47.11 GWh which is 14% larger than that of Case 1. Moreover, since the existing Unit No.1 which generates more than half of the annual power generation has operated for sixty five years, Unit No.1 is at risk of falling into long-term stoppage of operation by the occurrence of fatal equipment trouble due to aged deterioration. Table 6-3-4 shows the life period of water turbine equipment surveyed in Japan. This table indicates that it is about time that the existing Unit No.1has to be replaced with new equipment.

Table 6-3-4 Life Period of Water Turbine Equipment

Water Turbine Equipment	Life Period
Casing, Stay vane	61～80 years
Guide vane	61～80 years
Turbine Runner	31～40 years
Turbine Cover	61～80 years
Inlet Valve	11～80 years
Main Shaft	61～80 years
Bearing	61～80 years

(Source: Electric Technology Research Association, Japan, No. 59-3, 2004)

For the renovation work of Unit No.2, Case 2 is more cost-effective since both the construction cost per kW and the construction cost per kWh of Case 2 are smaller than those of Case 1.
For this reason, it can be said simply that Case 2 has benefit from having a larger scale because the maximum output of Case 2 is about 2.6 times that of Case 1. From the above, it is supposed that Case 2 is better than Case 1 in terms of both economic efficiency and benefit side, though construction costs of Case 2 is higher than that of case 1. And Case 2 contributes much to power supply capacity for winter when the amount of the power supply is short.

Furthermore, JSC Chakan GES has exported a lot of amount of power generation to the neighbor country, Kazakhstan so far. If the first purpose of this renovation work is to stabilize the domestic power supply, it is supposed that some commitments with JSC Chakan GES are necessary to supply increase of power after renovation to domestic demand.

6-3-3 Features and Construction Costs

Base on the maximum discharges for four (4) sites of Kegeti-1, Kegeti-2, Djardy-Kainda and Chon-Kemin-3 determined in 6-3-1, power plant features and rough construction costs for these four (4) sites are estimated in the method shown in “Guide Book on Small and Medium Scale Hydropower (3rd revision)” issued by New Energy Foundation (NEF) in Japan.

The results of calculations for all the candidate sites, including power plant features and rough construction costs on three renovation cases for Lebedinovka site examined in 6-3-2, are summarized in Table 6-3-5.

Table 6-3-5 Features and Construction Costs for Candidate Sites

Project Name		Kegeti-1	Kegeti-2	Djardy-Kainda	Chon-Kemin-3	Lebedinovka (Case 1-1*1)	Lebedinovka (Case 1-2*2)	Lebedinovka (Case 2*3)
Category of Project Site		New	New	Reconstruction	New	Renovation	Renovation	Renovation
Type of Waterway		Pressure Pipe	Pressure Pipe	Open Channel (Conventional type)	Dam and Conduit	—	—	—
Data	Installed Capacity P (MW)	0.59	1.08	0.81	5.97	0.72	2.22	5.67
	Max. Discharge Q (m3/s)	1.05	0.9	1.5	30	10.3	10.3	25.0
	Total Head H (m)	85	160	70	25	26.8	26.8	26.8
	Capable Annual Generation (MWh)	3,334	6,289	4,091	33,275	6,307	19,447	47,112
Design	Intake Weir	H=3m, L=5m	H=3m, L=5m	H=3m, L=5m	H=25m, L=50m	—	—	—
	Waterway	Pressure Pipe L=1,840m φ=1.9m	Pressure Pipe L=1,620m φ=1.9m	Open Channel L=1,500 m 1.3mx1.3m	Pressure Tunnel L=400m φ=3.72m	—	—	—
	Penstock	—	—	L＝230m φ=0.69m	L＝100m φ=3.09m	L＝58m φ=1.81m	L＝58m φ=1.81m	L＝58m φ=2.82m
	Powerhouse	On Ground Surface	On Ground Surface	On Ground Surface	On Ground Surface	On Ground Surface	On Ground Surface	On Ground Surface
	Turbine	Cross-flow	Horizontal Pelton	Horizontal Francis	Vertical Kaplan	Horizontal Francis	Horizontal Francis	Vertical Kaplan
Construction Cost	for Power Plant (million JPY)	1,601.6	1,745.1	1,215.5	7,377.4	1,271.7	1,271.7	2,407.5
	for Transmission (million JPY)	14.2	14.2	0.2	0.3	—	—	—
	Total (million JPY)	1,615.8	1,759.3	1,215.7	7,377.7	1,271.7	1,271.7	2,407.5
Construction Unit Cost	per kW (thousand JPY/kW)	2,739	1,629	1,501	1,236	1,766	572	425
	per kWh (JPY/kWh)	485	279,743	297,165	221,720	201,633	65	51

*1: Case 1-1 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that both existing Unit No.1 (2.9 MW) and Unit No.2 (1.5 MW) repaired by JSC Chakan GES are operable after the renovation.

