Chapter 5 Finding and Evaluation of PSPP Potential Sites

5.1 Literature Documentation

Before selecting the candidate sites for pumped storage power projects, the Study Team identified with or without of necessary information and data for the study and collected information and data.

As for topography, since the Map Department in EIE has topographical maps at 1:25,000 of the whole country, the Study Team selected areas which have a possibility of PSPP development using Google Earth and collected the necessary topographical maps from EIE.

Regarding geology, the Study Team collected from EIE information about the overall geological condition of the whole country, such as regional geological maps (1:500,000), active faults distribution maps, and an epicenter distribution map (refer to Appendix 5-1).

As for the natural and social environments, the Study Team studied the environmental policy in Turkey as shown in Appendix 5-2-1, and identified the national parks, natural parks, and Ramsar sites by visiting MOEF and browsing its websites (refer to Appendix 5-2-2).

5.1.1 General Geology of Turkey

Most part of Turkey sits on the Anatolian Plate, which is a micro plate belonging to the Eurasian Plate.

The Anatolian Plate is located between the African and the Eurasian Plates, and touches the Arabian Plate at its eastern edge (refer to Figure 5. 1).

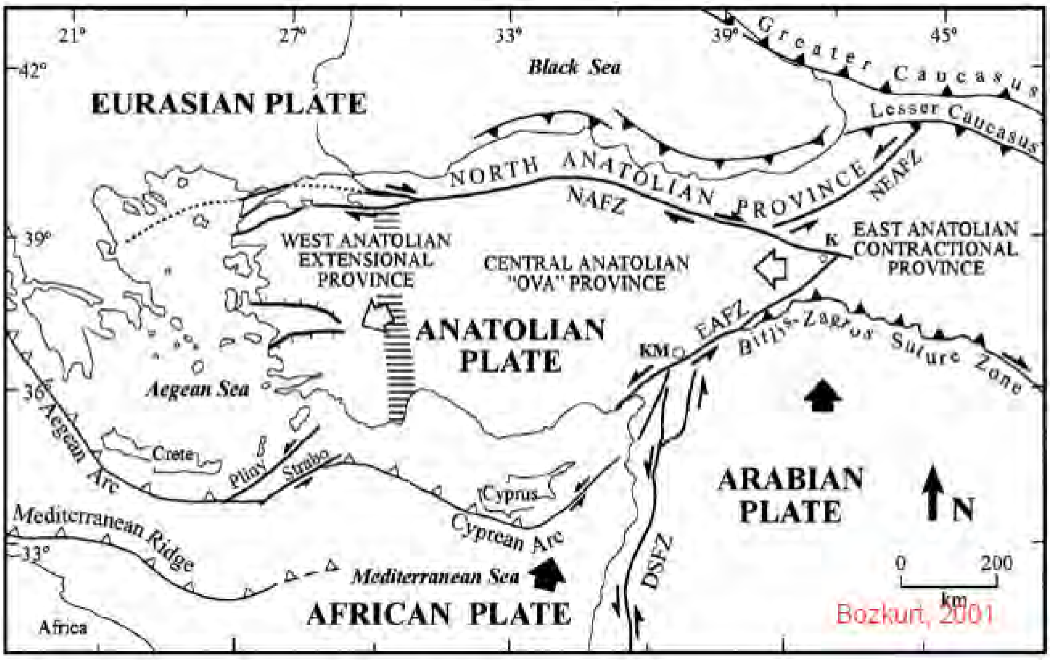
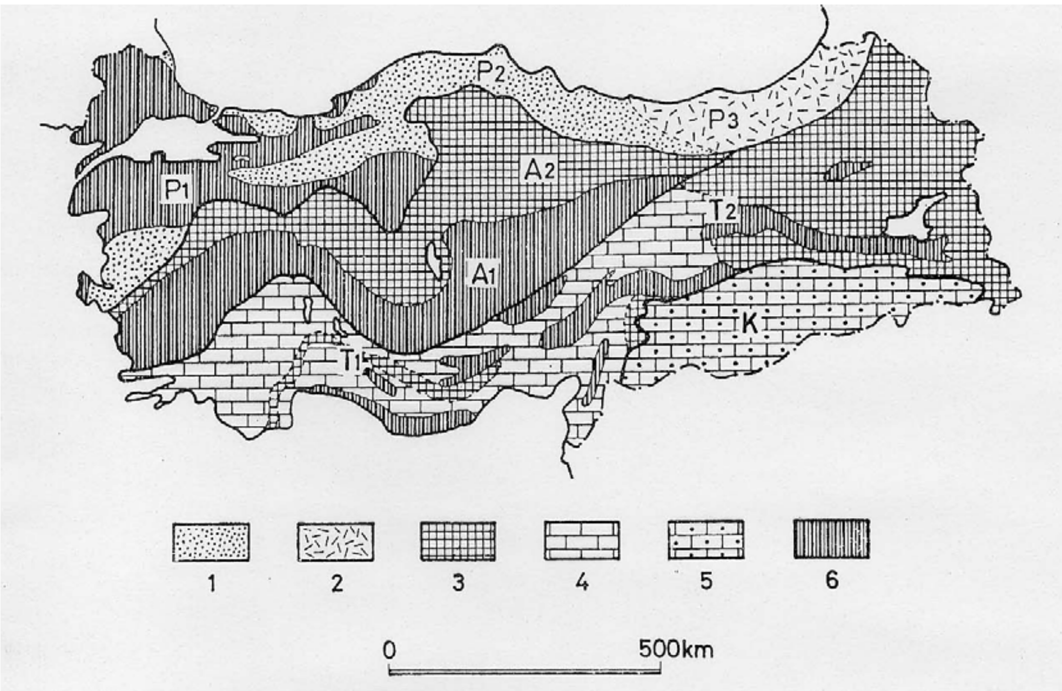


Figure 5. 1 The Anatolian and the neighbor plates (Source: Bozkurt 2001)

Geologically Turkey consists of a mosaic of several terrains, which were amalgamated during the Alpine orogeny. Topographically the country is totally dependent on them, and divided into four structural bands. They are as follows: (1) Pontid belt, (2) Anatoid belt, (3) Taurids, and (4) Border fold belt (refer to Figure 5. 2).

1) Pontid belt
The zone is at the southern border of Black Sea and in the back arc side of the mobile belt. The bedrock of this zone is metamorphic rocks and granitic intrusive in the Devonian and Carboniferous period. Sedimentary rocks were formed during Black Sea's expansion in the Cretaceous period, and then oceanic volcanism took place in tertiary period.
2) Anatoid belt
The zone acts on an axis of the mobile belt. Metamorphic rock and ophiolite distribute there, and terrestrial volcanism took place in the Tertiary period.
3) Taurids belt
This belt is in the fore-arc of mobile belt. Mesozoic sedimentary rocks were formed in the Tethys Sea, and terrestrial volcanism took place in the Tertiary period.
4) Border fold belt
The area spreads along the border of Syria and Iraq. In this area, sedimentation had continued ceaselessly from the Cambrian to Tertiary period.



P; Pontid belt, **A**; Anatoid belt, **T**; Taurid belt, **K**; Kurdistid belt
1;Mesozoic Erathem mainly flysch **2**; Mesozoic Erathem mainly acidic-basic oceanic volcanic rocks and pyroclastic rocks **3**; Mesozoic Erathem mainly ophiolite **4**; Mesozoic Erathem mainly limestone **5**; Mesozoic Erathem mainly neritic limestone **6**; Paleozoic Erathem and regional metamorphic rock

Figure 5. 2 Geological Structure of Turkey (Source: Metal Mining Agency of Japan 1981)

5.1.2 Environmental Policy in Turkey

(1) Organization related to environment

The main administration organization for environment in Turkey is the Ministry of Environment and Forestry (MOEF).

In 1991, the Under Secretariat of Environment was merged with the Special Environmental Protection Institution, and thus the Ministry of Environment was established by the Decree in the Force of Law of 443. Further in 2003, the current MOEF was established merging two central bodies: the Ministry of Environment and the Ministry of Forestry. The organic Law of the MOEF (No. 4856) aims to set forth the principles regarding the establishment, organization, and responsibilities of the MOEF so that the following are expected:

- ➢ To protect and improve environment
- ➢ To ensure effective use and protection of lands and natural resources in rural and urban areas
- ➢ To protect flora and fauna, and to develop the natural resources of the country
- ➢ To prevent any environmental pollution
- ➢ To harmonize protection and development of forests, and to expand forest area
- ➢ To develop villagers living inside and nearby forests, and to take necessary measures
- ➢ To meet needs for the development of forest products and forest industry

MOEF has responsibility for international conventions such as Ramsar Convention, and for coordination with other related agencies for environmental conservation. Also, MOEF is responsible for management of all environmental protection areas.

The organizational chart of MOEF is shown in Figure 5. 3.

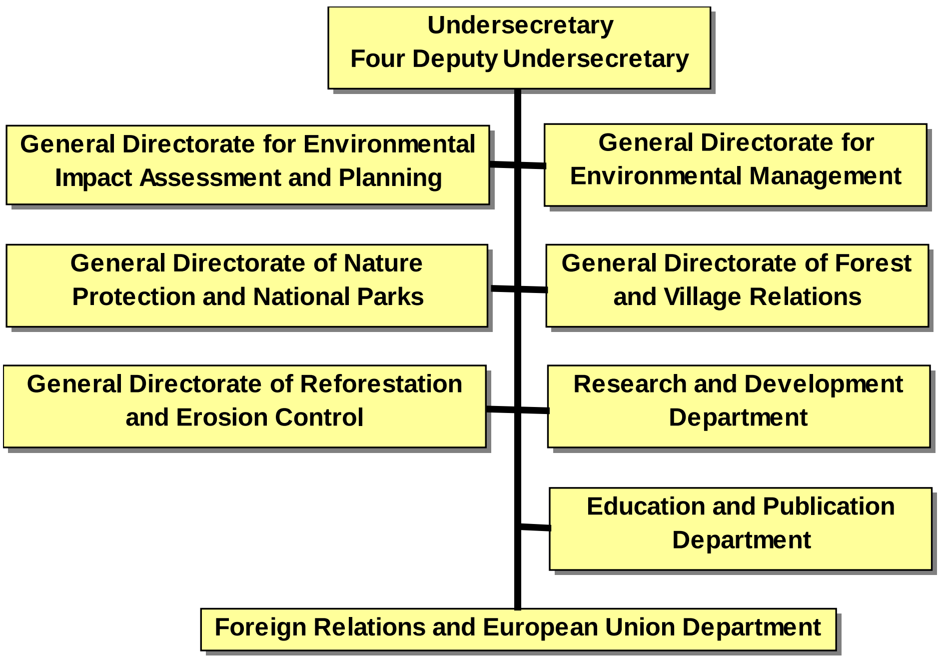


Figure 5. 3 Organizational Chart of Ministry of Environment and Forestry

The other agencies related to environment are the following:

- ➢ Ministry of Agriculture and Rural Affairs
- ➢ Ministry of Culture and Tourism
- ➢ Ministry of Energy and Natural Resources

During environmental study and/or Environmental Impact Assessment (EIA) related to land utilization, historical and cultural heritages, and mining resources, coordination with the agencies mentioned above is necessary.

(2) Environmental legislation

(a) Laws and regulations in Turkey

The law that governs environmental protection in Turkey is the Environment Law No. 2872, which was enacted in 1983. The Environment Law shows a fundamental concept of environmental conservation. Since the establishment of the law in 1983, many regulations to support the law have been established.

Currently effective laws and regulations related to development of pumped storage power plants (PSPP) are as listed in Table 5. 1.

Table 5. 1 Current Laws and Regulations related to Development of PSPP

Laws and Regulations	No.	Establishment
【Laws】		
Environmental Law	2872	Oct. 1983
Fishery Law	1380	Mar. 1971
Amendment of Fishery Law	3288	May. 1986
【Regulations】		
Regulation for Amendments to the Regulation Concerning Implementation of the Convention in International Trade of Endangered Wild Fauna and Flora Species	24623	Dec. 2001
Revised Regulation on Implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	25545	Jun. 2004
Forestation Regulation	25515	Jul. 2004
Regulation on Environment and Forestry Council	25622	Oct. 2004
Regulation on Preservation and Development Areas of Wildlife	25637	Nov. 2004
Regulation on Control of Water Pollution	25687	Dec. 2004
Protection of Living Spaces of Game and Wild Animals, Regulation on Harm Struggling Procedure and Fundamental Principles	25976	Oct. 2005
By-law on Environmental Impact Assessment	26939	Jul. 2008

(b) International conventions and agreements

The government of Turkey has ratified many international agreements. The agreements related to development of PSPP are as listed in Table 5. 2.

Table 5. 2 Agreements related to Development of PSPP

Agreements	Ratification
UN Convention on Biodiversity (CBD)	1997
Convention on International Trade in Endangered Species of Wild Flora and Fauna	1996
International Convention for the Protection of Birds, Paris 1959	1966
Convention on Wetlands of International Importance	1994
Convention for the Protection of the World Cultural and Natural Heritage	1983

(c) Others

In addition to environmental protection areas designated by the Turkish government, Doga Dernegi（DD）has been carrying out the designation of Key Biodiversity Areas (KBAs) to protect internationally important places for biodiversity with the support of the Royal Society for the Protection of Birds. DD is one of NGOs in Turkey, and is a partner of Birdlife International, International Association for Conservation of Nature (IUCN), and also Alliance of Zero Extinction (AZE).

Though MOEF is aware of the KBAs that should be fully considered, the KBAs have not been designated as official protection areas so far. Since KBAs are places of international importance for biodiversity at the global level, the possibility should be taken into consideration that those areas may be officially designated as protection areas in the future.

(3) Environmental Impact Assessment (EIA) Regulation

(a) Legal basis

Based on the Environmental Law No. 2872 of 1983, EIA Regulation (No. 21489) came into forth in February 1993. After amendment of the regulation three times, the currently effective By-law on Environmental Impact Assessment (No. 26939) was enacted in July 2008. MOEF has the responsibility for the EIA procedure.

(b) EIA procedure

The flowchart of EIA procedure is shown in Figure 5. 4.

(c) Screening criteria

Either “full-scale EIA” or “initial EIA” is required for project development in Turkey. Project owners are obliged to prepare an EIA report for each project.

Types of EIA depend on types, scale, and location of the projects.

a) Full-scale EIA

Types and scale of projects for which full-scale EIA is required are defined in Annex I of the bylaws. The criteria related to hydropower development are shown as follows:

- No. 15: Water storage facilities (dams and lakes with a reservoir volume of 10 million m^3 and over).
- No. 16: River-type power plants with an installed capacity of 25 MW or more.
- No. 32: Construction of overhead electrical power lines with a voltage of 154 kV or more and a length of more than 15 km (transmission line, transformer center, switch areas).

In addition to those criteria, projects located in the environmentally sensitive areas listed in Annex V of the bylaws are required to conduct full-scale EIA.

b) Initial EIA

Types and scale of projects for which initial EIA is required are defined in Annex II of the bylaws. The criteria related to hydropower development are shown as follows:

- No. 27 m): Water storage facilities (dams and lakes with a reservoir capacity of 5 million m^3 or more).
- No. 28: River-type power plants having 0.5 MW or more installed capacity.
- No. 32: 154 kV or more energy transmission facilities (5 km or more).

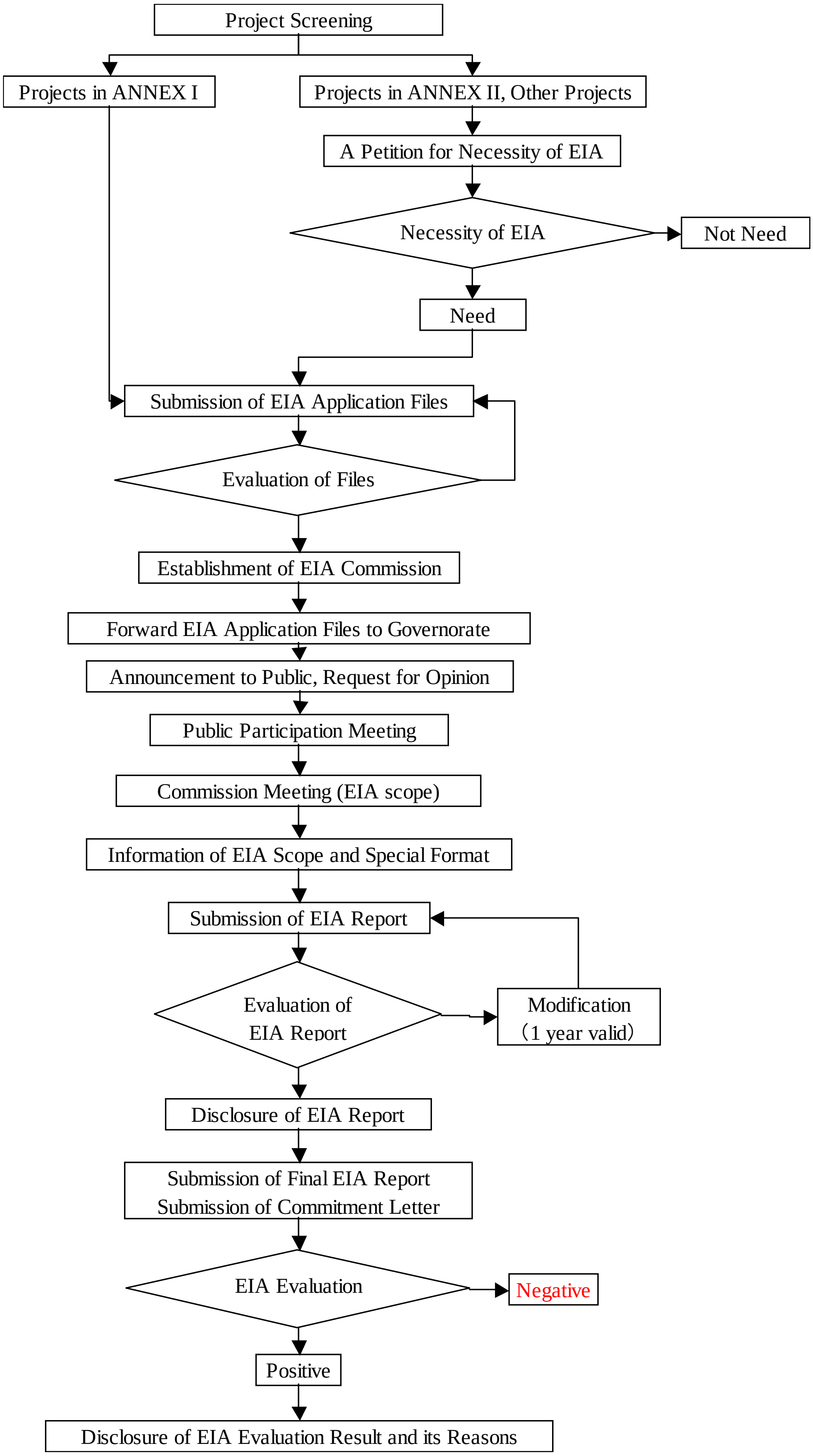


Figure 5. 4 Flowchart of Environmental Impact Assessment Procedure

(d) Disclosure of information

Disclosures of EIA information in Turkey are as follows:

- Announcement to public and request for opinion when application of EIA is submitted.
- Public participation meeting for EIA scope.
- Opening EIA report to public.
- Disclosure of results of EIA evaluation and those reasons.

Though the officially required number of public participation meetings is only one, there were cases that public participation meetings were held more than three times for hydropower projects. Therefore, it seems that disclosure of EIA information in Turkey is relatively at sufficient level.

EIA project list and recent EIA reports can be seen at the following URLs, respectively:

http://www2.cedgm.gov.tr/dosya/cedsonuckarar/cedsonuc.htm

http://www2.cedgm.gov.tr/dosya/cedilkbasvuru/cedbasvurudosyalari.htm

(4) Current status of environmental and social considerations in Turkey

Environmental awareness in Turkey has been raised recently. In general, there are many bare lands in Turkey where it is difficult for trees and plants to grow because the topsoil is relatively thin and the precipitation rate is small. In spite of such conditions, the Turkish government has been making efforts for reforestation such as planting for erosion protection, and forestation along expressways.

Environmental protection/conservation in national parks and natural parks has become stricter; actually, it has become difficult to develop any projects in such areas. Also, if projects are located at wildlife protection sites and other protection areas, EIAs for the projects are strictly evaluated.

As for hydropower development, MOEF strongly requests project owners for release of maintenance flow at river-crossing structures such as dams, and also requests for installation of fish path and/or fish lift for environmental considerations. However, on observing the actual application of such mitigation measures, it is apparent that private project owners have not complied with such environmental requests from MOEF because national-owned DSI has also not complied with the requests. One of the reasons is that there are no standards or criteria for environmental mitigation measures in Turkey.

As for EIA, it is seldom for project owners to carry out field survey on flora and fauna in every season through a year, which JICA and other international donor agencies require. EIA reports for most of hydropower projects in Turkey are prepared based only on brief field reconnaissance and literature study.

The Turkish government has been establishing the necessary regulations and procedures for environmental conservation. However, this is still insufficient in terms of the actual application of environmental and social considerations for project development.

5.2 Preparation of Criteria for Finding of PSPP Candidate Sites

The criteria for project finding of pumped storage power plan were prepared, taking into consideration the following conditions and special circumstances of Turkey after discussion between C/P and the Study Team:

a) Technological and economical conditions
b) Topographical and geological conditions (especially elongation from active fault)
c) Geographical conditions
d) Natural and social environment conditions (especially for upper and lower reservoirs)

The criteria for finding pumped storage power projects in Turkey were determined as shown in Table 5. 3.

Table 5. 3 Criteria for Finding Potential Pumped Storage Project in Turkey

Item		Consideration Point	Criteria	
Technical	Generation plan	- Peak duration time - Installed capacity	- 7hrs - More than 500 MW	○ ○
Technical	Limit of manufacturing of Power facility	- Design head - K Value (Hpmax / Hgmin) - Max. utilizing water depth of pond	- Less than 750m of maximum head - Less than the limit (1.25-1.4) - Less than 30m (40m in case of full facing pond type)	○ ○ ○
Technical	Location / Layout	- Catchment area of Lower reservoir - Crest length of Lower Dam - Dam height - Length of water way - Length / Head (L/H) - Overburden of underground power cavern	- More than 50km2 - Less than 500m - Less than 200m - Less than 10km - Less than 10 - Less than 500m	○ ○ ○ ○ ○ ○
Technical	Geological conditions	- Active fault (Quaternary fault) - Fault and fractured zone - Landslide area - Permeability of peripheral rock of upper reservoir	- Elongation from active faults >10km - Avoid large-scaled fault and fractured zone - Avoid large-scaled landslide area - Avoid lime stone / Quaternary volcanic rock	● ● ● ●
Topographical conditions		- Demand center / pumping energy source - Existing and planned power network - Accessibility	- Near demand center / pumping energy source - Near bulk power network (Substation) - Good accessibility to the site	○ ○ ●
Environmental	Natural	- Protected Area (e.g. Natural Parks) - Endangered species	- Avoid important Protected Areas (Natural Parks, Nature Parks, and Ramsar Sites) - Avoid the critical habitats of important fauna and flora	○ ●
Environmental	Social	- Mining right - Historical and Cultural heritage - Houses to be resettled	- Avoid the area of mining concession - Avoid being submerged - Less than 50	● ● ●

○ : considered in primary project finding ● : necessary to confirm the situation by site survey

5.3 Map Study

(1) Procedure of map study

At first, 18 pumped storage projects selected by EIE are reviewed based on the above-mentioned project-finding criteria, referring to the 1:25,000 topographical map, active faults distribution maps, maps of national parks and other environmental protection areas, and Ramsar site maps.

The Study Team found new potential sites by map study with the 1:25,000 topographical maps.

The 18 reviewed pumped storage projects and the new potential sites selected by the Study Team are screened according to the project-finding criteria. Then, potential sites that passed these criteria are selected as candidate sites. The Study Team calculates the project profile and estimates rough project cost for the selected candidate sites.

The Study Team assigns priority to the candidate sites primarily from the viewpoints of economical efficiency (unit construction cost), geological conditions, and geographical conditions.

At last, the candidate sites surveyed are determined in consultation with EIE counterparts.

(2) Finding and evaluation of PSPP potential sites

(a) Evaluation of PSPP potential sites selected by EIE

Eighteen pumped storage projects selected by EIE are screened from the viewpoints of the geological condition of elongation from the active faults and the environmental conditions of physical relationship between locations of potential sites and the national parks and other environmental protection areas (incl. Ramsar sites). In addition, the Study Team carried out map study for the screened projects and revised those project plans to meet the above-mentioned project-finding criteria.

As a result, 14 potential sites out of 18 pumped storage projects selected by EIE were excluded from the viewpoints of topographical and geological conditions and natural/social environmental conditions, and the Study Team revised the project plans of the remaining four potential sites, such as location of the upper reservoir, and selected them as the candidate sites (refer to Appendix 5-3-1).

(b) Finding and evaluation of new PSPP potential sites

The Study Team found 38 new potential sites by using the 1:25,000topographical map.

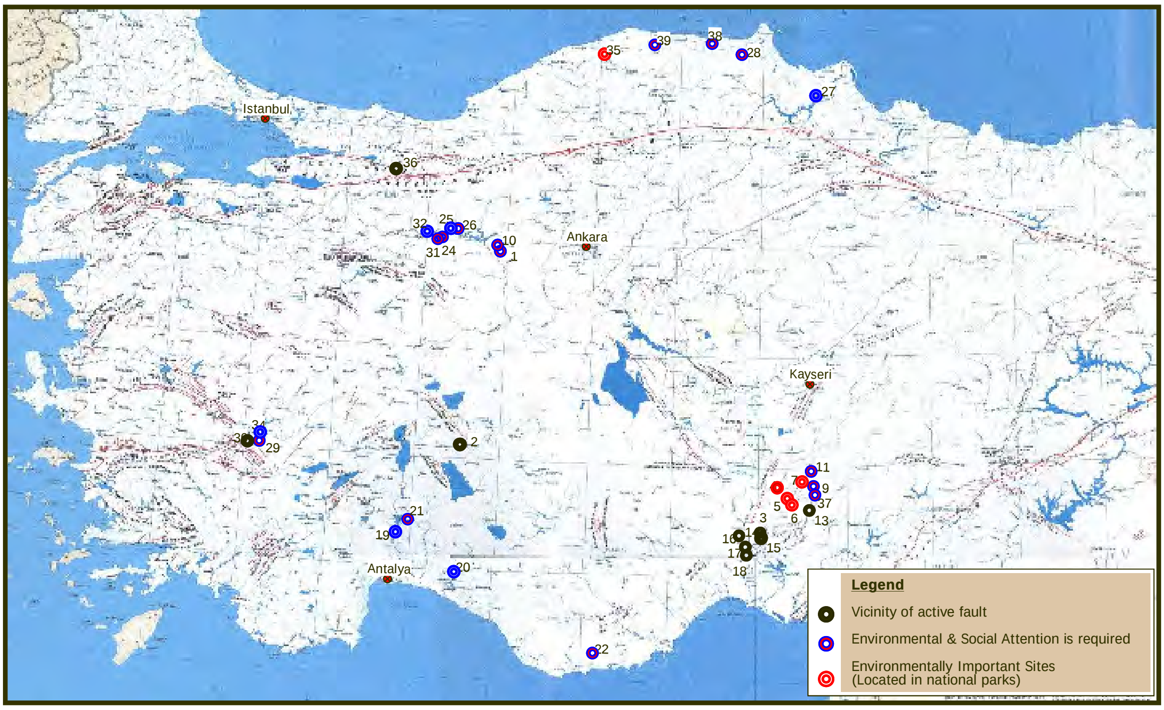
1) Screening by geological criteria

There are various types of active faults in this country. The North Anatolian Fault is the biggest active fault in Turkey and the East Anatolian Fault is the second biggest.

Figure 5. 5 (Appendix 5-3-2-1) shows all the PSPP potential sites plotted on the map of active faults. Since the 11 PSPP potential sites plotted by the black circle are located within an elongation less than 10 km from the active faults, those are excluded.

Figure 5. 6 (Appendix 5-3-2-2) shows all potential sites plotted on the epicenter distribution map. No site is located in the vicinity of the large-magnitude epicenter.

Evaporites such as gypsum, halite, and limestone are common in Turkey. Also, these rocks are often karstified, and form underground caverns. Appendixes 5-3-2-3 and 5-3-2-4 show the distribution of karstified zone and limestone caves, respectively.



(Source: MTA)

Figure 5. 5 Map of Active Faults and PSPP Potential Sites

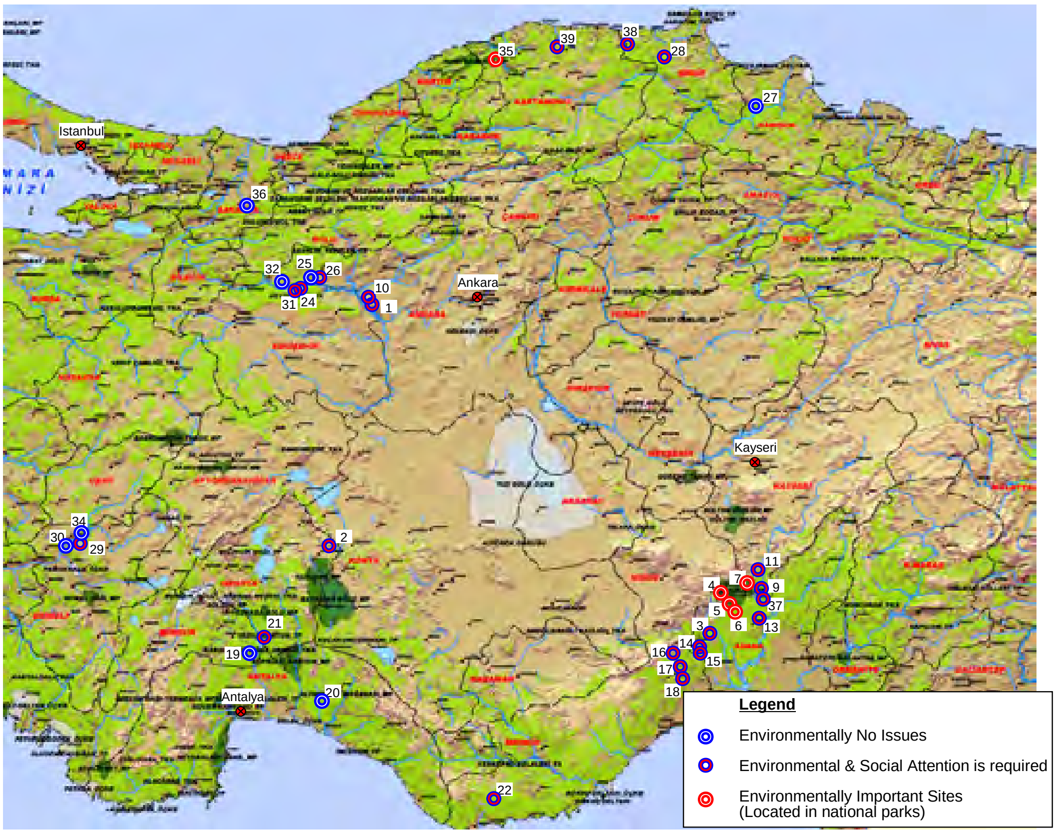
(Source: MTA)

Figure 5. 6 Map of Epicenter Distribution and PSPP Potential Sites

2) Screening by environmental criteria

Figure 5. 7 (Appendix 5-3-3-1) shows all PSPP potential sites plotted on the map of national parks. Since the four PSPP potential sites plotted by the red double circle are located within the national park, those are excluded.

The locations of national parks, nature parks, and wildlife protected areas and the key biodiversity areas (KBAs) are shown in Appendixes 5-3-3-2 and 5-3-3-3, respectively. Also, provincial environmental protection area maps on which PSPP potential sites are plotted are shown in Appendix 5-3-4.



Source : http://gis.cevreorman.gov.tr/sayfalar/ana_sayfa.html

Figure 5. 7 Map of National Parks and PSPP Potential Sites

3) Selection of PSPP candidate sites

Fourteen potential sites out of 38 found by the Study Team, 10 sites from the viewpoints of geological criteria and three sites from environmental criteria, and one site from both criteria, were excluded. The remaining 24 potential sites were selected as the candidate sites (refer to Appendix 5-3-2). Selection flow of PSPP candidate sites is shown in Figure 5. 8.

A total of 28 PSPP potential sites (adding 4 candidate sites out of 18 potential sites found by EIE) are selected as the PSPP candidate sites. The locations of these 28 PSPP candidate sites are shown in Figure 5. 9.

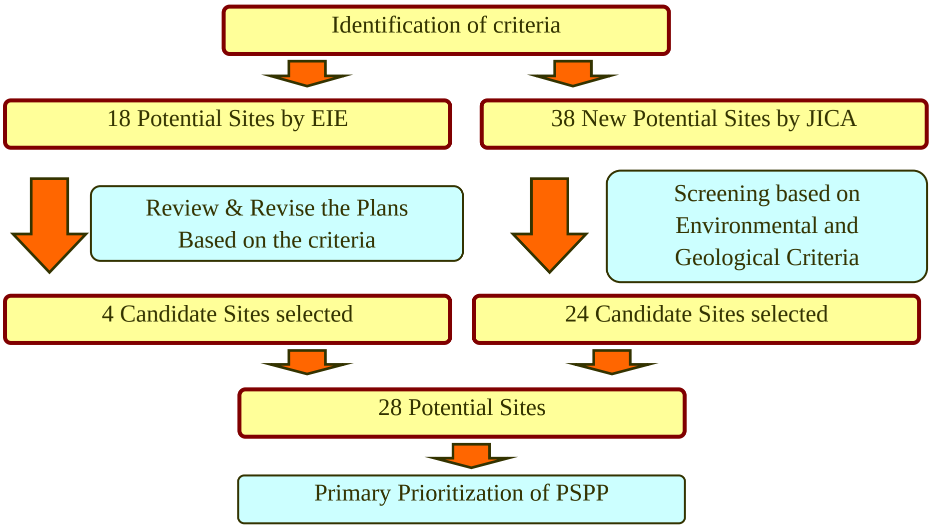


Figure 5. 8 Selection Flow of PSPP Candidate Sites

Figure 5. 9 Location of 28 PSPP Candidate Sites

(3) Selection of candidate sites for site survey

The JICA Study Team calculated the project profile and estimated a rough project cost for the total 28 selected candidate sites. Then, the Study Team gave priority to the candidate sites primarily from the following viewpoints:

1) Economical efficiency (unit construction cost)
2) With or without limestone caves in the limestone distribution area
3) Distance from the nearest 380 kV substation (power line length)

The project profile and cost of 28 candidate sites of PSPP and results of primary prioritization are shown in Table 5. 4 (for details refer to Appendix 5-3-5). Here, priority rank of ◎: Excellent, ○: Fairly Good, △: Good, and ×: Bad are applied.

At last, 10 out of 13 candidate sites with priority of Excellent and Fairly Good are selected to be surveyed in consultation with EIE counterparts, taking into consideration the available period of site survey of 3 weeks.

Locations of the 10 candidates selected for site survey are shown in Figure 5. 10.