*2: Case 1-2 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that the only existing Unit No.1 (2.9 MW) is operable after the renovation.

*3: Case 2 is Estimation of Unit No.2 replacement with new equipment (5.67 MW) on condition that neither the existing Unit No.1 (2.9 MW) nor Unit No.2 (1.5 MW) repaired by JSC Chakan GES is operable after the renovation.

6-3-4 Beneficiaries

(1) Effect of Reduction of Planned Outage in Winter

As mentioned in sub-section 5-6, the new SHPP may be to contribute to increase in power supply capacity in the entire grid. The increase in power supply capacity in the entire grid is most expected to lead to reduction of planned outage caused by tight supply and demand situation in winter. Since output of SHPP changes depending on change in river flow duration, power output, construction unit costs, etc. in summer (June – August) and winter (December – February) of every candidate sites were calculated based on river flow discharges. In order to make it easy to quantitatively understand the effects that power output of SHPP in winter leads to increase in supply capacity in the grid and eventually contributes to reduction of targeted areas (houses) for planned outage, the number of houses which can be supplied by the SHPP (=Power Output of SHPP in winter ÷ Electricity Demand per house (assuming 2 kW per house)) are calculated as the number of houses which can escape from outage. These results are summarized as shown in Table 6-3-6.

Power outputs of candidate SHPPs in winter except for Lebedinovka drastically drop down to about 40% - 55% of that in summer in proportion to decrease in available intake water volume, while the power outputs of Lebedinovka SHPP in winter are the same as that in summer or 85% of that in summer. Kegeti-1, Kegeti-2 and Djardy-Kainda SHPP located in rivers flowing down through the north slope of Kyrgyz Range have the smallest power output in winter with less than 0.5 MW and about 100 – 200 houses can escape from outage by the SHPPs. Chon-Kemin-3 SHPP is 2.14 MW in power output in winter and about 1,000 houses can escape from outage by the SHPP. Lebedinovka SHPP (case 2) taking water from Chu River has the largest power output in winter with 4.88 MW and about 2,440 houses can escape from outage by the SHPPs.

In addition, construction unit costs per power output in winter (total construction costs/power output in winter) are also calculated for the purpose to compare investment efficacies for effects in winter. Lebedinovka SHPP (case 2) has the smallest construction unit cost in winter with JPY 493 thousand /kW, which is only 7% - 8% of the other candidate SHPPs. Lebedinovka SHPP (case 2) is evaluated to be the most promising candidate among all the candidate SHPPs because it has the largest power output and the smallest construction unit cost in winter. However, 4.88 MW of power output in winter of Lebedinovka SHPP (case 2) is 2.4% of 200 MW, the maximum power deficit in wither in the power grid system. (200 MW is equivalent to outage of 100,000 houses)

Except for Lebedinovka, Chon-Kemin-3 has the largest power output in winter with 2.14 MW and the smallest construction unit cost in winter, while its total construction cost is the highest with about JPY 7,300 million. Djardy-Kainda has the smallest total construction cost with JPY 1,200 million and its construction unit cost in winter is not very different from that of Chon-Kemin-3. Construction unit costs of Kegeti-1 and Kegeti-2 are the highest, because these sites have to adopt pressure pipes with a length of 1.5 – 2.0 km for all the sections of their headrace.

Table 6-3-6 Seasonal Power Outputs for Candidate Sites

Items			Kegeti-1	Kegeti-2	Djardy-Kainda	Chon-Kemin-3	Lebedinovka		
							Case 1-1[*1]	Case 1-2[*2]	Case 2[*3]
Category of Project Site			New	New	Reconstruction	New	Renovation	Renovation	Renovation
Features for SHPP	Installed Capacity P (MW)		0.59	1.08	0.81	**5.97**	0.72	2.22	5.67
	Max. Discharge Q (m3/s)		1.05	0.9	1.5	30	10.3	10.3	25.0
	Capable Annual Generation (MWh)		3,334	6,289	4,091	33,275	6,307	19,447	**47,112**
	Total Cinstruction Cost (million JPY)		1,616	1,759	1,216	7,378	1,272	1,272	2,408
Construction Unit Cost	per kW (thousand JPY/kW)		2,739	1,629	1,501	1,236	1,766	572	**425**
	per kWh (JPY/kWh)		485	280	297	222	202	65	**51**
Seasonal Power Output, etc.	Available Intake Amount[*4] (m^3/s)	Summer	1.05 (=max. discharge)	0.9 (=max. discharge)	1.5 (=max. discharge)	30.0 (=max. discharge)	10.3 (=max. discharge)	10.3 (=max. discharge)	25.0 (=max. discharge)
		Winter	0.41	0.35	0.58	10.73	10.3 (=max. discharge)	10.3 (=max. discharge)	21.5
	Power Output (MW)	Summer	0.59 (=installed capacity)	1.08 (=installed capacity)	0.81 (=installed capacity)	**5.97** (=installed capacity)	0.72 (=installed capacity)	2.22 (=installed capacity)	5.67 (=installed capacity)
		Winter	0.23	0.41	0.31	2.14	0.72 (=installed capacity)	2.22 (=installed capacity)	**4.88**
	Number of houses escaping from outage[*5]		114	207	156	1,070	360	1,110	**2,440**
	Seasonal Construction Unit Cost (1,000 JPY/kW)	Summer	2,739	1,629	1,501	1,236	1,766	572	**425**
		Winter	7,076	4,242	3,887	3,448	1,766	573	**493**