Figure 5. 10 Location of Candidates for Site Survey

Table 5. 4 List of candidate sites of PSPP

No.	Province	Upper Reservoir Latitude North	Upper Reservoir Longitude East	Upper Reservoir HWL (m)	Upper Reservoir LWL (m)	Upper Reservoir Dam Vol. (10^6m^3)	Upper Reservoir Active Cap. (10^6m^3)	Lower Reservoir HWL	Lower Reservoir LWL	Lower Reservoir Dam Vol. (10^6m^3)	Max. Head	Hpmax /Hgmin	Waterway length(L)	L/H	Cost (mUS$)	New power line (km)	Rank	Survey Site	Notes
1	Ankara	39°56' 51"	31°46' 29"	1065	1045	1.63 (Excavation)	6.8	557.5	552.6	Private HP Project	512	1.11	3,246	6.3	696	10	▲		·No storage capacity for PSPP in the low reservoir which is developed by Private Co.
6	Adana	37°39' 31"	35°15' 43"	1580	1550	15.6	7.5	1125	1110	6.4	470	1.17	3,674	7.8	887	30	×		·Large upper dam and low economic efficiency
9	Kayseri	37°48' 30"	35°28' 08"	1380	1350	2.9	5.1	700	690	2.3	690	1.13	2,148	3.1	704	30	○		·Construction of alternative public road arround Lower reservoir would be hard.
10	Ankara	39°57' 47"	31°46' 35"	1000	980	1.7	7.0	510	500	2.2	500	1.13	3,846	7.7	727	10	△		·A community exists on the surface of UGPH
11-1	Kayseri	37°58' 08"	35°28' 23"	1650	1630	1.75 (Excavation)	5.8	1060	1040	6.5	610	1.13	1,613	2.6	709	30	○	○	·Upper reservoir : Artificial pond and full facing might be needed
11-2	Kayseri	37°57' 36"	35°28' 56"	1590	1560	2.5	6.3	1050	1030	5.1	560	1.16	2,150	3.8	706	30	◎	○	
11-3	Kayseri	37°58' 05"	35°30' 54"	1540	1520	5.2 (Excavation)	7.1	1060	1040	6.5	500	1.15	1,842	3.7	758	30	△		·Upper reservoir : Artificial pond and full facing might be needed
19	Burdur	37°17' 42"	30°50' 15"	740	710	6.1	6.3	188	185	Existing	555	1.13	2,349	4.2	695	30	◎	○	
20	Antalya	36°55' 43"	31°34' 46"	910	890	1.2	4.7	184	166	Existing	744	1.12	2,456	3.3	646	20	△		·In the Limestone zone ·Underflows from limestone cave exist (EIE)
21-1	Isparta	37°24' 49"	30°55' 34"	860	840	1.2	5.7	270	242	Existing	618	1.15	4,824	7.8	706	40	○	○	·In the Limestone zone ·Outlet : Morning glory type due to sharrow dead space of Lower reservoir
21-2	Isparta	39°56' 61"	31°46' 39"	730	700	5.4	7.3	270	242	Existing	488	1.20	3,764	7.7	754	40	△		·In the Limestone zone ·Outlet : Morning glory type due to sharrow dead space of Lower reservoir
22-1	Mersin	36°17' 01"	33°01' 49"	1180	1150	2.4 (Excavation)	4.8	460	450		730	1.12	2,754	3.8	770	20	△		·In the Limestone zone ·Limestone caves exist (EIE)
22-2	Mersin	36°12' 03"	32°58' 30"	860	840	3.6 (Excavation)	4.8	140	130		730	1.11	2,693	3.7	780	20	△		·In the Limestone zone ·Limestone caves exist (EIE)
24	Eskisehir	40°01' 08"	31°06' 40"	1100	1070	4.3	4.9	389	377.5	Existing	723	1.12	3,815	5.3	707	10	○	○	
25	Ankara	40°05' 28"	31°13' 41"	970	940	8.8	5.9	389	377.5	Existing	593	1.14	4,039	6.8	756	20	△		·Narrow col exists on the left bank of Reservoir
26	Ankara	40°05' 05"	31°15' 50"	980	960	2.3	5.8	389	377.5	Existing	603	1.12	2,977	4.9	694	20	◎	○	
27-1	Samsun	41°23' 48"	35°35' 30"	810	790	1.8	5.4	189	160	Existing	650	1.15	5,302	8.2	706	10	◎	○	
27-2	Samsun	41°23' 57"	35°37' 47"	820	790	5.7	5.4	189	160	Existing	660	1.16	4,222	6.4	716	10	△		·Several Communes exist arround Upper reservoir
28	Sinop	41°44' 16"	34°37' 58"	1190	1160	10.6	7.0	700	680	7.0	510	1.18	3,281	6.4	823	20	×		·Large upper and lower dam, and low economic efficiency
29	Denizli	39°56' 70"	31°46' 48"	910	890	3.9	5.6	300	290	Existing	620	1.11	1,811	2.9	712	30	△		·Carbonate rock zone ·A commune exists closed to Upper reservoir
31	Eskisehir	40°00' 48"	31°04' 00"	1010	980	4.8	5.6	389	377.5	Existing	633	1.13	3,220	5.1	711	10	○	○	
32-1	Ankara	40°04' 04"	30°57' 50"	805	780	1.1 (Excavation)	6.6	273.1	272	Existing	533	1.11	3,784	7.1	732	20	△		·Lower dam profile is not clear
32-2	Ankara	40°03' 51"	30°59' 31"	800	770	1.6	8.4	389	377.5	Existing	422.5	1.18	3,649	8.6	689	20	○	○	·Big commune exists on the left bank of Upper resevoir
34	Denizli	38°09' 19"	29°09' 08"	770	740	5.7	7.4	300	290	Existing	480	1.16	2,263	4.7	727	30	△		·Carbonate rock zone ·Lower dam profile is not clear
37-1	Adana	37°45' 16"	35°28' 30"	1250	1220	2.8	5.0	550	540	3.1	710	1.12	3,768	5.3	709	30	○	○	
37-2	Adana	37°44' 37"	35°31' 47"	1260	1230	1.6	5.0	550	540	3.1	720	1.12	4,740	6.6	713	30	○		·In the Limestone zone
38	Sinop	41°50' 23"	34°18' 52"	930	900	5.6	5.9	340	330	3.7	600	1.14	2,731	4.6	730	40	○		·Trasnmisson Lines are submerged in Lower Reservoir
39	Kastamonu	41°48' 33"	33°38' 40"	1140	1110	5.6	6.2	580	570	4.8	570	1.14	3,341	5.9	749	80	△		·Long new power line

5.4 Site Survey

(1) Purpose of the survey

A reconnaissance study is conducted for the priority candidates of PSPP (10 sites) selected in order to identify the issues, which are extracted in the map study, such as topographical/geological conditions, natural and social environment conditions, and conditions of land use.

Based on the results of the site survey, the project plan and economical efficiency (construction cost) of each candidate site are re-reviewed. Besides, based on the results of the natural/social environment survey, its viability/difficulty level of development is evaluated.

According to the above evaluation results, candidate sites of better economical efficiency and less negative environmental impact are selected as the priority candidate sites for development.

(2) Description of site survey

The Study Team, in consultation with EIE counterparts, built the schedule of site survey for 10 candidate sites so as to complete the survey efficiently within the limited period of 3 weeks.

The Study Team prepared checklists for the 10 candidate sites surveyed in advance in order to survey without omission. In particular, for the candidate sites that used the existing reservoir as a lower reservoir, the Study Team made plans to visit the existing hydropower plant and collect information and data of generation records and reservoir operation records.

The dates, participants, and site names surveyed are shown in Table 5. 5.

Table 5. 5 Schedule of Site Survey

Date	Participants of C/P	Participants of JICA	Site No.
31 May – 4 June	Mr. Maksut Sarac (Civil) Ms. Ozlem Yilmaz (Environment) Mr. Hakan Aksu (Geology) Mr. Burhan Gulek Ozel (Geology) Mr. Huseyin Kokcuoglu (Civil)	M. Ito (Civil) H. Shinohara (Civil) J. Tamakawa (Environment) K. Nakamata (Geology)	No. 24 No. 26 No. 27-1 No. 31 No. 32-2
7 June －11 June	Ms. Ozlem Yilmaz (Environment) Mr. Burhan Gulek Ozel (Geology) Mr. Huseyin Kokcuoglu (Civil) Mr. Veysel Dag (Civil)	M. Ito (Civil) H. Shinohara (Civil) J. Tamakawa (Environment) K. Nakamata (Geology)	No. 11-1 No. 11-2 No. 37-1
15 June －18 June	Mr. Zafer Karayilanoglu (Civil) Ms. Ozlem Yilmaz (Environment) Mr. Burhan Gulek Ozel (Geology) Mr. Huseyin Kokcuoglu (Civil)	M. Ito (Civil) J. Tamakawa (Environment) K. Nakamata (Geology)	No. 19 No. 21-1

(3) Results of survey and priority evaluation

Based on the results of the site survey, the project plan and project cost of each site were re-reviewed. The site survey reports of each site and a revised layout of the main facilities are shown in Appendix 5-4. Based on the results of the natural/social environment survey, the Study Team quantified the priority of each site as shown in Table 5. 6.

The results of the re-review of project plan and project cost are shown in Table 5. 8 and Table 5. 10. Meanwhile, the countermeasure cost for geological issues was estimated roughly based on the experience of the Study Team and was included in the project cost.

Considering the economical efficiency and comprehensive score of each site, the Study Team put the priority rank on the candidate sites surveyed based on the criteria for priority ranking as shown in Table 5. 7.

As a result, three candidate sites of No. 19, No. 27-1, and No. 32-2 are selected with a priority rank of “AA.”

Meanwhile, as for the No. 31 candidate site, since the geology of the upper dam site is jointy limestone, calcareous caves exist around the site, and it is hard to find an alternative site, the Study Team judged that the upper dam is quite hard to construct and ranked it as "C".

As for No. 37-1 candidate site, although there are few geological issues and its economical efficiency is superior, there are many negative environmental impacts. Therefore, the Study Team ranked it as "B."

Table 5. 6 Natural and Social Environment Evaluation of PSPP Potential Sites

Site No.	Natural Environment		Social Environment		Multiplied Score	Comprehensive Score
	Direct	Indirect	Direct	Indirect		
11-1	1	1	1	1	1	1.00
11-2	1	1	2	1	2	1.19
19	1	1	2	1	2	1.19
21-1	1	1	1	2	2	1.19
24	2	1	1	1	2	1.19
26	1	1	1	1	1	1.00
27-1	1	1	1	1	1	1.00
31	2	1	1	1	2	1.19
32-2	1	1	1	2	2	1.19
37-1	2	2	2	2	16	**2.00**

Scores of environmental Impacts:
- 3 = Significant negative impacts
- 2 = Can be mitigated, or uncertain
- 1 = No significant impacts

Comprehensive Score
- Score = Geometrical average (forth root of multiplied score)
- If any individual items are scored as **"3"**, no calculation.
  - --> Regarded as **"Environmentally Difficult"** to develop

Table 5. 7 Criteria for Priority Ranking

Priority Rank	Criterion
AA	It is economically superior and there is no significant natural / social environmental impacts expected.
A	It is economically superior, and there are natural / social environmental impacts or technical problems expected
B	It is economically feasible and there are natural / social environmental impacts or technical problems expected
C	It is uneconomical or there are significant natural / social environmental impacts or technical problems expected.

Furthermore, from the viewpoints of technology transfer, the Study Team selected two candidate sites for the conceptual design of No. 27-1 and No. 32-2 among three high-priority candidate sites, because the upper dam types of No. 27-1 and No. 32-2 are different: the upper dam of No. 27-1 is a concrete gravity dam type or concrete facing dam type and the upper dam of No. 32-2 is artificial pond with full facing type.

Layouts of the main facilities of No. 19, No. 27-1, and No. 32-2 candidate sites are shown in Figure 5. 11, Figure 5. 12, and Figure 5. 13 respectively.

In consultation with EIE, the Study Team and EIE use the following project names for further study on three high-priority candidate sites:

- No. 19 → "Karacaoren II PSPP"
- No. 27-1 → "Altınkaya PSPP"
- No. 32-2 → "Gökçekaya PSPP"

Table 5. 8 Results of site survey of PSPP candidate sites (1/2)

No.			Unit	11-1	11-2	19	21-1	24
Installed Capacity P			(MW)	1,000	1,000	1,000	1,000	1,000
Designed Discharge Qd			(m^3/s)	248	240	240	222	179
Effective Head Hd			(m)	510	525	525	568	707
Peak Duration Hours			(hr)	7.0	7.0	7.0	7.0	7.0
Reservoir	Upper	Type		Full Faced Pondage (Asphalt)	Fill Type Dam	Concrete Gravity Dam	Full Faced Pondage (Asphalt)	Fill Type Dam
		Height	(m)	No.1: 35, No.2: 25	85	130	No.1: 75, No.2: 30	75
		Crest Length	(m)	No.1: 460, No.2: 240	570	450	No.1: 500, No.2: 300	250
		Dam (Bank) Volume	(1000m^3)	No.1: 1,100, No.2: 300	4,900	1,500	No.1: 2,260, No.2: 340	1,634
		Exavation Volume	(1000m^3)	320	0	0	1,700	0
		HWL	(m)	1,650.0	1,610.0	760.0	860.0	1,150.0
		LWL	(m)	1,630.0	1,580.0	730.0	840.0	1,120.0
		Active Water Depth	(m)	20.0	30.0	30.0	20.0	30.0
		Active Storage Capacity	(1000m^3)	6,300	6,100	6,100	5,600	4,600
		Catchment Area	(m^2)					
	Lower (Coffer)	Type		Concrete Gravity Dam	Concrete Gravity Dam	Karacaören II Dam	Karacaören I Dam	Gökçekaya Dam
		Height	(m)	145	165	(33)	(53)	(44)
		Crest Length	(m)	235	140	(350)	(1,200)	(250)
		Dam (Bank) Volume	(1000m^3)	1,200	920	(470)	(3,500)	(550)
		HWL	(m)	1,110.0	1050.0	188.0	270.0	389.0
		LWL	(m)	1,090.0	1030.0	185.0 (182.0)	242.0 (241.6)	377.5 (377.0)
		Active Water Depth	(m)	20.0	20.0	6.0	28.4	12.0
		Active Storage Capacity	(1000m^3)	6,300	7,000	6,300 (6,100)	887,000 (5,600)	214,000 (4,600)
		Catchment Area	(km^2)					
Water Way		Headrace L(m) x n		800 x 1	900 x 1	0	900 x 1	3,500 x 1
		Penstock L(m) x n		850 x 1	900 x 1	1,100 x 1	1100 x 1	1,300 x 1
		Tailrace L(m) x n		450 x 2	700 x 1	1,200 x 1	3200 x 1	1,200 x 1
		Horizontal Length	(m)	1,500	2,000	2,100	5,000	5,700
		Longitudinal Length	(m)	2,100	2,500	2,300	5,300	6,000
Powerhouse		Type		Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe
		Cavern Volume	(1000m^3)	150	150	150	150	150
		Overburden Depth	(m)	500	500	250	500	450
L/Hd				2.94	3.81	4.00	8.80	8.06
Construction Period			(Year)	6	6	6	6	7
Countermeasure Cost			(mil.US$)	nil	Leakage from upper dam : 36	Leakage from upper dam : 30	Underground Powerhouse : 22	Outlet Slope Protection : 42 Underground Powerhouse : 22
Project Cost			(mil.US$)	744	780	734	778	767
Unit Cost			(US$/kW)	**744**	**780**	**734**	**778**	**767**
Length of power line			(km)	30	30	30	40	10
Primary evaluation stores of Social/Natural Environment				**1.00**	**1.19**	**1.19**	**1.19**	**1.19**
Priority Rank				A	B	AA	B	B

Table 5. 9 Results of site survey of PSPP candidate sites (2/2)

No.			Unit	**26**	**27-1**	**31**	**32-2**	**37-1**
Installed Capacity P			(MW)	1,000	1,000	1,000	1,000	1,000
Designed Discharge Qd			(m^3/s)	226	214	219	330	201
Effective Head Hd			(m)	558	591	577	382	628
Peak Duration Hours			(hr)	7.0	7.0	7.0	7.0	7.0
Reservoir	Upper	Type		Full Faced Pondage (Asphalt)	Concrete Gravity Dam	Concrete Gravity Dam	Full Faced Pondage (Asphalt)	Fill Type Dam
		Height	(m)	45	65	105	No.1: 55, No.2: 25	75
		Crest Length	(m)	550	300	420	No.1: 600, No.2: 380	410
		Dam (Bank) Volume	(1000m^3)	1,360	380	950	No.1: 2,500, No.2: 430	2,750
		Exavation Volume	(1000m^3)	3,670	0	0	1,520	0
		HWL	(m)	990	810.0	1,010.0	800.0	1,250.0
		LWL	(m)	960	790.0	980.0	770.0	1,220.0
		Active Water Depth	(m)	30.0	20.0	30.0	30.0	30.0
		Active Storage Capacity	(1000m^3)	5,700	5,400	5,600	8,400	5,100
		Catchment Area	(m^2)					
	Lower (Coffer)	Type		Gökçekaya Dam	Altınkaya Dam	Gökçekaya Dam	Gökçekaya Dam	Concrete Gravity Dam
		Height	(m)	(44)	(54)	(44)	(44)	75
		Crest Length	(m)	(400)	(300)	(300)	(250)	200
		Dam (Bank) Volume	(1000m^3)	(900)	(900)	(620)	(440)	340
		HWL	(m)	389.0	190.0	389.0	389.0	580.0
		LWL	(m)	377.5 (377.0)	160.0 (159.9)	377.5 (377.0)	377.5 (377.0)	560.0
		Active Water Depth	(m)	12.0	30.1	12.0	12.0	20.0
		Active Storage Capacity	(1000m^3)	214,000 (5,700)	2,892,000 (5,400)	214,000 (5,600)	214,000 (8,400)	5,100
		Catchment Area	(km^2)					
Water Way		Headrace L(m) x n		1,650 x 1	2,300 x 1	2,000 x 1	2,300 x 1	2,300 x 1
		Penstock L(m) x n		1,050 x 1	1,100 x 1	1,100 x 1	600 x 1	1200 x 1
		Tailrace L(m) x n		1,300 x 1	2,100 x 1	1,300 x 1	800 x 1	1,200 x 1
		Horizontal Length	(m)	3,700	5,200	4,100	3,400	3,400
		Longitudinal Length	(m)	4,000	5,500	4,400	3,700	3,700
Powerhouse		Type		Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe	Egg Shape Tyoe
		Cavern Volume	(1000m^3)	150	150	150	150	150
		Overburden Depth	(m)	300	450	500	400	550
L/Hd				6.63	8.80	7.11	8.90	5.41
Construction Period			(Year)	6	7	7	6	6
Countermeasure Cost			(mil.US$)	Outlet Slope Protection : 21	nil.	Leakage from upper dam : unknown	nil.	Underground Powerhouse : 22
Project Cost			(mil.US$)	758	727	–	732	729
Unit Cost			(US$/kW)	**758**	**727**	–	**732**	**729**
Length of power line			(km)	20	10	10	2	30
Primary evaluation stores of Social/Natural Environment				**1.00**	**1.00**	**1.19**	**1.19**	**2.00**
Priority Rank				**A**	**AA**	**C**	**AA**	**B**

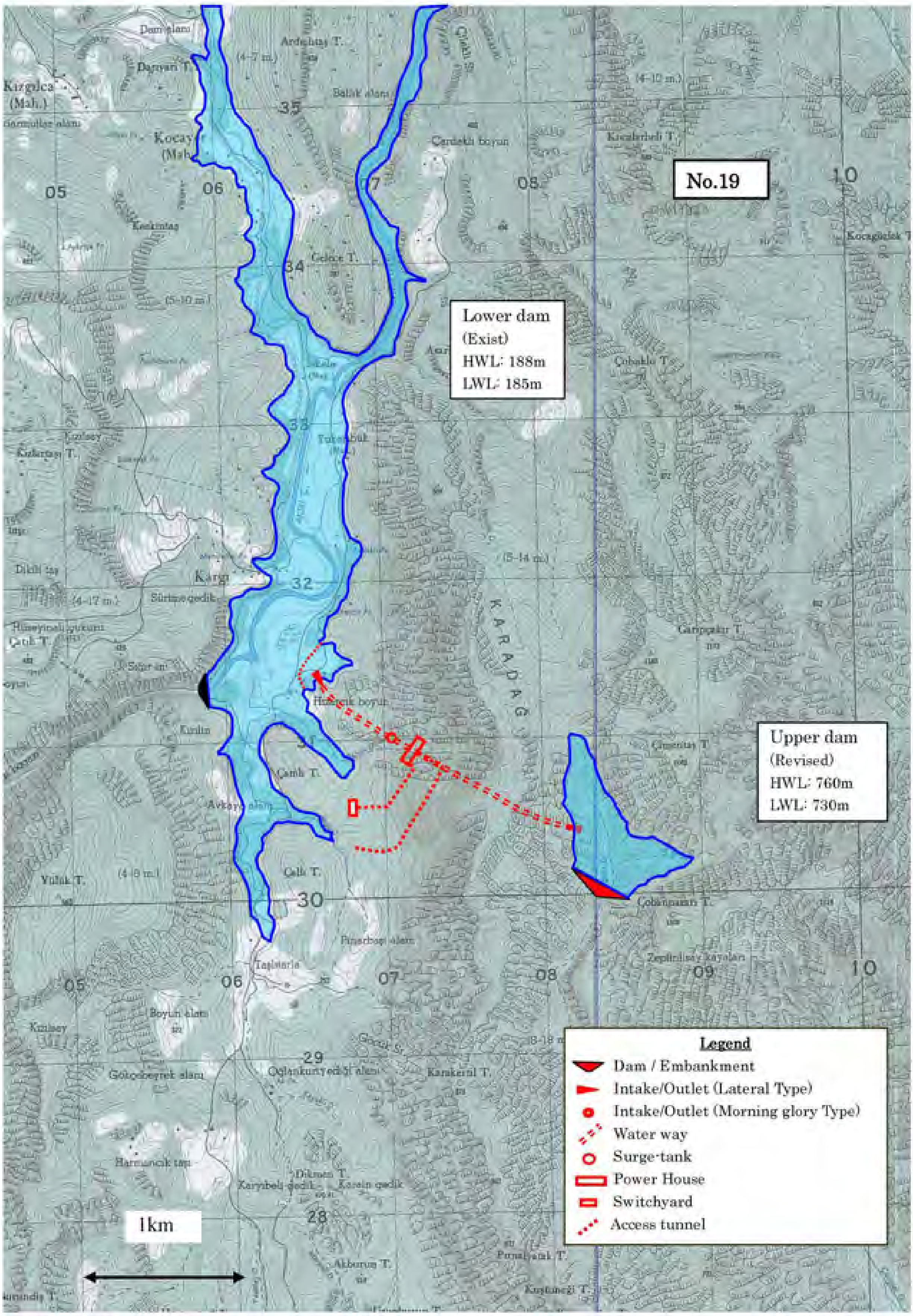


Figure 5. 11 Layout of Main Facilities of No.19 (Karacaoren II)

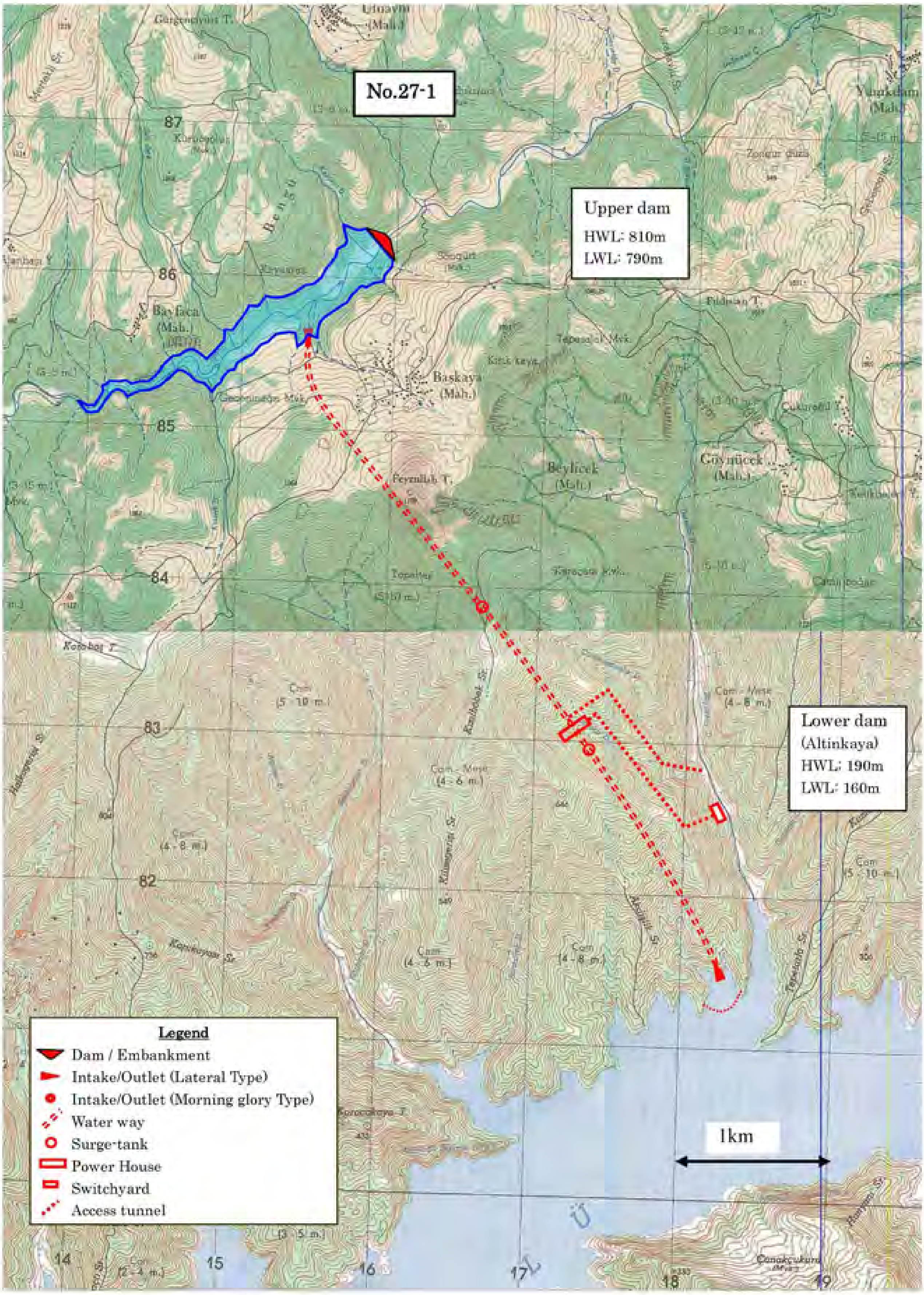


Figure 5. 12 Layout of Main Facilities of No.27-1 (Altınkaya)

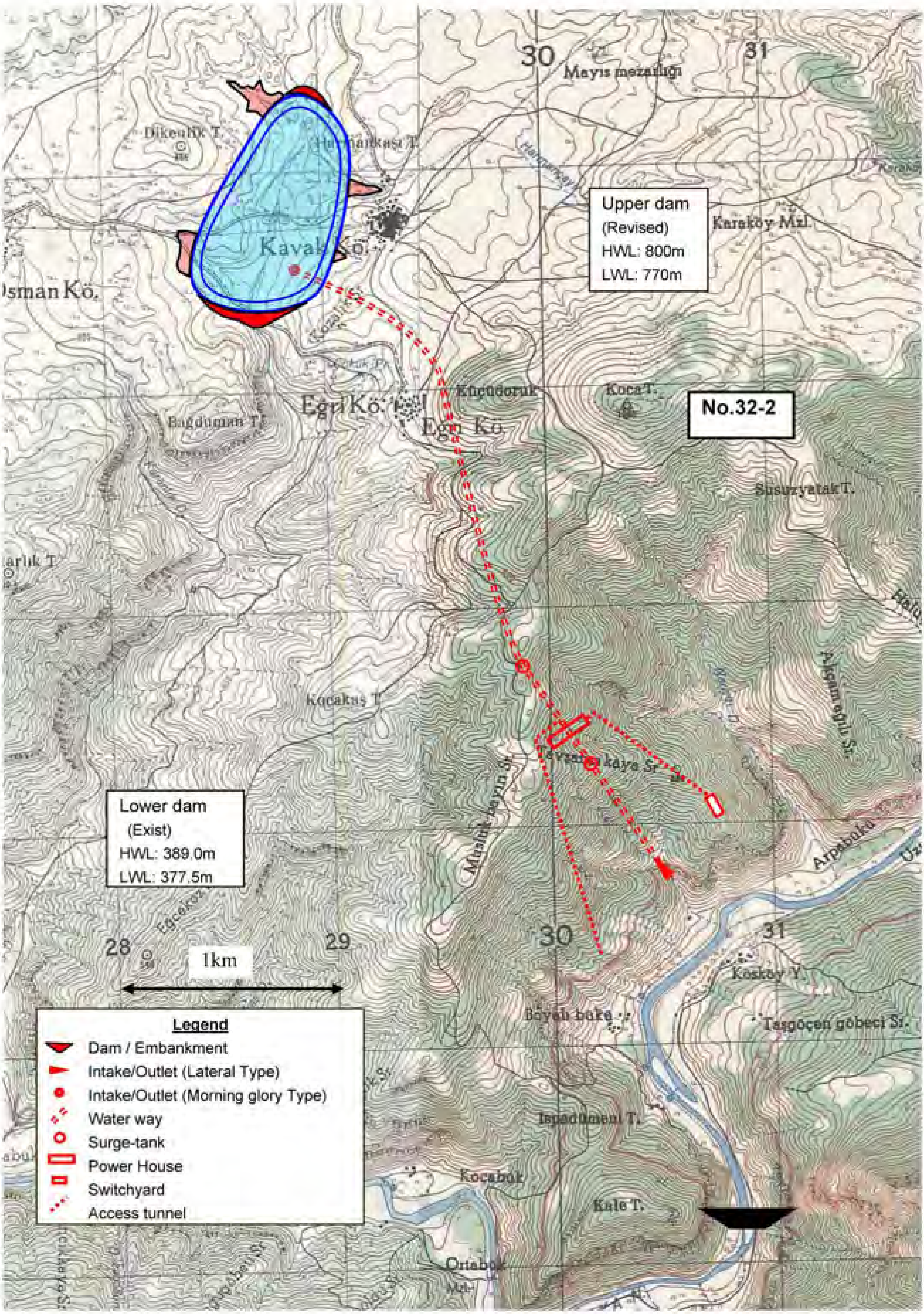


Figure 5. 13 Layout of Main Facilities of No.32-2 (Gökçekaya)

5.5 Detailed Site Survey on Conceptual Design Sites

5.5.1 Purpose of Site Survey

A detailed site survey on the conceptual design sites Altınkaya PSPP and Gökçekaya PSPP was carried out to survey the geographical and geological conditions and environmental conditions in detail based on the former site survey results and topographical map of 1/5,000 prepared by EIE, and to reflect the results of the detailed site survey onto the conceptual design.

5.5.2 Description of Site Survey

(1) Methodology of site survey on geography/geology and design relations

A preparatory study was carried out without omission by getting together the revised layout of structures and it pointed out issues based on the results of the primary site survey. In addition, the survey team reconfirmed the optimal location and feature of the main structure by using the topographical map of 1/5,000.

(2) Methodology of environmental site survey

Detailed site investigation for Environmental Impact Assessment (EIA) will be carried out during the feasibility study stage in the future. In the current conceptual design stage, the survey team carried out the initial site survey with visual observation and interview with related people at the level of Initial Environmental Examination (IEE) as follows:

- The Study Team and EIE environmental engineer visited the related villages, and made interviews with heads of villages on the social environment of the villages.
- The Study Team and EIE environmental engineer visited the project sites, and carried out visual observation of the natural environment surrounding the project sites. They also made interviews with heads of villages and local people on the natural environment of the area.
- The Study Team and EIE environmental engineer also visited the related provincial and district offices, and obtained information related to the natural and social environment of the project sites.

The Study Team summarized the results of the site survey with a checklist, which was made based on the checklists of international donor agencies, and evaluated the current environmental and social situation of the project sites.

5.5.3 Itinerary of Survey

Site survey was carried out in consultation with the counterparts as shown in Table 5. 10.

Table 5. 10 Itinerary of Detailed Site Survey

Date	Participants of C/P	Participants of JICA	Site No.
31 Aug. - 2 Sep.	Ms. Ozlem Yilmaz (Environment) Mr. Burhan Gulek Ozel (Geology) Mr. Huseyin Kokcuoglu (Civil)	N. Seki (Team Leader) M. Ito (Civil) H. Shinohara (Civil) J. Tamakawa (Environment) K. Nakamata (Geology)	No. 27-1
3 Sep. - 4 Sep.	Ms. Ozlem Yilmaz (Environment) Mr. Burhan Gulek Ozel (Geology) Mr. Huseyin Kokcuoglu (Civil)	M. Ito (Civil) H. Shinohara (Civil) J. Tamakawa (Environment) K. Nakamata (Geology)	No. 32-2

5.5.4 Results of Site Survey

(1) Altınkaya PSPP (No.27-1)

1) Geographical/geological conditions and design relations

a) Current condition

Location and transportation conditions:

The project site is located about 100 km west from the center of Samsun, which is a big city on the Black Sea, and the road condition is fairly good. There is an arterial road between Samsun and Bafra, the distance being about 50 km. There is a paved local road between Bafra and Altınkaya Dam, this distance being about 30 km. Also, there is a dirt road, but maintained, of about 30 km between Altınkaya HES office and the upper dam site. Although there is a dirt road between the upper dam and the outlet, as that is a punishing road, it takes about one and half hours to reach by a four-wheel drive vehicle.

Meanwhile, there is a dirt road along the left bank of the Altınkaya reservoir and it is possible to drive from the Altınkaya Dam to the outlet. Trace records by GPS are shown in Appendix 5-5-2.

General geology:

According to the 1/100,000 Aralık quadrangle (2000), the geology surrounding the project site belongs to upper Cretaceous System of Mesozoic Erathem. The geology of the upper dam and reservoir area consists of Yemışlıçay formation (ky) and Cankurtaran formation (kc). The former is a volcanogenic sedimentary rocks containing flysche, and the latter is non-volcanic facies.

Cankurtaran formation (kc), which seems to be distributed in the lower horizon, is composed of sandstone, mudstone, and sandy limestone. Yemışlıçay formation (ky) is composed of tuff, volcanic breccia, sandstone, calcareous mudstone, and shale.

According to the site survey result, the boundary between them was estimated to locate around EL.900m on the right bank of Degirmen River. Sandstone and weathered tuff which overlay the sandstone are cropped out on the ridge of SE direction from the dam site. Onion structural weathering of the tuff layer was observed on the roadside near the village (refer to Photo 5.1 and 5.2). Figure 5. 14 shows the geological map of Altınkaya PSPP site prepared by the Study Team based on the detailed site survey result.