*1: Case 1-1 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that both existing Unit No.1 (2.9 MW) and Unit No.2 (1.5 MW) repaired by JSC Chakan GES are operable after the renovation.

*2: Case 1-2 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that the only existing Unit No.1 (2.9 MW) is operable after the renovation.

*3: Case 2 is Estimation of Unit No.2 replacement with new equipment (5.67 MW) on condition that neither the existing Unit No.1 (2.9 MW) nor Unit No.2 (1.5 MW) repaired by JSC Chakan GES is operable after the renovation.

*4: When river flow is below maximum discharge, it is the same as the river flow. When river flow exceeds maximum discharge, it is the maximum discharge. Summer: June - August, Winter : December - February.

*5: The number of houses escaping from outage = Power output in winter÷Electricity demand in winter per house. Assuming electricity demand in winter per house is 2 kW which is two third of 3 kW, average demand per house in Japan.

(2) Other Effects

As mentioned in sub-section 5-6 “Beneficiaries of Small Hydropower Plants”, when power supply deficit does not occurred, increase of power supply capacity in the power grid system is expected to lead to the positive effects for the entire power grid system or whole Kyrgyzstan, such as the followings:

1) Stabilization for power grid system, including stabilization of voltage and frequency
2) Reduction of fuel consumption in coal fired power plants, which is correspondent to increased power by SHPP (reduction of coal import, reduction of CO_2 emission, etc.)
3) Increase of electric power export

In addition, the following collateral positive effects by SHPP are expected.

1) Creation of short-term employment by construction of SHPP
2) Creation of the medium to long-term employment because of securing personnel for operation and maintenance of SHPP
3) The SHPPs can be a good reference to the personnel who are involved in developing SHPPs in Kyrgyzstan. In particular, since conduit layout type of Kegeti-1 and Kegeti-2 has not been adopted in Kyrgyzstan so far, its design material and construction methods are likely to be very helpful for further development of SHPPs with the same type of conduit layout type in the country. And, since Lebedinovka SHPP project is to renovate an old SHPP which has a stopped turbine and generator due to deterioration, this project can be a useful reference for formulating renovation/replacement plans and their implementation plans of the other old SHPPs which will needs to be renovated in the near future.

Chapter 7 Summary

7-1 Issues on the Power Sector

As policies of the government, the power sector aims to firstly obtain stable power supply to the country, and finally earn foreign currency by exporting electricity to the neighboring countries, focusing upon management improvement of the power sector and also development for sustainable and efficient operation of the power system. There are however the following issues in the power sector currently to be solved for obtaining the stable power supply immediately.

- Insufficient power supply for the winter demand
- Aging Power Plants
- Tariff structure that does not reach the full cost recovery level
- High Level of Distribution Losses
- The Constraints for Water Management in Central Asia
- Transparency of Accounting Management System

Since policy approaches for overcoming the abovementioned issues have a very deep interrelated, the activities and efforts initiated by the government should be executed immediately, concurrently and in parallel.

7-2 Power Demand & Supply Plan in Winter

Focusing upon the issue, "Insufficient power supply for winter demand", mentioned above, the power demand and supply plan in winter is examined for a next decade and shown in Figure 7-2-1. The related information can be collected and defined as below.

- New power development plans are described in the Power Sector Development Strategy over the period 2012-2017(PSDS2012-2017)/MEI. As for rehabilitation plans of existing power plants, the latest information were interviewed with JSC EPP and others. Also, "Strategic Planning for Small and Medium Sized Hydropower Development (MEI & EBRD, July 2011)" are referred to as the latest information of small hydropower development plan.
- Demand forecasts for a next decade are estimated based on the relationships between previous growth rates of GDPs and power consumptions. The growth rate of power consumption can be estimated to be 2.5% in the "Base Case" as "5% of GDP growth rate × GDP elasticity 0.5= 2.5% of the growth rate of power consumption in a decade". In addition, for estimating maximum peak demands, it is assumed that load factor of 2011 is to be continued as a constant value in a next decade.