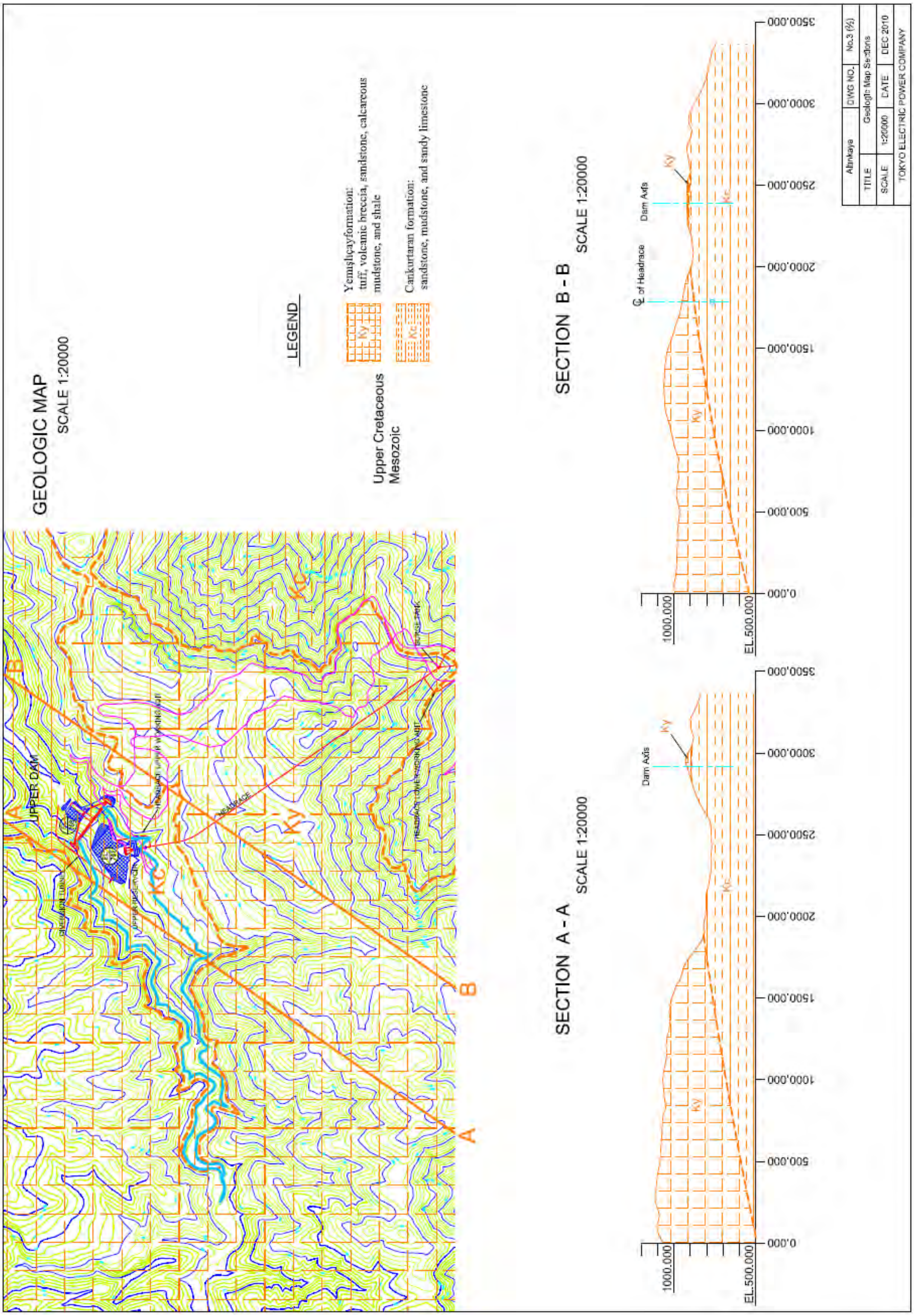


Figure 5. 14 Geological Map of Altınkaya PSPP

Photo 5.1 Tuff cropped out on the cut slope of the road around El.900m

Photo 5.2 Sandstone(left) and Tuff(right) cropped out on the ridge of SE direction from Upper dam

Upper Reservoir:

The location of the upper dam site was shifted from the former location to about 500 m upstream site based on the result of the site survey using the topographical map of 1/5000. The valley width of the new dam site is the narrowest in the area.

The new dam site landform is asymmetric, which has steep slope on the left bank and gentle slope on the right bank. Generally the alternation of strata of sedimentary rock distributes at a higher level than the mid-elevation of the left bank (refer to Photo 5.3). Strike and dip of the bedding is WNW/SW. Joints orthogonal to the bedding was observed in the sandstone and slaking was observed in the mudstone at the outcrop of the cut slope on the right bank (refer to Photo 5.4).

Photo 5.3 Alternation of strata of sedimentary rocks on the left bank of dam site

Photo 5.4 Sandstone (above) and mudstone (below) cropped out on the cut slope of the right bank

There is a gentle slope covered by sandy sediments with around 10 m thickness along the river between the new dam site and a small bridge which crosses over the Degirmen River. The width of the gentle slope is 30 m on the left bank and 50 m on the right bank. Grass covers the surface of the gentle slope, and aquatic plants and shrubs grow thickly in and along the river.

Lower Reservoir:

Alternation of sandstone and mudstone (and rarely conglomerate) was observed on the left bank of the Altınkaya reservoir. The alternation of strata has a flexural-folds structure and a good continuity (refer to Photo 5.5).

Photo 5.5 Alternation of sandstone and mudstone (conglomerate) with flexural-folds structure

Waterway and Underground Powerhouse (UGPH):

The alternation of conglomerate, sandstone, and mudstone crops out on the ground surface through the waterway route and UGPH. The strata form low-level flexure fold.

Slaking of mudstone and dissolution of the blocks of conglomerate were observed here and there.

Sandstone and conglomerate crop out near the outlet site. Some of the coarse fragments of limestone in the conglomerate had dissolved on their surfaces (refer to Photo 5.6).

Photo 5.6 Sandstone (left) and conglomerate (right) crop out on the cut slope near the outlet site

b) Evaluation and issues

Location and Transportation Conditions:

The length of roads to be altered, which are necessary for approach and maintenance of the upper reservoir and the outlet, is estimated at about 30 km for the upper dam and 15 km for the outlet. Besides, a connection road of 15 km between the upper dam and the outlet for construction and maintenance needs to be constructed newly.

Upper Reservoir:

The upper dam site has asymmetric landform: the slope of the right abutment is steep (70°) and one of the left banks is gentle (35°) (refer to Photos 5.7 and 5.8).

Photo 5.7 Gentle slope on the left bank of the dam site

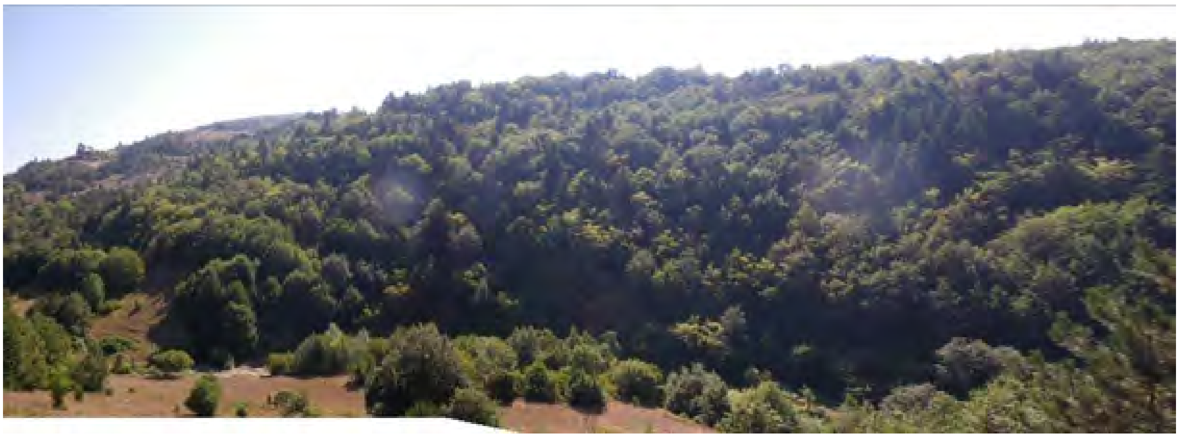


Photo 5.8 Steep slope on the right bank of the dam site

An alternation of sandstone and mudstone crops out on the river bed, whose strike/dip of bedding is N80W/10S. Joints are developed in sandstone outcrops on the river bed, and calcite veins fill the joints. The strike/dip of joints are N5E/90 with interval of 0.5 m, forming dextral flying geese arrangement. The thickness of calcite veins is 5-7 mm. Double calcite veins exist in some joints, which show track of two times infilling. Such phenomena suggest that there might be some joints with insufficient infilling of calcite veins (refer to Photo 5.9).

On the other hand, mudstones are divided into stick-like fragments by development of slaking and are crumbled in many places (Refer to Photo 5.10).

Judging from such a geological condition, confirmation of the quality of concrete aggregate for concrete gravity dam or rock materials for fill-type dam is an important issue.

Concrete aggregates for concrete gravity dam or rock materials for fill-type dam would be got from a quarry site because there are less riverbed deposits in the Degirmen River. A mountain body, which has a width of 200 m and length of 300 m, on the left bank approximately 500 m upstream from the dam site is considered as a primary candidate site of quarry. Geological investigation and laboratory tests are required to identify both quality and quantity for concrete aggregate or rock materials for a fill-type dam.

Photo 5.9 Calcite veins filled in joints of sandstone

Photo 5.10 Crumbling mudstone to stick-like fragments by slaking

The intake site is planned to locate on a narrow ridge between small tributaries. Rocks crop out on the riverside below the intake, and the slope seems to be stable (Refer to Photo 5.11).

Photo 5.11 Landscape around the intake site

Water quality of the Degirmen River is as follows:

Temp.: 21.9 °C, Ec(electric conductivity): 0.333 ms/cm, pH: 9.13 (Aug. 31, 2010).

Since the pH of present river water expresses alkaline, it is expected that calcite veins in joints have not been dissolved by river water. However, there is a possibility that calcite veins in the rock on the dam abutment had been dissolved by weathering. Therefore, the permeability of bedrock of the dam site and the reservoir area should be examined.

Outlet:

Lacks of outcrop of rock are observed in some places that are washed out by the lake water and show concave terrain. The width of a lacking zone is several meters. It implies that hidden weak zones such as fracture or hydrothermal alteration exist in this area.

The inclination of the beds at the outlet site is opposed to the original dip of the strata. It is judged that rocks around the surface slant to the south due to creep (refer to Photo 5.12). Mudstones which are divided into stick-like fragments by slaking were observed on the surface near the outlet site (refer to Photo 5.13).

Geological investigation such as bore-hole drilling and seismic prospecting is required in and around the outlet site to clarify the weathering depth and bedrock condition.

Photo 5.12 Weathered, turned edges of the mudstone which is bending to the south due to creep

Photo 5.13 Crumbling and disintegrated mudstone due to slaking

Waterway and Underground Powerhouse (UGPH) :

There are no hydrothermal alterations and fracture zones on the cut slope of the dirt road in the mountain. However, there may be some hidden weak zones under the ground; therefore, seismic prospecting along the waterway route and bore-hole drilling and in-situ tests for the surge tank and underground powerhouse are required.

2) Environmental and social considerations

a) Current situation

The checklist filled and photographs taken during the site survey are shown in Appendix 5-5-2 and Appendix 5-5-3, respectively.

(Social conditions)

Upper Reservoir:

i) Site location and current situation of village

The upper dam/reservoir site is located in Baskaya Village, Bafra District, Samsun Province. It is in the Degirmen River, which is a tributary of Kizilirmak River through Ilyasli River.

Baskaya Village is mainly divided into two communities: main village on the right bank and Uluavlu on the left bank, as shown in Photos 5.14 and Photo 5.15, respectively. Each of the communities has 20 households (HHs). Therefore, the total number of houses of the village is 40 HH. Since both of the communities are located on the higher hillside, no resettlement by the project is anticipated.

Many of houses in the main village are used as summer houses in which retired people from Samsun and/or Bafra live. Since young people go out of the village to look for jobs, most of the residents in the village are old.

Photo 5.14 Baskaya Village (Main Village)

Photo 5.15 Baskaya Village (Uluavlu Community)

ii) Socio-economic conditions

The main income source of the residents is animal breeding. The residents used to breed sheep; however, they changed to breeding cow. The reasons are as follows:

- No one can drive sheep because the number of young people has decreased.
- Sheep meat is not popular in the local market of the region.

Income from breeding cow is about 1,000 TL/month/HH (USD700/month/HH). Recently, the residents started producing tobacco as an income source. However, it is not successful at the moment. Therefore, planting tobacco is still a limited income source. The residents also harvest vegetables, but only for self-consumption.

The residents are allowed to get firewood from dead trees in the surrounding forest.

iii) Education

There are five elementary school students, three to four high school students, and four university students. Since there is no school in the village, they have to commute to the schools staying in dormitories in Bafra City and/or Samsun City.

iv) Public facilities, cultural heritages, and tourist resources

There are two mosques and a guest house in the village. Since there is no clinic, a doctor comes to the village from Bafra City once a month to do a check-up of the villagers. There is no school as mentioned above.

Cultural heritages and tourist resources do not exist in the village so that no impact by the project is anticipated.

v) Water use

The residents do not use the water of Degirmen River. Drinking water for the residents is taken from springs. People of Bengi village, which is located upstream of the dam site, use a small amount of water from the river for their gardening.

River water at the downstream of Degirmen River is not utilized until the confluence point of Degirmen River and Ilyasli River. Water of the Ilyasli River until the junction with Kizilirmak River, which is the main stream of the basin, is taken for planting tobacco, but its amount is very limited and its period is also limited only in May and June.

vi) Development plan and needs

The village submitted a request for an additional water supply project to the district office because their current water supply facilities are insufficient, especially during summer time. However, there is no answer from the district office at this moment.

Meanwhile, Bafra district office has a plan to create leisure facilities at highland in the village in order to enhance the village’s economy inviting people for summer houses and paragliding.

Lower Reservoir:

The lower dam/reservoir is planned to utilize the existing Altınkaya Dam, which has 5.76 billion m^3 of total storage capacity as shown in Photo 5.16. There are no social activities around the outlet site, and no salmon breeding unlike other reservoirs (refer to Photo 5.17).

Photo 5.16 Altınkaya Dam (As the lower dam)

Photo 5.17 Outlet Site and Altınkaya Reservoir

(Natural environment)

There are no national parks and other environmentally protected areas designated around the project site. A part of the upper reservoir area is used for wheat field or as meadow for breeding animals as shown in Photo 5.18. Another area is a relatively dense secondary forest consisting of pine, hornbeam, spruce, and chestnut trees. The vegetation around the waterway route is the same as the one of the upper reservoir.

Wildlife in the area are mostly rabbits, foxes, *Sus scrofa* (wild pigs), snakes, *Capra aegagrus* (wild goat), and falcons. The number of wild goats has been considerably increasing in the recent two years' period, since the government released them to the mountains. However, there is no important species in the area. All species of fauna are commonly found in Turkey.

As for the water quality of the river and the reservoir, there are no available data. According to the visual observation, since bubbles, which are most likely caused by surfactant, are observed in the Degirmen River, it seems that miscellaneous drainage is released to the upstream of the river. The water quality of the Altınkaya reservoir seems relatively clean and transparent. It is assumed that upstream of the Altınkaya reservoir has not been contaminated.

Photo 5.18 Upper Dam / Reservoir Site (viewing from downstream)

b) Anticipated direct impacts

Most of the affected land by the upper dam/reservoir will be mainly forest while a part of the affected land is wheat field. Most of the affected wheat field is owned by Mr. Osman Celebi, who is the head of Baskaya Village. In addition, there are two units of water mills at the upstream of the dam site, which might be affected by the upper reservoir.

As for the waterway and the powerhouse, they will be underground structures. So, affected land for the construction of those structures will be limited to access roads and tunnel mouths. Those lands are government-owned forest.

The matter of land expropriation will be solved in the next stage.

c) Evaluation and issues

During the site survey, crucial environmental and social issues were not found as mentioned above. Also, the existing Altınkaya reservoir can be utilized as the lower reservoir. Therefore, it is expected at this moment that environmental and social impacts by the PSPP project will be limited. Furthermore, the villagers are hoping to have job opportunities during the construction, and also to realize an additional water supply project and expansion of surrounding roads under the purview of corporate social responsibility (CSR) activities related to the project. Therefore, the villagers are expecting realization of the project.

Even if it is anticipated that environmental and social impacts of the project are limited at this moment, careful and detailed EIA procedures should be carried out through sufficient site survey and consultation with project-affected people (PAPs) and other related persons.

3) Transmission line

It was expected that there needed to be several long-span transmission lines in the route from the switch yard of Altınkaya PSPP to that of the existing Altınkaya HES (refer to Figure 5. 15).

The Study Team conducted site survey and confirmed that there is no big problem in the above new transmission route. Site conditions observed in the site survey are shown in Photos 5.19 to 5.24.

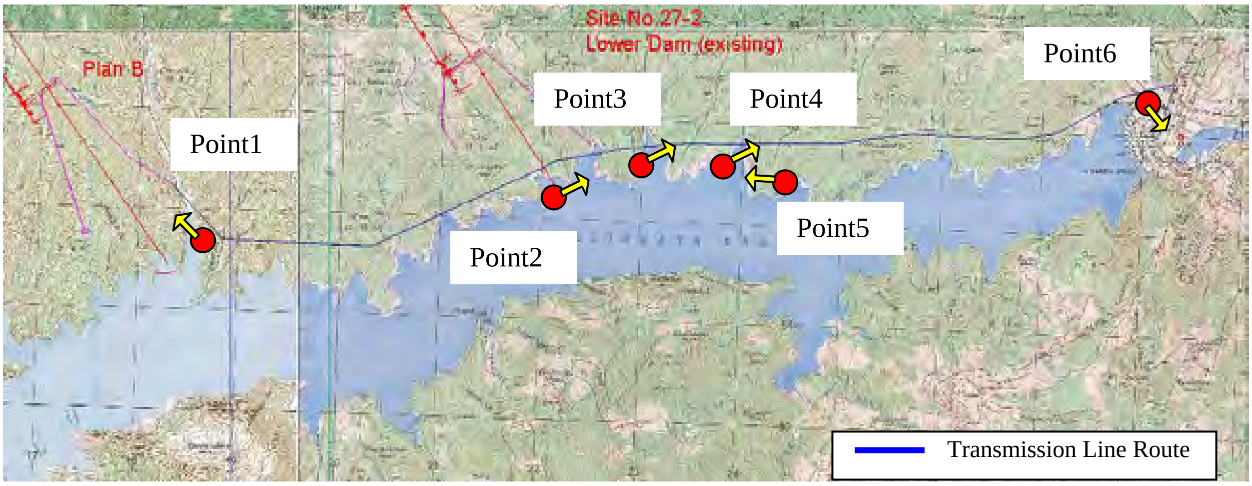


Figure 5. 15 Site Survey Location Map of Transmission Line Route of Altınkaya PSPP

Photo 5.19 No.1 Point

Photo 5.20 No.2 Point

Photo 5.21 No.3 Point

Photo 5.22 No.4 Point

Photo 5.23 No.5 Point

Photo 5.24 No.6 Point

(2) Gökçekaya PSPP (No.32-2)

1) Geographical/geological conditions and design relations

a) Current conditions

Location and Transportation Conditions:

The project site is located about 190 km west from the center of Ankara, the capital of Turkey, and the road condition is fairly good. There is an arterial road between Ankara and Nallihan, whose length is about 150 km. There is a paved local road between Nallihan and Osmankoy Village, which is west of the upper pond, the distance being about 40 km. Also, there is a dirt road between Osmankoy and the headrace surge tank site though the upper pond. However, the dirt road does not reach to the existing Gökçekaya Dam, the remaining 2 km. Therefore, in order to reach from the upper pond site to the outlet site, we cannot help but get around about 30 km to Yenice Dam, located downstream of Gökçekaya Dam. Trace records by GPS are shown in Appendix 5-5-4.