As shown in Figure 7-2-1, since the power supply is 250MW below the demand of 2012, "minus value" of RMR of 2012 is observed. This is continued up to the commission of Kambarata-1 (1,900M) which is planned in 2021 in the "Base Case".
It is understood in the "Base Case" that, although the gap between demand and supply is temporarily mitigated by completion of the 500kV transmission line (Datka-Kemin) in 2015, etc., the worst gap of 500MW might occur in 2020 just before the completion of Kambarata-1 (1,900 MW) in 2021.

As a short-term measure in power crisis, simple cycle gas turbines of thermal power plants are commonly installed as an emergency project without distinction of developing countries and developed countries. However, in Kyrgyzstan, there are difficulties in procurement of financial resources for fuel imports as well as the installation of new gas turbines.

Also, in general, for a new development of a large-scale HPP, it may take total 8 to 11 years, i.e., 1 year for selection of the candidate site, 1 year for feasibility study, 1 year for tender document preparation and the bidding process, and 5 to 8 years for construction. Namely, if attempting to develop a large-scale HPP immediately from now on, it is difficult to complete it before the commissioning of Kambarata-1 (1,900 MW) in 2021

From the above, realization of power supply expansion projects is an urgent issue in a short period of time up to commissioning of Kambarata-1 (1,900 MW, 2021).

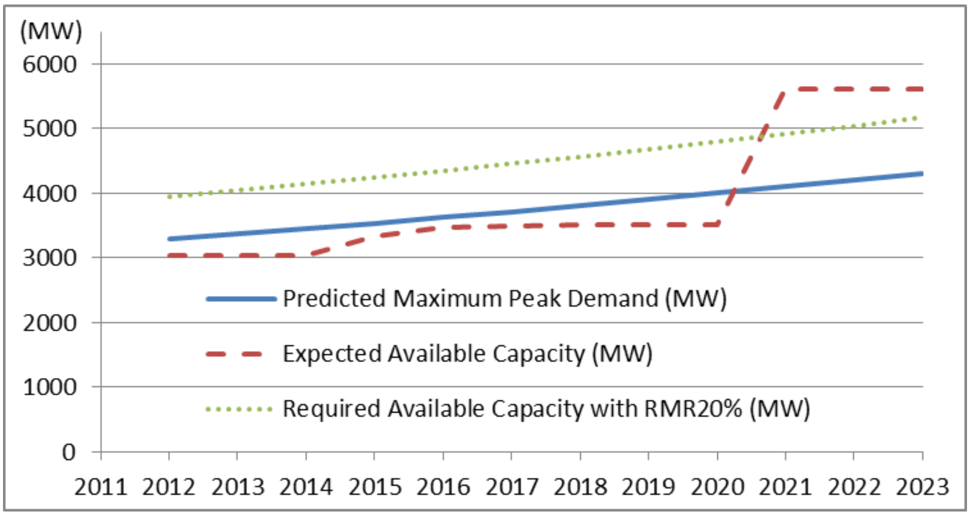


Figure 7-2-1 Power demand and supply plan
(Base Case: Peak Demand Growth Rate = 2.5%)

7-3 Fast Project to be expected in the future

Initiatives aimed at short-term measures are extremely important in the current Kyrgyzstan. Therefore, it is highly expected by the government for donors to urgently support the projects of the "completion fast" and "procurement easy" to mitigate the power crisis before commissioning of Kambarata-1 (1,900MW) in 2021. Donors have been supporting the following measures actively.

- Development of Small Hydropower Plants
- Securing and Increasing Power Outputs by Rehabilitation
- Distribution Loss Reduction
- Energy Saving and Peak Load Suppression due to Tariff Hikes

Lists of fast projects to be expected for an urgent realization, which is not included in the power development plan mentioned above, are summarized in Table 7-3-1. Most of the projects mentioned herein are under examination stage for the respective implementation activities, and therefore most of expected outputs presented in Table 7-3-1 are assumed by the study team.

Table 7-3-1 Additional Power Outputs to be expected in the Future
(The study team assumed.)