General Geology:

According to the explanation sheet of Adapazarı quadrangle, bedrocks of this site belong to Gökçekaya formation –metamorphics- (Peg) and Kızlıçay formation (TPek), which distribute from south to north in order. The geological age of the former is upper Paleozoic to Triassic period of Mesozoic age, and the latter overlays the former in unconformity. Furthermore, Gemiciköy formation (Temg) of upper Eocene to lower Miocene age lays on both PEg and TPeK in unconformity. The schematic geologic profile of this area is illustrated in Figure 5. 16, which is cited from the Adapazarı quadrangle.

Figure 5. 16 Typical Geology Profile of N-S Direction shown in the Adapazarı Quadrangle

Gökçekaya metamorphics (Peg) consists of chlorite – sericite schist, phyllite, metabasic lava, and calcschist, and contains a huge block of recrystallized limestone and marble, which are the members of Eğriköy marble (PEge). Kızlıçay formation (TPek) consists of alternation of conglomerate, sandstone, and mudstone (continental). Gemiciköy formation (Temg) consists of conglomerate, sandstone, claystone, marl, and lacustrine limestone.

The outlet is planned in the existing Gökçekaya reservoir which is used for the lower dam. The geology of the area is an ophiolitic mélange of Dağküplü formation (Of/Kg) in upper Cretaceous period of Mesozoic era**.** This stratum plunges under the PEg in thrust state. These are described based on the published geological map (1:100,000 Adapazarı H-25(2002) and H-26(2002).

Upper Reservoir:

The upper dam site is located on the right bank of the existing Gökçekaya reservoir.

There are PEg, PEge, and Temg in the dam site area. The previous site was planned on a steep cliff, and it was recognized as a huge block of limestone (refer to Photo 5.25). Although it was not clear, but there is a boundary of Tpek and Temg on the upper horizon. The strike/dip of the boundary is N40E/20NW and inclined gently to the direction of the upper pond.

Since the previous upper dam site was located on the huge limestone block, the dam axis was shifted to the relatively flat upstream area. Furthermore, the reservoir type was changed to artificially excavated pond type with asphalt facing, since there is a concern of water leakage from the reservoir. Tuff fragments are distributed on the surface of the left bank（refer to Photo 5.26）, and chlorite-biotite schist of PEg crops out at the foot of Kavak köy on the left bank. Measured strike and dip of the schistosity of PEg was N70W/45-40N（refer to Photo 5.27）.

Photo 5.25 Outcrop of recrystallized limestone of Eğriköy formation **(PEge)** with steep slope

Photo 5.26 Tuff**: Temg(t)** of Gemiciköy formation (**Temg**) distributed on the left bank of dam site

Photo 5.27 Outcrop of Chlorite-sericite schist of Gökçekaya metamorphics (**PEg**) at the foot of Kavak köy on the left bank

Lower Reservoir:

The existing Gökçekaya (arch) dam is used for the lower reservoir.

Since the slope of the right bank of the reservoir is steep and devoid of vegetation, outcrop of rock can be seen well. General strike and dip of the strata is N70E/70～80NW.

Landslides were observed a lot around the Gökçekaya reservoir, especially on the left bank. There are a few loosened rock masses on the right bank, and the outlet site is on one of the loosened rocks due to creep（refer to Photo 5.28 and 5.29）.

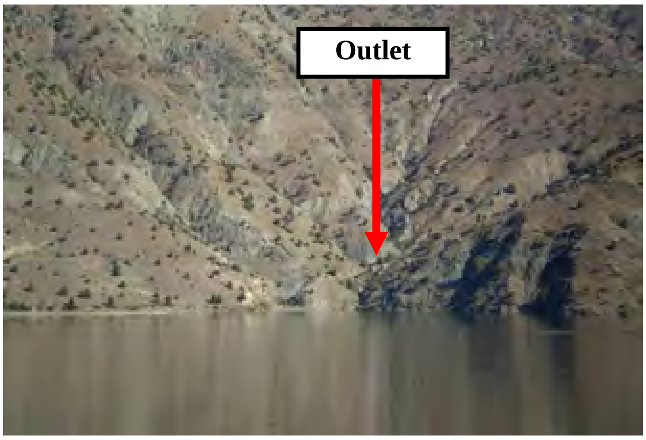


Photo 5.28 Creeping rock mass in the outlet site on the right bank of Gökçekaya lake


Photo 5.29 Loosened rock on the surface of creeping rockmass at the outlet site

Waterway and Underground Powerhouse (UGPH):

The intake is designed as a morning-glory-type shaft on the bottom of the upper reservoir pond. The intake and some part of the waterway route will go through Temg, TPek, and PEge in order; however, most part of the waterway and the UGPH will be located in PEg, which seems to be little weathered, hard, and massive. However, since PEge contains huge limestone blocks, the waterway might encounter caves.

b) Evaluation and issues

Location and Transportation Conditions:

Since the existing local road runs through the upper pond, before constructing the upper pond, a bypass road should be constructed. As for approach and maintenance road to the outlet site, the existing road has to be altered and extended by 2 km newly so as to have an approach from the upper pond.

Meanwhile, it is appropriate that an access tunnel is constructed from the existing Gökçekaya dam’s spillway to the outlet site, since the slope of the right bank near the Gökçekaya dam is so steep and pollution of the Gökçekaya reservoir by fall of excavated soil and rocks should be prevented.

Upper Reservoir:

The dam axis was shifted to upstream of around 200 m, judging from the topographical condition based on the 1/5000 map. The new dam site is located on a gentle slope used for a wheat field. There are some fragments of weathered bedrock on the surface, and no bedrocks were observed. However an outcrop of bedrock was observed on the top of the hill near the dam site. The thickness of sediment at the dam site is estimated at less than 3 m.

Bedrock of the dam site belongs to Temg. The facies of Temg are volcanogenous sedimentary rocks such as tuff and tuff breccia, though it is described as sedimentary rocks in the explanation paper of Adapazarı quadrangle. The tuffaceous rocks are distributed widely in the upper pond area (refer to Photos 5.30 and 5.31).

Photo 5.30 Bedded Tuff: **Temg(t)** of Gemiciköy formation (**Temg**) cropped out on the hillside on the left bank of the reservoir

Photo 5.31 Tuff breccia: **Temg(b)** of Gemiciköy formation (**Temg**) cropped out at the upmost stream of the reservoir

The upper pond needs to be artificially excavated in order to secure the storage capacity. It is expected that there is little possibility of water leakage from the upper pond, because tuff and tuffaceous rock of Temg are distributed mainly around the upper pond. However, the boundary with PEge or PEg, the lower stratum, is undulated, and permeability of the boundary and PEge or PEg is unclear. Therefore, it's required to examine the hydrogeological property and permeability of the bedrock of the upper pond by bore-hole drilling including Lugeon tests. If there is no risk of water leakage from the upper pond, i.e., confirming higher ground water level than HWL on both right and left bank and low permeability, the full facing with asphalt can be omitted.

Besides, with or without of expansive clay mineral should be examined by X-ray diffraction analysis, because the tuffaceous rocks were originated in past volcanic activities.

Figure 5. 17 shows the geological map of Gökçekaya PSPP site prepared by the Study Team based on the detailed site survey result.

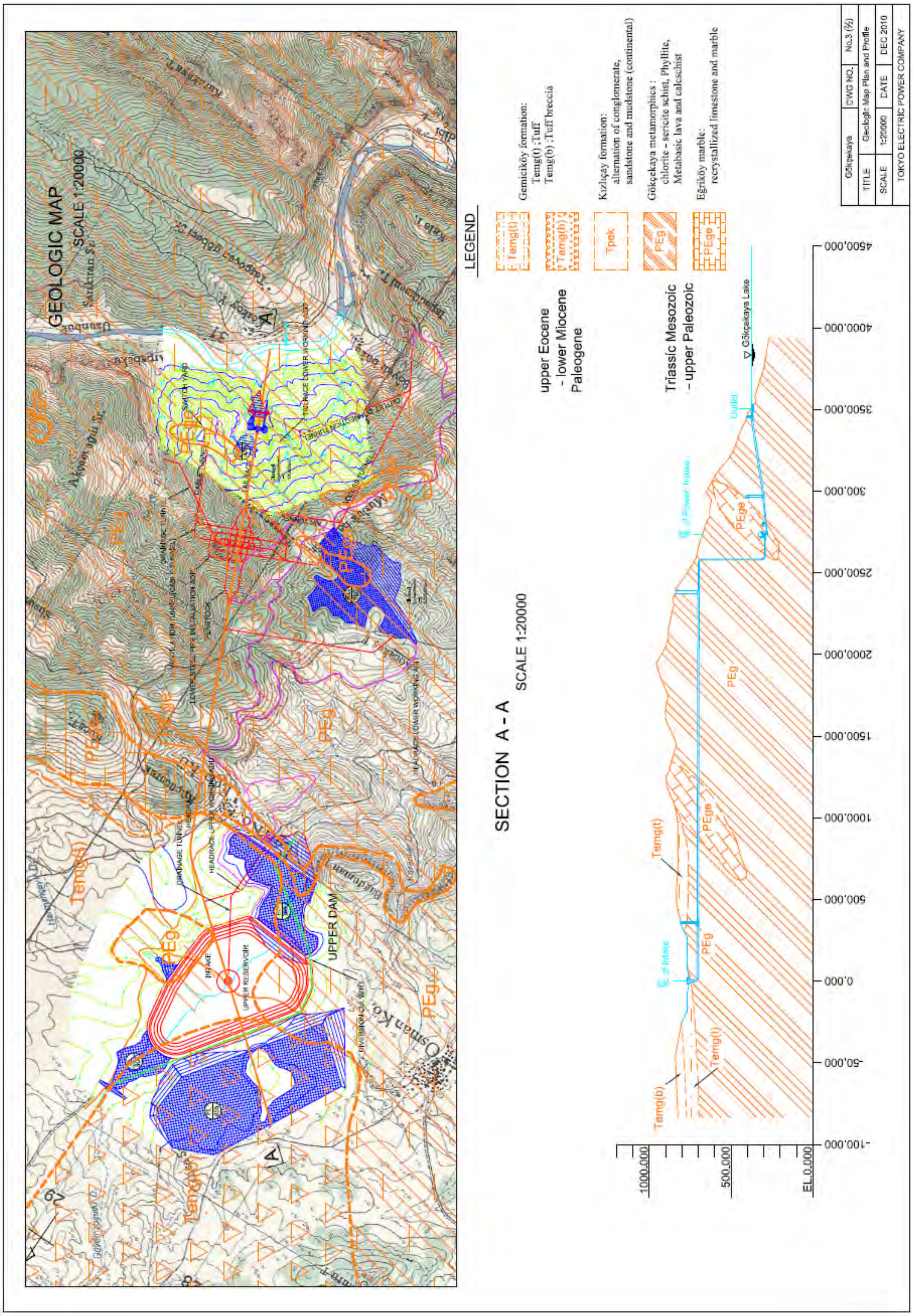


Figure 5. 17 General Geology of Gökçekaya PSPP

Outlet:

Massive and hard bedrock crop out on the right bank of the Gökçekaya reservoir, however, there is a rock mass that has slipped down from halfway the slope due to creeping at the outlet site.

The rock mass should be removed, and the upper slope of the outlet should be protected for the stability of slope during and after construction.

Waterway and Underground Powerhouse (UGPH):

Geological investigations concerning weathering condition are required for the intake and intake gate shaft site. On the other hand, the degree of weathering through waterway route and the underground power station is expected to be low, since the fresh and hard rock belonging to PEg is distributed.

Geological condition of TPek and PEge and location of the boundary between TPek or PEge and PEg need to be identified along the waterway route from the intake to the upper reach of headrace tunnel. PEg outcrop is fresh and hard (refer to Photo 5.32 and 5.33). However, since PEge is distributed in PEg, the existence of caves in PEge should be paid attention.

Photo 5.32 Outcrop of chlorite-biotite schist of **PEg** on the surface of headrace tunnel route

Photo 5.33 Close up photograph of the outcrop in Photo 5.32

2) Environmental and social considerations

a) Current situation

The photographs taken and checklist filled during the site survey are shown in Appendices 5-5-3 and 5-5-5, respectively.

(Social environment)

Upper reservoir:

i) Site location and current situation of villages

The upper dam/reservoir site is located in Kavak Village and Egri Village, Nallihan District, Ankara Province. It is on the upstream of Kisla River, which is a tributary of Sakarya River.

The waterway route passes near Kavak Village.

There are totally 120 HHs in Kavak Village, which is shown in Photo 5.34, but the number of houses in which residents permanently live is only 80 out of 120 HHs. The population of the village is 280. Most of the residents are old people who have already retired from government offices. Most of the young people go out of the village to look for jobs. The number of children is only 10.

As for Egri Village, there are totally 60 HHs in the village, but the number of houses in which residents permanently live is only 30 out of 60 HHs. The population of the village is 120. Most of the residents are also old people who have already retired from government offices, same as Kavak Village. There are no children in the village.

Photo 5.34 Kavak Village (Viewing from upper stream)

ii) Socio-economic conditions

Most of the residents of the two villages rely on retirement allowance (annual pension). Aside from the allowance, they can earn only from wheat harvest at the price of 200 TL/donum (0.1 ha). Only one person (head of the village) is engaged in keeping cows, and he can earn 30,000–35,000 TL/year.

iii) Public facilities, cultural heritages, tourist resources

There is no school and also no clinic in both the villages. The only public facilities are two mosques in both the villages.

There are no cultural heritages and no tourism resources in the villages. Therefore, no impacts of the project are anticipated.

iv) Water use

There is a pumping-up facilities in the reservoir site as shown in Photo 5.35 in Kavak Village. The residents get drinking water from deep wells. Photo 5.36 shows the additional pumping-up facility, which was newly constructed, and it will be operated soon. In Eğri Village, there are also two deep wells.

Very limited water flows on Kisla River through the year except during snowmelt season. The limited water is used for stockbreeding. Since there are no water resources near the villages, irrigation facilities do not exist in the villages.

Photo 5.35 Existing Pumping-up Facility

Photo 5.36 New Pumping-up Facility

v) Development plan and needs

The residents of the villages have needs to extend the existing road, and they have requested the government for the road extension. However, when it is realized is obscure.

They wish construction of a road reaching to the Gökçekaya reservoir to make fishing for self-consumption possible. If the road is constructed, they would access the reservoir easily. They can shorten their travel distance from the current 30 km to 7-8 km.

The other needs of the residents are watering facilities for animal breeding, irrigation facilities, health facilities, and any other income generation development.

Lower reservoir:

The lower dam/reservoir is planed to utilize the existing Gökçekaya Dam, which has 0.91 billion m^3 of total storage capacity as shown in Photo 5.37. There are no social activities around the outlet site as shown in Photo 5.38. Although there are activities of raising salmon in the reservoir, no direct impacts to these activities of the project are anticipated.

Photo 5.37 Gökçekaya Dam (as Lower Dam)

Photo 5.38 Outlet Site and Gökçekaya Reservoir

(Natural environment)

There are no national parks and other environmentally protected areas around the project site. Most of the upper reservoir area is used for wheat fields as shown in Photo 5.39, and a part of the area is used for vegetable gardens and mixed orchards for self-consumption. The waterway route passes through a damaged forest as shown in Photo 5.40 and 5.41.

Wildlife in this area is foxes, wild pigs, wolves, and bears. Wild pigs are drastically increasing in their numbers, and damaging agricultural products in recent years. The villagers have requested the governmental office to protect their fields from wild pigs.

As for the water quality of Gökçekaya reservoir, propagation of algae is observed on the surface of the reservoir as shown in Photo 5.42. However, according to the water quality data, nutrient values such as nitrogen and phosphorus are relatively small. Therefore, the reservoir is regarded as a mesotrophic lake.

Photo 5.39 Upper Reservoir Site (viewing from left bank)

Photo 5.40 Waterway Route (Surge Tank)

Photo 5.41 Switchyard Site

Photo 5.42 Propagation of Algae in Gökçekaya Reservoir

b) Anticipated direct impacts

The anticipated direct impacts of the PSPP project are as follows:

i) Resettlement of two houses

The following two houses and two storages for animal breeding will be directly affected by construction of the upper reservoir:

- A house which is the second house owned by the person who is living outside of the Village. The owner stays in the house for limited days a year (refer to Photo 5.43).
- A house which is the second house owned by a resident of Kavak Village (Photo 5.44).
- Two storage houses for animal breeding (refer to Photo 5.45).

ii) Relocation of cemetery

Several ten graves of the cemetery of Kavak Village will be affected by construction of the upper reservoir. Therefore, compensation for relocation of the graves should be paid (refer to Photo 5.46). According to the head of Village (Mr. Huseyin Eryucel), relocation of graves can be accepted by the local residents if compensation cost is paid to them.