Expected Project for increasing Power Outputs	Additional Power Outputs (Assumptions)	Assumptions By the study team	Support of Donors	Progress
1) Rehabilitation of At-Bashi HPP	4 MW	10% of installed capacity of 40MW	SECO	Under Implementation
2) Distribution loss reduction at 5%	40 MW	As described in section 3-7-2 (*)	KfW and WB	Under Implementation
3) Energy saving due to tariff hikes	50 MW	Assumption	USAID and WB	Under Implementation
4) Development of a new small HPP	50 MW	Upon the ongoing feed-in tariffs, 1% influence to tariffs	UNDP and EBRD	Under Implementation

		for 100 MW small HPP development. Assumed half of the above.		
5) Rehabilitation of Toktogul HPP	100 MW	10% of installed capacity of 1,200 MW	ADB	Under studying
6) Rehabilitation of Uchkurgan HPP	18 MW	10% of installed capacity of 180 MW	JSC EPP will be requesting to JICA	Under arrangement of funds
7) Rehabilitation of Lebedinovka small HPP	3 MW	Differential between existing and plan as described in section 6	JSC Chakan GES will be requesting to JICA	Under arrangement of funds

（Total expected additional power outputs ＝265MW）

In case of the power demand and supply plan of “Base Case: Peak Demand Growth Rate = 2.5%” described above, the gap between maximum power output and peak demand is calculated to be 500 MW shortage in 2020 just before the completion of Kambarata-1 (1,900 MW, 2021). Assuming that all of the abovementioned projects shown in Table 7-3-1 are completed before 2021, total expected additional power outputs, i.e., 265 MW, can be effective against the 500 MW shortage. Thus, the lack of capacity "235 MW" (= 500 MW-265 MW) is estimated and it is observed that demand still exceeds supply in 2020. This power shortage of "235 MW" in 2020 is almost same as the current shortage "250 MW" in winter 2012. Therefore, MEI will have to actively promote the fast projects more such as "small hydropower development project", etc..

7-4 Projects that are expected for Support of JICA

According to Table 3-7-1, projects expected by MEI with the urgent support of JICA are described below.

A) As JICA’s Grant Aid Projects, "Development of a new small HPP (USD 10-20mil.)"
B) As JICA’s Grant Aid Projects, "Rehabilitation of Lebedinovka small HPP (USD 10-25mil.)"
C) As JICA’s Loan Projects, "Rehabilitation of Uchkurgan HPP (Approximately USD 50mil.)

For these, sufficient investigation has not yet been performed. It should be therefore noted that the following investigation items should be particularly included in the basic design at the next stage.

- For a new development of small HPPs as shown in item A) above
  - Review of the project layout based on topographic survey
  - Review of river flow discharge based on actual measurement
  - Review of maximum intake water and design layout based on the optimum generation plan
- For a rehabilitation of small HPPs as shown in items B) and C) above
  - Understanding details of current situation of the existing power plants by a facility inspection
  - Review of the design layout by drawings and/or site surveys, if necessary, of existing facilities
  - Study of the optimal intake flow based on the previous operation and/or water flow data

7-5 Points of Concern for JICA’s Assistance of Small HPP Development

1. <u>The Ongoing Feed-in Tariffs and Agreement</u>

According to estimates by UNDP, even if total amount of small hydropower has been developed up to 100MW level, deficit between fixed purchasing prices and electricity selling tariffs will impact on

0.01 Som/kWh as electricity tariff surcharges that are only approximately 1% increase from the weighted average tariff 0.879 Som/kWh in 2013. From this, UNDP has a plan to propose to MEI that a fixed purchasing price should be more increased and also should extend the contractual period of the feed-in tariffs for promoting further private participation. Further, UNDP will propose to MEI not only new development projects but also rehabilitation projects to be in the frame of the feed-in tariffs.
On the other hand, based upon the Renewable Energy Law of the latest (N170), regarding international projects implemented by the international institutions as well as donors such as JICA Grant Aid Project, agreements between the both governments shall be separately required to determine the appropriateness and content of the “feed-in tariffs”.

Therefore, in case of JCIA’s assistance related to the ongoing feed-in tariffs, the agreement should be carefully examined taking into account of the progress of discussion between MEI and UNDP regarding the mechanism revision of the feed-in tariffs.

2. Treatment of Un-transparency of Retained Earnings

Stock dividend rate is different in each case for the power entities. It must be paid to SPF at 70% or more of dividends in some cases even making efforts for profits. It is reality that enough profit as retained earnings is not left for the future overhauling and replacement of equipment, which lead to unsuitable operation and maintenance of the plants. In a grant aid project particularly, it is required to clearly define the money flow in advance for a sustainable operation and maintenance of the project. For achieving the above, it is necessitated i) to wait for the launch of Regulation Center and Settlement Center to ensure transparency of accounting system and/or ii) to establish the separate accounting management system such as the other escrow accounting system only for a small hydropower plant.

3. Adequate Ownership and O&M Organizational Framework of Donors’ Project such as JICA’s Grant Aid Project

There are two (2) choices for the ownership from the government-owned organizations, i.e., JSC Chakan GES that has a sufficient operating ability and Directorate that does not have enough operational experience. Those can execute the O&M directory and also work out the O&M to the private sector.

An adequate ownership and O&M organizational framework for a JICA’s Grant Aid project shall be examined in advance. JSC Chakan GES has experience in O&M management of small HPPs over the long period in Chui Oblast. It is therefore understood that JSC Chakan GES is the suitable entity for the O&M in views of technical and organizational managements.

7-6 Basic Information on Small Hydropower Plant Development in Chui Oblast

7-6-1 Hydrological and Meteorological Information

- The amount of precipitation from March to May of the year is the highest, while that from July to September of the year is the lowest. The amount of the annual precipitation in this region is around 400 mm, which is an average value in whole Kyrgyzstan and one forth of the amounts observed in Japan.
- On the other hand, the river flow discharge is small during the winter period from January to March and large during the summer period from June to August, and there is a big difference in seasonal variation between precipitation and river flow discharge. Such a tendency indicates that the melting of snow and/or glaciers in the alpine areas has a significant impact on the river discharges. The specific discharges in winter (drought discharges) of rivers flowing through the north slope of Kyrgyz Range are 0.5 – 0.6 $m^3/s/100\ km^2$, which are half of 1.0 $m^3/s/100\ km^2$ of drought discharge in Japan.

7-6-2 SHPP Sites in Chui Oblast

- In the north slopes of Kyrgyz Range, there are a large number of mountain valleys lying south to north as tooth comb, through which mountain river run. These mountain rivers start to flow down from the steep alpine zone, then run through alluvial fans forming Chui Valley, and finally flow into Chu River. The SHPP potential sites are basically limited to a small stretch which is upper than the alluvial fans (higher than 1,300 m above sea level), and lower than 2,000 above sea level where roads exist, due to the topographical and geological conditions along the rivers.
- Chui Oblast has had extensive irrigation system since former Soviet Union era. More than30 m^3/s of water discharge flows in the major irrigation canals and the nine (9) existing SHPPs well-utilizing this discharge have been operated for a long time by Chakan GES.
- Only twelve (12) SHPPs with a total output of 42 MW throughout Kyrgyzstan are currently in operation, but in the past, a large number of SHPPs had been built in the country for the period from the 1930s to the 1960s. The average output of the 161 abolished SHPPs is 0.274 MW, only 10 SHPPs had an output capacity of more than 1.0, and 120 SHPPs corresponding to three-quarters of the whole, had an output of below 0.3 MW. Very small-scale hydropower plants accounted for the majority.
- 11 SHPPs of the 12 SHPPs in operation, and 43 SHPPs or more than a quarter of the 161 abolished SHPPs, are located in Chui Oblast. Many of them, except for SHPPs of JSC Chakan GES, are located in the rivers flowing on the north slopes of Kyrgyz Range.
- SHPPs now in operation are only power plant utilizing irrigation canal or reservoir, or power plants reconstructed at the places of the abolished power plants. There is no existing SHPP which takes water from a natural river and was constructed at a new site. Except for SHPPs of JSC Chakan GES, there are many existing and abolished SHPPs constructed in the rivers flowing through the north slope of Kyrgyz Range, which have small installed capacity of 1.6 MW at maximum. L/H of the power plants reconstructed at the places of abolished power plants is more than 25. If the power plant were entirely a new project, it would be economically unfeasible due to the high construction costs for the long waterway. However, utilizing remaining facilities of the abolished power plant contributes to reducing construction costs.

7-6-3 Beneficiaries of SHPPs

- In winter planned outages caused by lack of power supply to the grid system have been often performed recently. Since the scale of electricity demand for planned outage targeted areas is equivalent to the amount of power supply deficit, a newly constructed SHPP connecting to the grid leads to reduction of areas being forced to suffer from power outage and/or outage duration.

- As for the other positive effects by SHPP, when power supply deficit does not occurred, increase of power supply capacity in the power grid system is expected to lead to the positive effects for the entire power grid system or whole Kyrgyzstan, such as 1) Stabilization for power grid system, including stabilization of voltage and frequency, 2) Reduction of fuel consumption in coal fired power plants, which is correspondent to increased power by SHPP (reduction of coal import, reduction of CO2 emission, etc.) and 3) Increase of electric power export.

7-7 Promising SHPP Potential Sites

7-7-1 Selection of Potential Sites and Site Surveys

- In order to identify promising SHPP potential sites in Chui Oblast, the candidate sites to be surveyed were selected based on the following information.
  1) Relevant information obtained from KSTC: 3 sites
  2) SHPP potential sites approved by the Presidential Decree No.365 (2008): 10 sites
  3) EBRD's small hydropower master plan (Strategic Planning for Small and Medium Sized Hydropower Development): 4 sites
  4) Renovation plan for existing SHPP by JSC Chakan GES: 1 site
- A total of 5 sites, which are the sites where the negative information for development has been indentified until this stage or the sites located in Suusamyr Valley far removed from Chui Valley, were excluded from the sites to be surveyed. As a result, the Survey Team carried out the site surveys on a total of 12 sites (17 sites minus 5 excluded sites).
- As a result of the site surveys, 8 sites were excluded from promising candidates because major issues to development were confirmed at this stage, while the other 5 sites with added Kegeti-2 during the site survey were evaluated as promising candidates.