Photo 5.43 House to be resettled (Second House)

Photo 5.44 House to be resettled (Second House)

Photo 5.45 Affected Storage House

Photo 5.46 Affected Graves

iii) Relocation of Deep well for drinking water

Two deep wells in the upper reservoir are important as a source of drinking water for the residents of Kavak Village. Therefore, deep wells should be newly drilled at out side of the reservoir.

iv) Loss of Agricultural Land

The agricultural lands of the upper reservoir site are owned by local residents of Kavak and Eğri Villages. Since the lands will be submerged by the PSPP project, the loss of land itself as well as the loss of income from the wheat harvest and gardening should be compensated to the land owners.

On the other hand, the land along the waterway is located in the government-owned forest.

c) Evaluation and Issues

As for the upper reservoir, three houses and several tens' graves will be required to relocate. And also, since the construction yard of the upper reservoir is closed to Kavak Village, special considerations such as noise and vibration measures are required. Resettlement Action Plan and Environmental Management Plan should be prepared taking the residents' opinion into consideration through sufficient consultation with them. In addition, since the upper reservoir will be an artificially excavated pond type, a bypass channel will be constructed to avoid sediment inflow. The bypass channel is also required from the viewpoint of a social measure that provides water places for animal breeding.

As for the waterway and the powerhouse, crucial environmental and social impacts by the PSPP project are not anticipated as mentioned above.

Also, the existing Gökçekaya reservoir can be utilized as the lower reservoir. Therefore, it is expected at this moment that environmental and social impacts by the PSPP project will be limited.

Furthermore, the villagers are expecting implementation of the project to get job opportunities during construction.

Even if anticipated environmental and social impacts by the project are limited, careful and detailed EIA should be carried out through sufficient site survey and consultation with Project Affected People (PAPs) and other related persons.

3) Transmission Line

It was expected that a transmission line from the switch yard of Gökçekaya PSPP to that of Existing Gökçekaya HES, which length is about 2km, has to cross over the Gökçekaya Reservoir and two existing transmission lines extended to the upstream direction (refer to Figure 5. 18).

The Study Team conducted site survey and confirmed that there is no big problem in the above new transmission route. Site conditions observed in the site survey are shown in Photos 5.47 to 5.50.

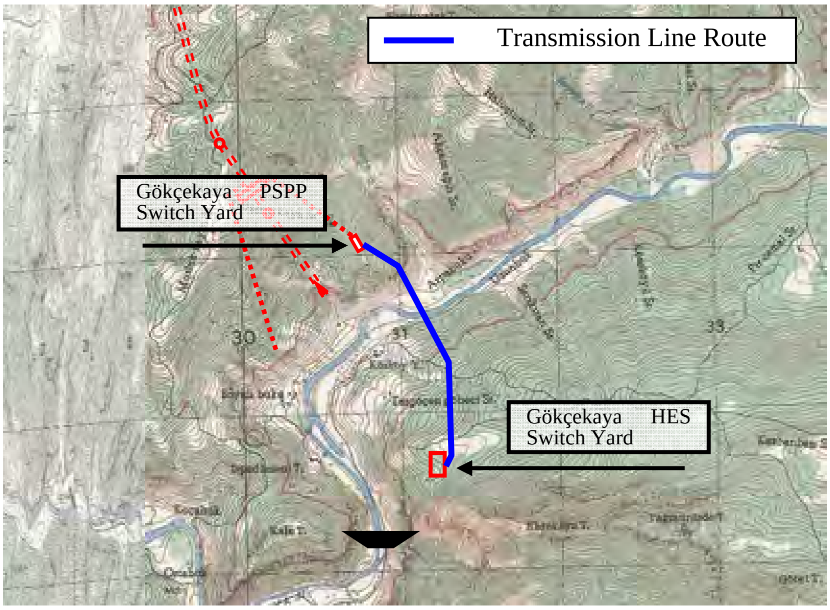


Figure 5. 18 Transmission Line Route of Gökçekaya PSPP

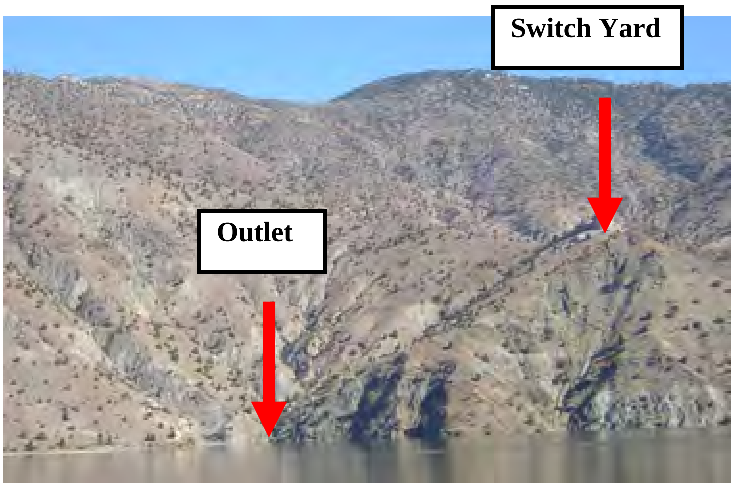


Photo 5.47　Location of Gökçekaya PSPP Switch Yard

Photo 5.48　Existing Switch yard（Upstream Left Bank of Dam）

Photo 5.49　Transmission Lines from Existing S.Y to Upstream (2 Systems)

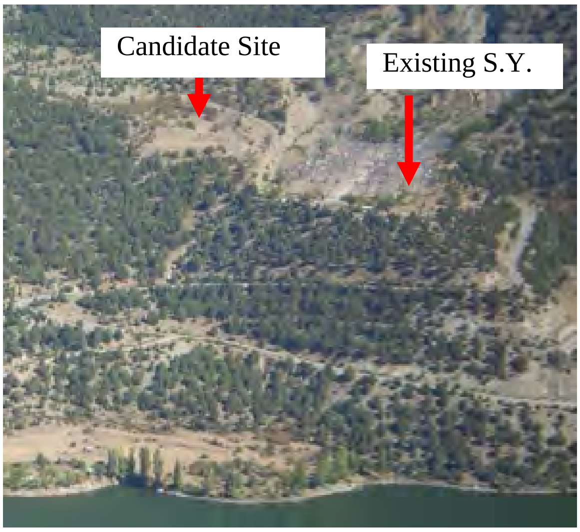


Photo 5.50 Candidate Site for Transmission Tower for Connecting to Existing S.Y.

Chapter 6 Proposal of Long-Term Power Development Planning (from 2011 to 2030)

Based on the result of the study made so far, the Study Team proposed a draft of a long-term power development plan covering 20 years between 2011 and 2030.

6.1 Current Power Development Plan and Its Future Directions

The power development plan which covers years up to 2018 uses the Turkish Electrical Energy 10-Year Generation Capacity Projection (2009-2018) formulated by TEIAS in June 2009 as reference. However, considering that the future power development planning is left to the free will of private power generation companies, this plan only includes generation facilities which are expected to start operation in the near future. The plan points out that with these facilities alone, power plants will gradually run short from 2014, making it impossible to sustain the predetermined supply reliability level. For this reason, even during the period up to 2018, in a case where the predetermined supply reliability cannot be maintained, additional development of power plants will be made in line with the government policy on electric energy in attempts to sustain supply reliability and minimize costs.

6.1.1 Turkish Electrical Energy 10-Year Generation Capacity Projection (2009–2018)

(1) Demand forecast

Two cases of demand forecast, high case and low case, are proposed. Forecast values are as shown in Table 6. 1.

Table 6. 1 Maximum Power Demand Forecast（TEIAS Projection）

(MW)

	2010	2011	2012	2013	2014	2015	2016	2017	2018
High case	31,246	33,276	35,772	38,455	41,339	44,440	47,728	51,260	55,053
Low case	31,246	32,964	35,173	37,529	40,044	42,727	45,546	48,553	51,757

(2) Power development plan

The power development plan presents two scenarios, Scenario 1 and Scenario 2 as shown in Table 6. 2.

Table 6. 2 Power Development Plan（TEIAS Projection）

(MW)

		2009	2010	2011	2012	2013	2014	2015	2016
Scenario 1	Imp. Coal	187		410	1,216	1,213			
	Gas	92	146	806	1,912	840			
	Wind	206	173	269					
	Hydro	1,057	1,495	1,678	1,818				1,200
	Others	126	11	8					
	Total	1,668	1,825	3,171	4,946	2,053	0	0	1,200
Scenario 2	Imp. Coal	187		410	608	1,213			
	Gas	92	78	873		1,865			
	Wind	173	184	202					
	Hydro	908	1,364	1,626	1,594				1,200
	Others	118	19	8					
	Total	1,478	1,645	3,119	2,202	3,078	0	0	1,200

(3) Supply reliability levels

With regard to the combination of two cases of demand forecast and two power development scenarios, respective supply reliability levels (ratio of reserve capacity against maximum capacity) are presented in Table 6. 3.

Table 6. 3 Supply Reliability Levels （TEIAS Projection）

(MW)

		2011	2012	2013	2014	2015	2016	2017	2018
High case demand		33,276	35,772	38,455	41,339	44,440	47,728	51,260	55,053
Scenario 1	Capacity	48,182	53,128	55,182	55,182	55,182	56,382	56,382	56,382
	Reserve	44.8%	48.5%	43.5%	33.5%	24.2%	18.1%	10.0%	2.4%
Scenario 2	Capacity	47,760	49,962	53,040	53,040	53,040	54,240	54,240	54,240
	Reserve	43.5%	39.7%	37.9%	28.3%	19.4%	13.6%	5.8%	- 1.5%
Low case demand		32,964	35,173	37,529	40,044	42,727	45,546	48,553	51,757
Scenario 1	Capacity	48,182	53,128	55,182	55,182	55,182	56,382	56,382	56,382
	Reserve	46.2%	51.0%	47.0%	37.8%	29.1%	23.8%	16.1%	8.9%
Scenario 2	Capacity	47,760	49,962	53,040	53,040	53,040	54,240	54,240	54,240
	Reserve	44.9%	42.0%	41.3%	32.5%	24.1%	19.1%	11.7%	4.8%

Reserve (%) = ((Capacity) – (Maximum demand)) x 100 / (Maximum demand)

6.1.2 Future Direction of Power Development

As for future directions of power development, the government with the SPO playing a central role has formulated “The Electricity Energy Market and Supply Security Strategy Paper” (May 2009). This paper includes the following numerical targets:

- Nuclear power: Seek to account for at least 5% of the total generation by 2020.
  Introduce the total capacity of 5,000 MW between 2010 and 2020.
- Renewable energy: Seek to generate at least 30% of the total power by 2023.
- Wind: Develop 20,000 MW by 2023.
- Natural gas: Reduce the current share of 50% to 30% or lower.
- Domestic lignite coal and coal:
  Use up the available amount currently under exploration by 2023 as power generation fuels. Afterward, make efforts to utilize the amount which is considered to be exploitable.
- Imported coal: Examine ways to achieve high-quality power generation and enhance generation efficiency.

6.2 Study on Long-Term Power Development Plan（2011～2030）

6.2.1 Calculation Condition

Basic conditions of calculation are the same as those presented in the study on the 2030 projection in Chapter 4.

(1) Demand forecast

A low-demand scenario in the Turkish Electrical Energy 10-Year Generation Capacity Projection (2009–2018) is used up to 2018. The linear extrapolation was applied for demand forecast from 2019 onward. Specific numerical values are as shown in Table 6. 4.

Table 6. 4 Demand Forecast

(MW, GWh, %)

	2010	2015	2020	2025	2030	Annual growth rate (%)		
						’20/’10	’30/’20	’30/’10
Maximum demand (MW)	31,246	42,727	56,000	68,000	80,000	6.0%	3.6%	4.8%
Annual energy (GWh)	202,730	277,222	352,915	420,775	488,634	5.7%	3.3%	4.5%
Load factor (%)	74.1%	74.1%	71.9%	70.6%	69.7%			

(2) Benchmark on supply reliability

A benchmark on supply reliability is set at 8% or higher of reserve supply capacity. In addition, even in a peak month, generation facilities which are equal to 2% or higher of the maximum demand will be shut down for a periodical maintenance.

(3) Basic development policy for various types of generation facilities

(a) Nuclear power: Operation starting period has been fixed.

Develop a generation site (1,200MW × 4 units in a total of 4,800 MW) along the Mediterranean coast in the south by 2020. Between 2021 and 2030, develop a generation site in the north (4,800 MW) along the Black Sea.

(b) Wind power: Operation starting period has been fixed.

Develop 800 MW every year from 2013 onward. This will bring about wind power output of 10,000 MW in 2023. However, since about only 30% of the facility capacity can be used to supply power, the annual increase of supply capacity will be 240 MW.

(c) Small-scale generation facilities: Operation starting period has been fixed.

- Conventional hydropower: Develop 200 MW every year from 2013 onward.
- Small-scale gas-fired thermal power: Develop 100 MW every year from 2013 onward.
- Geothermal: Develop 100 MW from 2013 onward every 5 years.

(d) Decommissioning plan of existing facilities

Facilities which have been in operation for 40 years or longer after their starting operation will be decommissioned. Many domestic coal-fired plants will reach the 40th year by 2030 and be decommissioned. At the time of decommissioning, a highly efficient power plant using domestic coal-fired power plant will be built in the same premise, and upon the new plant starting operation, the old thermal plant will be decommissioned. (No new locations of domestic coal-fired thermal plants will be developed.)

(e) Facilities whose operation starting periods will be changed

Facilities whose operation starting periods will be changed include the following four types:

- Pumped storage power plants (PSPPs): a 300 MW plant as one unit
- Gas turbine (GT) thermal power plants: a 300 MW plant as one unit
- Gas combined-cycle (C/C) thermal power plants: a 700 MW plant as one unit
- Imported coal-fired thermal power plants: a 600 MW plant as one unit

In addition to the Scenario 1 development plan in the TEIAS projection, based on the above-mentioned development policy, the development schedules of plants whose starting periods have been fixed are incorporated in the overall plan illustrated in Table 6. 6. These facilities do not include ones whose operation starting periods will be changed. Reserve capacity rates up to 2018 calculated based on the table are as shown in Table 6. 5.

Table 6. 5 Annual Reserve Capacity Rates

	2011	2012	2013	2014	2015	2016	2017	2018
Reserve capacity rate	17.1%	21.1%	20.8%	14.9%	9.5%	5.6%	2.6%	-0.1%

Even without changing the operation starting periods, reserve capacity rates of 8% or higher, which is a benchmark of supply reliability, will be satisfied until 2015. In other words, it will be in 2016 and from thereon when taking into consideration of changing starting periods in the power development planning will become necessary. (Until 2015, the power development plans under any scenario will be identical.)

Table 6. 6　Power Development Plan up to 2030（only plants whose operation starting periods have been fixed）

					2010 (Existing)		2011-2015		2016-2020		2021-2025		2026-2030	
						16396		4139		2200		1000		1000
	Ataturk	2400	Menzelet	124	Darica I	99	DERINER	670	ILISU	1200				
	Karakaya	1800	Muratli	115	Uzuncayir	84			small hydro	1000	small hydro	1000	small hydro	1000
	Keban	1330	Dicel	110	Akocak	90	Yedigoze	317						
	Altinkaya	703	Torul	103	Cirakdami	59	Sariguzel	105						
	Biurecik	672	Yamula	100	ERMENEK	309	Kandil Enerji Pro	218						
	Berke	510	Kralkizi	94	TOPCAM	60								
	H. Ugurlu	500	Kokluce	90	small hydro	100	Tatar	116						
	Borcka	300	Kurtun	85	small hydro	200	Feke II	71						
	Sir	284	Kesikkopru	76	small hydro	200	small hydro	200						
	Gokcekaya	278	Dogankent	75	small hydro	200	Akkoy 2	234						
	Batman	198	Kadinak	70	small hydro	300	Goktas	293						
Hydro	Karkams	189	Demirkopru	69			Gullubag	99						
	Ozluce	170	S Ugurlu	69	Kigi	140	Menge Baraji ve	87						
	Catalan	169	Adiguzel	62	Cevizlik	102	Akinci	102						
	Sanyar	160	Seyhan1	60	Dereli	59	Pembelik	122						
	Gezende	159	Derbent	56	Ceyhan	64	Daran	55						
	Aslantas	138	Kadinak2	56	Erenler	51	Toros	51						
	Hirfanli	128	Kapulukaya	54	Alkumru Baraji ve	247	small hydro	800						
	Kilickaya	120	Camlica	84	Hacininoglu	144	small hydro	600						
					small hydro	200								
	Oymapinar	540	AKKOPRU	115	small hydro	200								
	Akkoy I	102	OBRUK	200	small hydro	200								
	ALPASLAN-I	160	Uluabat Kuwet Ti	110	small hydro	200								
					small hydro	100								
						2237		0		0		(560)		0
	Aliaga+ Cevrim	180	Samsun 2	131							Aliaga+ Cevrim	(180)		
	Ambarli Fuel-Oil	380	Samsun 1	131							Ambarli Fuel-Oil	(380)		
Oil														
	Erdemir (Eregli)	75	Petkim Aliaga	170	Ken Kipas Elektr	43								
	Tupras Rafineri (Y	84	Karkey (Silopi)	172	small (Autoprodu	600								
	Ataer Enerji	70			small (Private)	200								
						8815		0		195		322		365
	Afsin Elbistan B	1440	Tuncbilek B	365	Yatagan	630			Seyitomer	(600)	Soma A-B	(1038)	Afsin Elbistan A	(1355)
	Afsin Elbistan A	1355	18 Mart Can	320	Kemerkoy TS	630			New Seyitomer	720	New Soma	1250	New Afsin Elbista	1670
Lignite, Hard coal	Seyitomer	600	Orhaneli	210	Yenikoy	420			Tuncbilek B	(365)	Yatagan	(630)	Catalagzi TS	(300)
	Kangal TS	457	Soma A-B	1038	Catalagzi TS	300			New Tuncbilek	440	New Yatagan	740	New Catalagzi	350
					Park Termik	620							Yenikoy	(420)
	Isdemir (Iskederu	220	small (Autoprodu	210									New Yenikoy	420
						1805		2840		0		0		0
	Iskenderun Sugo	1320					Icdas Celik Enerj	410						
Import coal	Colakoglu	190	Eren Enerji Elekt	165			Icdas Celik Enerj	608						
	Icdas Celik	130					ICDAS Elektrik E	608						
							Eren Enerji Elekt	1213						
						14832		3862		500		500		500
	Bursa Dogalgaz	1432	Adapazari-1	1595	Unimar	504	Ambarli B DGKC	840	small (Private)	500	small (Private)	500	small (Private)	500
	Ambarli Dogalgaz	1350	Adapazari-2	798	Enron	499								
	Hamitabat	1120	Izmir	1590	Ova Elektrik	258	Aliaga Cakmakte	216						
			Ankara Baymina	798	Esenyurt	189	Aksa Enerji Ureti	257						
							AS Enerji Elektril	67						
	Bis Enerji Sanay	410	Entek (Demirtas)	146	Manisa Organize	85	Camis Elektrik U	130						
	Zorlu Enerji	189	Enerji-Sa (Zeytinl	130	Erdemir (Eregli)	80	small (Private)	140						
Gas	Entek Kosekoy	145	Ak Enerji (K.Pas	127	Nuh Enerji-2	73								
	Bosen Enerji Ele	143	Ak Enerji (Bozuy	127	Modern Enerji (B	97	Borasco Elektrik	887						
	Cam Is Enerji (M	126	Enerji-Sa (Kents	120	Eskisehir End. E	59	Enerjisa Enerji U	1025						
	Zorlu Enerji	90	Ak Enerji (Cerkez	98	Aksa Enerji (Ant	184								
	Alarko Altek	83	Enerji-Sa	65	small (Autoprodu	650	small (Private)	300						
	Zorlu Enerji (B.K	66	Enerji-Sa (CANA	64	small (Private)	740								
	Cebi Enerji	64	Habas(Aliaga)	225										
	Zorlu Enerji (Sinc	50	Colakoglu	123	Delta Enerji Ureti	64								
					Nuh Cimento Sar	48								
					small (Private)	30								
						0		0		4800		2400		2400
Nuclear									Nuclear	4800	Nuclear	2400	Nuclear	2400
						900		3000		4100		4100		4100
Wind, Geothermal, Others	Wind	100	Wind	100	Geothermal	100	Wind	400	Wind	4000	Wind	4000	Wind	4000
	Wind	100	Wind	100	Wind	100	Wind	2400	Geothermal	100	Geothermal	100	Geothermal	100
	Wind	100	Wind	100	Wind	100	Geothermal	200						