7-7-2 Evaluation of Candidate Sites

- Power plant features and rough construction costs for five sites of Kegeti-1, Kegeti-2, Djardy-Kainda, Chon-Kemin-3 and Lebedinovka Sites remaining as candidate sites were estimated.
- The results of calculations, including power output in winter which is important indicator for evaluating beneficiary of SHPP, for these five candidate sites are summarized as shown in Figure 7-7-1.
- Lebedinovka SHPP (case 2) is evaluated to be the most promising candidate among all the candidate SHPPs because it has the largest power output and the smallest construction unit cost in winter. However, 4.88 MW of power output in winter of Lebedinovka SHPP (case 2) is 2.4% of 200 MW, the maximum power deficit in wither in the power grid system. (200 MW is equivalent to outage of 100,000 houses)

Table 7-7-1 Comparison of Candidate SHPPs

Sites		Category of Project Site	Power Plant Features			Construction Unit Cost		Power Output in Winter*4 (MW)
			Installed Capacity (MW)	Capable Annual Generation (MWh)	Total Construction Cost (million JPY)	per kW (thousand JPY/kW)	per kWh (JPY/kWh)	
Kegeti-1		New	0.59	3,334	1,616	2,739	485	0.23
Kegeti-2		New	1.08	6,289	1,759	1,629	280	0.41
Djardy-Kainda		Reconstruction	0.81	4,091	1,216	1,501	297	0.31
Chon-Kemin-3		New	5.97	33,275	7,378	1,236	222	2.14
Lebedi-novka	Case 1-1*1	Renovation	0.72	6,307	1,272	1,766	202	0.72
	Case 1-2*2	Renovation	2.22	19,447	1,272	572	65	2.22
	Case 2*3	Renovation	5.67	47,112	2,408	425	51	4.88

*1: Case 1-1 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that both existing Unit No.1 (2.9 MW) and Unit No.2 (1.5 MW) repaired by JSC Chakan GES are operable after the renovation.
*2: Case 1-2 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that the only existing Unit No.1 (2.9 MW) is operable after the renovation.
*3: Case 2 is Estimation of Unit No.2 replacement with new equipment (5.67 MW) on condition that neither the existing Unit No.1 (2.9 MW) nor Unit No.2 (1.5 MW) repaired by JSC Chakan GES is operable after the renovation.
*4: December - February

- Concerning items to be considered in the future for the candidate SHPPs, items common to all the sites are shown below, and main items to considered taking into account features of technical design and construction, and environmental and social considerations for each candidate site, are described in Table 7-7-2.

  1) River flow discharge data: Since the melting of snow and/or glaciers in the alpine areas has a significant impact on the river discharges in Chui Oblast, there is a need for calculations of discharges at each site taking this impact into account.
  2) Improvement in the precision of estimates for construction cost: Construction costs need to be estimated by incorporating local construction unit rate, etc.
  3) Connection of SHPPs to the Grid: In order to clarify connecting points and what equipment should be installed, it is required to ask for confirmation of technical conditions as well as to seek for JSC Severelectro’s direction on the optimal connection method.
  4) O&M organizational framework: Except for Lebedinovka site, the candidate SHPPs are new power plant. For such SHPPs, it is necessary to plan detailed O&M organizational framework including project implementation body and/or operating body.

Table 7-7-2 Features and Major Items to be Considered of Candidate SHPPs

Sites	Category	Installed Capacity (MW)	Source	Technical Features	Environmental and Social Impact	Major Items to be Considered
Kegeti-1	New	0.59	Site as requested through the application form for grand aid from Japan（note: plant features were determined by the Study Team)	Headrace is pressure pipe to be embedded for all the stretches from the intake to the powerhouse along the road.	No intake water from river such as irrigation around the site. A water fall for sightseeing is near the intake site, but low environmental and social impact because of no houses	Consultation with road administrator on burying pipe along road.
Kegeti-2	New	1.08	Identified by the Study Team, right upstream of Kegeti-1	Headrace is pressure pipe to be embedded for all the stretches from the intake to the powerhouse along the road.	No intake water from river such as irrigation around the site. A water fall for sightseeing is near the powerhouse, but low environmental and social impact because of no houses around the site.	Consultation with road administrator on burying pipe along road.
Djardy-Kainda	Reconst-ruction	0.81	KSTC（note: plant features were determined by the Study Team)	Facilities are to be reconstructed on abolished SHPP. Headrace is conventional open channel（similar to recently developed SHPPs including Issyk-Ata-1 and Sokuluk-2）	No intake water from river such as irrigation around the site. Low environmental and social impact because of no houses around the site.	Examination to determine slope protection method and its target areas around existing headrace platform
Chon-Kemin-3	New	**5.97**	Presidential Decree No.365（note: plant features were determined by the Study Team)	SHPP is to fully utilize a large amount of river flow discharge at a confluence of two large rivers as dam type or dam and waterway type.	Since Chu River is an international river flowing through the border of Kazakhstan and Kyrgyzstan, consultations with the two countries are required. Low environmental and social impact because of no houses around the site.	Identifications to preparatory items necessary for consultation with Kazakhstan, time necessary for consultation, etc. Geological surveys including drilling survey for feasibility study because of project with dam and tunnel construction.
Lebedi-novka **Case 1-1**[*1]	Reno-vation	0.72	Proposed by the Study Team	to replace one unit of deteriorated and damaged turbine and generator in existing SHPP utilizing irrigation major canal. (another generation unit should continue to be operated even	Low environmental and social impact because of renovation mainly including replacement of turbine and generator in existing SHPP	Considerations on suitable renovation method having no impact on continuous operation of another existing turbine and generator
Lebedi-novka **Case 1-2**[*2]	Reno-vation	2.22				
Lebedi-novka **Case 2**[*3]	Reno-vation	5.67				

*1: Case 1-1 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that both existing Unit No.1 (2.9 MW) and Unit No.2 (1.5 MW) repaired by JSC Chakan GES are operable after the renovation.
*2: Case 1-2 is Estimation of Unit No.2 replacement with new equipment (2.22 MW) on condition that the only existing Unit No.1 (2.9 MW) is operable after the renovation.
*3: Case 2 is Estimation of Unit No.2 replacement with new equipment (5.67 MW) on condition that neither the existing Unit No.1 (2.9 MW) nor Unit No.2 (1.5 MW) repaired by JSC Chakan GES is operable after the renovation.
*4: December - February

7-8 Overview of Feasibilities on SHPP Development

In order to overview the feasibilities on SHPP development in Chui Oblast, the important findings obtained through the Survey are shown as follows:

- The annual precipitation in Chi Oblast is 400 mm, which is very small and only about one third of Japan, and river flow discharge also is only a half of Japan. Moreover, river flow discharges in winter in Chui Oblast are the smallest of the whole year. Such river flow conditions are unfavorable to SHPP aiming at increase of power supply capacity in winter.
- There are many rivers flowing down through the north slope of Kyrgyz Range, but the river sections where SHPP can be constructed are limited due to the topographical conditions, and SHPPs to be constructed in such river sections will have only an installed capacity of 2 MW at maximum.
- In the past, a lot of SHPPs had been constructed in Kyrgyzstan, but their 120 SHPPs corresponding to three-quarters of the whole, had an output of below 0.3 MW. Very small-scale hydropower plants accounted for the majority.
- SHPPs now in operation are only power plants utilizing irrigation canal or reservoir, or power plants reconstructed at the places of the abolished power plants. There is no existing SHPP which takes water from a natural river and was constructed at a new site.
- Both plant factor and river flow utilization ratio of SHPPs utilizing irrigation canals are relatively very high because the amount of possible intake water is large and there is a small gap of discharge between summer and winter. Such SHPPs can generate electricity economically.
- In Japan, only SHPP with a construction unit cost of less than JPY 200/kWh are likely to be selected at the early stage for SHPP site selection. There are no candidate sites with a construction unit cost of less than JPY 200/kWh, but Lebedinovka site, which is renovation project on an existing SHPP utilizing major irrigation canal.

It is necessary to improve the precision of design and estimates of construction cost for the SHPP project in order to determine the feasibilities on SHPP development. However, only based on the above-mentioned findings, the feasibilities of SHPPs in Chui Oblast are overviewed as follow:

Projects of new SHPPs which will take water from a natural river are generally unfeasible. Feasible SHPP projects may be only special projects including projects for SHPPs utilizing remaining facilities of abolished SHPPs or existing irrigation facilities*[1], and/or projects to renovate deteriorated SHPP. In conclusion, it is not expected to develop a large number of SHPPs in short term under current conditions in Kyrgyzstan. In order to promote SHPP development by private sector, there is a need for significant expansion of economical/financial incentives given to SHPP developers such as much higher selling electricity price.

*[1]: In Chui Oblast, there are two types of irrigation canals. One is irrigation canals which flow water throughout the year, while another is irrigation canals flow water only for irrigation period. If planning SHPP using a irrigation canal, it is necessary to well-understand such seasonal changes in flow discharges in a irrigation canal.