	2010	2015	2020	2025	2030
Hydro	16396	20535	22735	23735	24735
Oil	2237	2237	2237	1677	1677
Lignite, Hard coal	8815	8815	9010	9332	9697
Import coal	1805	4645	4645	4645	4645
Gas	14832	18694	19194	19694	20194
Nuclear	0	0	4800	7200	9600
Wind, Geothermal, others	900	3900	8000	12100	16200
Total	44985	58826	70621	78383	86748

6.2.2 Comparison of Base Supply Capacity

Facilities whose operation starting periods will be changed include gas C/C thermal and imported coal-fired thermal generation plants which will serve to provide base supply capacity. It was studied to what extent and in what ratio these two facilities should be developed.

(1) Development plan scenario

Comparison was made on the economics, share of natural gas, CO_2 emissions, etc., for the five scenarios under which the ratio of gas C/C thermal and imported coal thermal plants is changed.

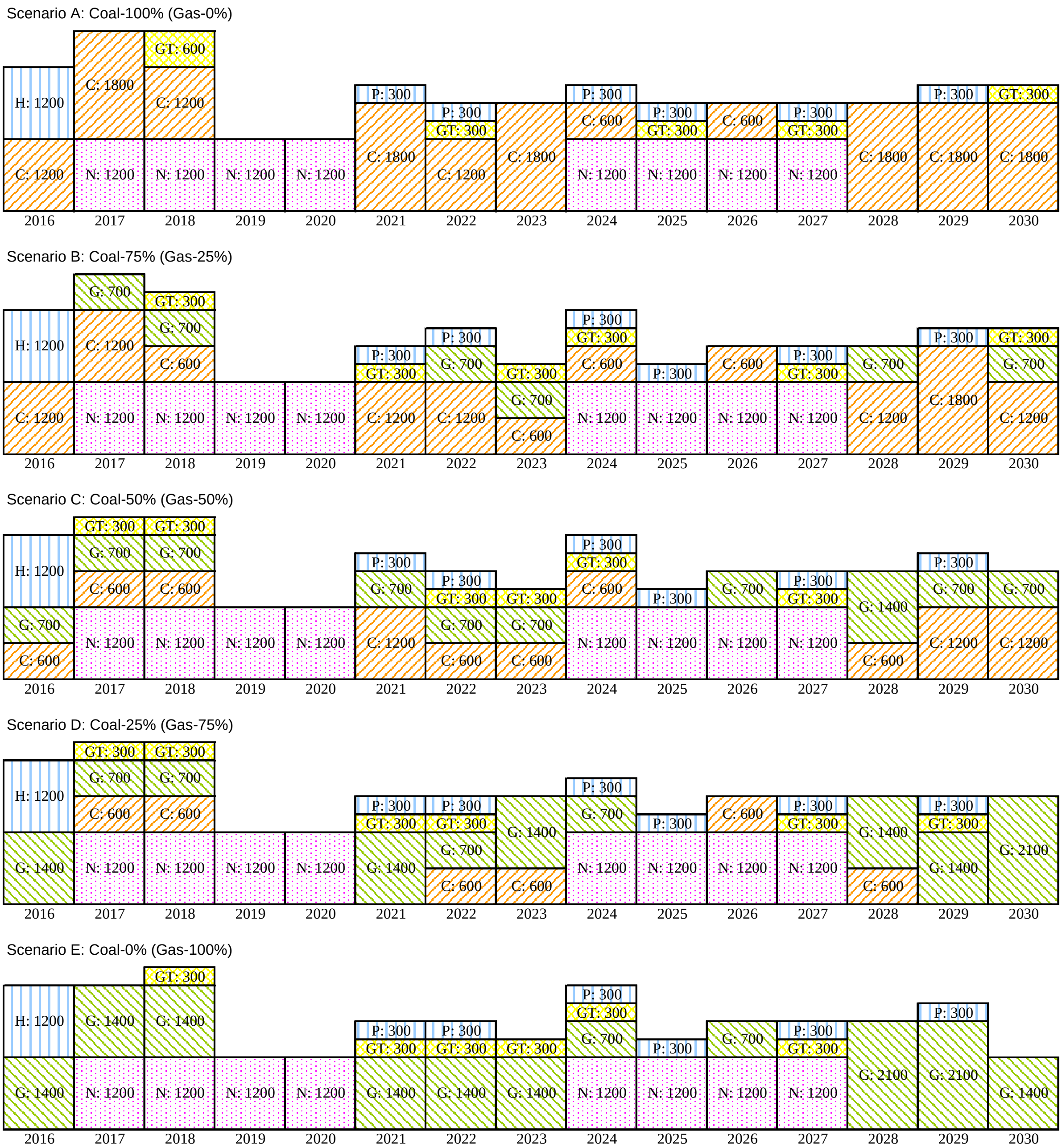


Figure 6. 1 Comparison of the Studied Scenarios（Base supply capacity）

(2) Economics

The cumulative present value at 2015 for 15 years between 2016 and 2030 under the five scenarios is compared as shown in Table 6. 7.

Table 6. 7 Present Value Comparison as of 2015

(Billion USD)

	Fixed cost	Fuel cost	Total
Scenario A: Coal-100%	111.3	134.6	245.9
Scenario B: Coal-75%	109.5	138.6	248.1
Scenario C: Coal-50%	107.8	142.3	250.1
Scenario D: Coal-25%	106.5	145.4	251.9
Scenario E: Coal-0%	104.8	149.1	253.9

Scenario A (Coal-100%), in which the fixed cost is somewhat higher, will be lowest in the total cost due to cheaper fuel price.

With regard to cost of every year, comparison is shown in Figure 6. 2 when cost of Scenario A (Coal-100%) is regarded as 1.

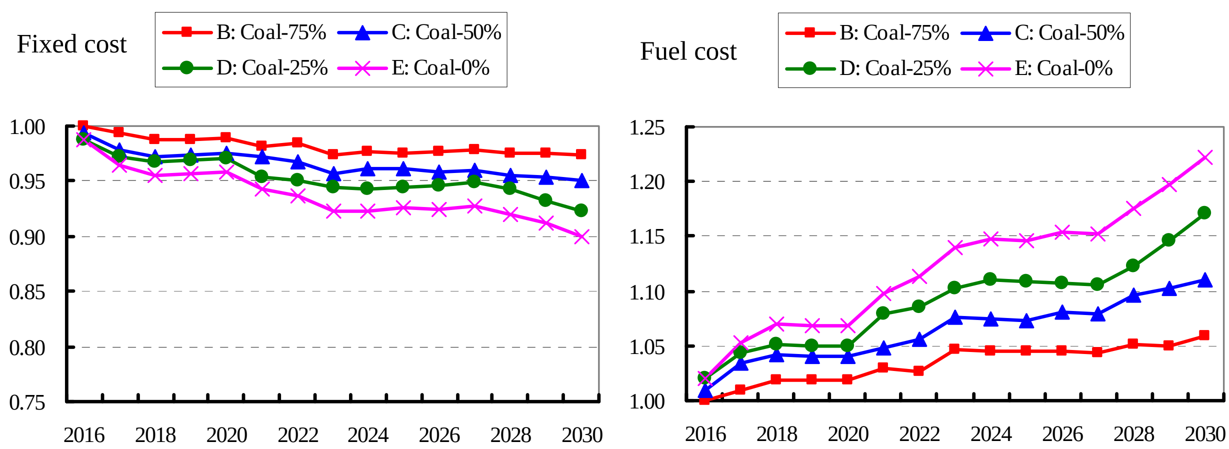


Figure 6. 2 Cost Comparison over Years

(3) Share of natural gas

Comparison is made in Figure 6. 3 on the shares of natural gas during 15 years from 2016 to 2030 under five scenarios.

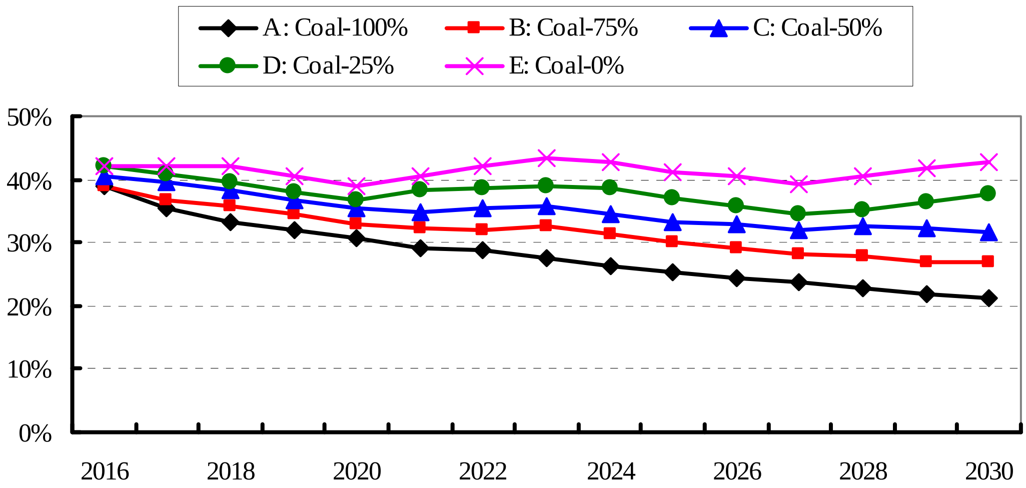


Figure 6. 3 Transition of Natural Gas Share

Under Scenario E (Coal-0%), the share of natural gas remains constant at around 40% over the years. On the other hand, in a case of Scenario A (Coal-100%), the share of natural gas will gradually decline to 20% in 2030. In order to bring it down to below 30% advocated by the government, the development ratio of imported coal-fired thermal power plants must be raised to 60% or higher.

(4) CO_2 emissions

CO_2 emissions for 15 years from 2016 to 2030 under five scenarios are shown in Figure 6. 4.

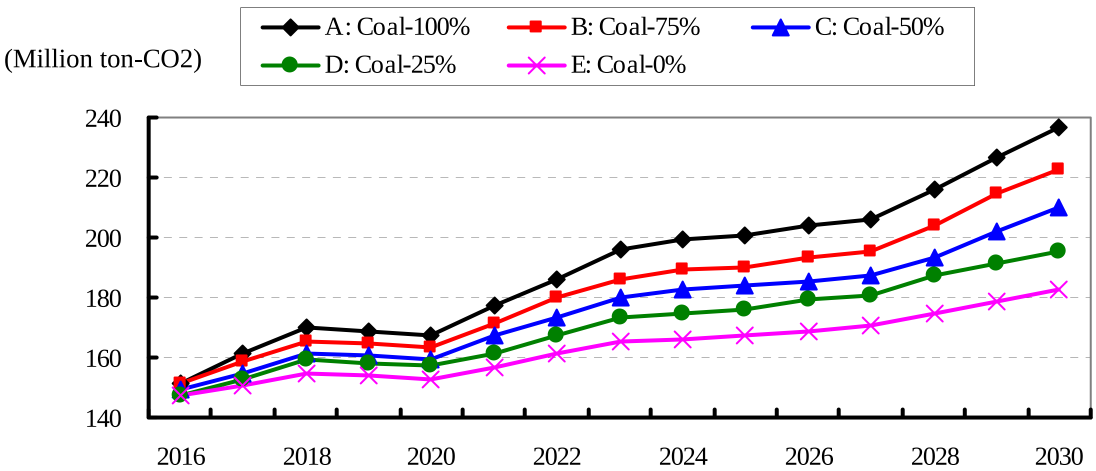


Figure 6. 4 Changes in CO_2 emissions

Because of growing demand, CO_2 emissions will grow under any scenario (emissions in 2010 are around 110 million ton-CO_2). Especially, under a scenario with a greater ratio of imported coal-fired thermal power plants, growth of CO_2 emissions is pronounced. Under the scenario of a 75% development ratio of imported coal-fired power plants, CO_2 emissions will be more than double of the current level in 2030.

Furthermore, although the level of CO_2 emissions will not directly affect the cost at current system, there are moves toward charging based on CO_2 emissions in the future. If the cost associated with

CO_2 emissions is set at 1 USD/ton, and comparison is made between Scenario A (Coal-100%), in which all developments are about imported coal-fired thermal power plants, and Scenario E (Coal-0%), with all developments for gas C/C thermal power plants, there will be a difference of 169 million USD at the value as of 2015. At this unit price, the difference is not great enough to reverse the economics described in (2). As the unit price associated with CO_2 emissions goes up, the economic competitiveness relatively goes down.

CO_2 emission intensity for 15 years from 2016 to 2030 is comparatively illustrated in Figure 6. 5.

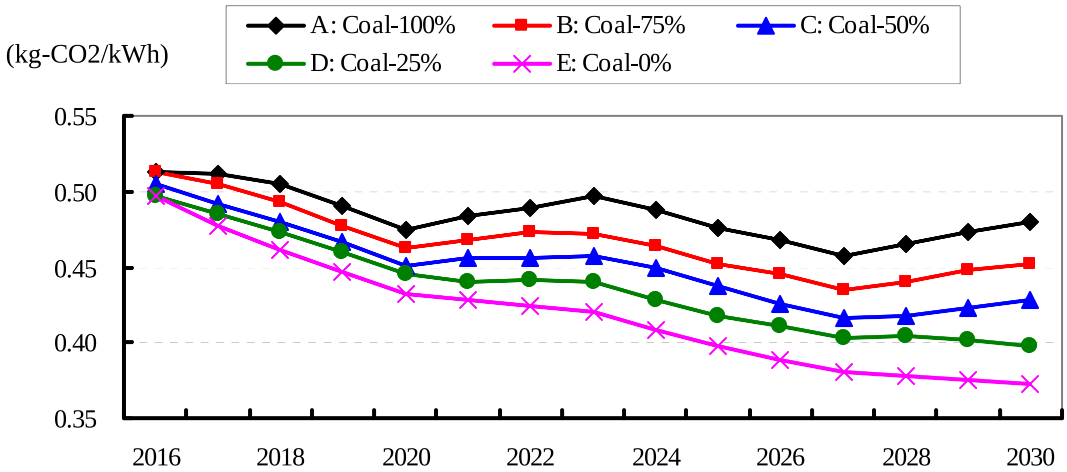


Figure 6. 5 Comparison of CO_2 Emission Intensity

CO_2 emission intensity will gradually decline through the development of nuclear power and renewable energy sources such as wind under any scenario. (The emission intensity of 2010 is around 0.55 kg-CO_2/kWh.) In a case of Scenario E (Coal-0%), under which all the developments are about gas C/C thermal power plants, CO_2 emission intensity will dramatically decline.

(5) Risk analysis

For Turkey, which is dependent on overseas countries for energy resources except for its domestic coal, risk factors considered to be the most serious in power development planning include discontinuation of imported energy sources, declining supply, supply price surge, etc. How to secure energy security as a nation is the greatest issue.

For this reason, the country has clarified its governmental policy to actively promote sub-domestic energy sources such as nuclear and renewable energy sources while gradually bringing down the share of natural gas for whose much of the supply, Turkey depends on imports from Russia.

Regarding an issue of whether either gas C/C thermal or imported coal-fired will be preferentially promoted, since both of them must depend on their respective fuels, both have equal levels of security risk. In a case of placing importance on avoiding security energy risk, it is reasonable to diversify supply sources instead of excessively relying on one or the other.

(6) Conclusion

From the viewpoint of economics, it is appropriate to preferentially develop imported coal-fired thermal power plants. However, the increase in developing coal-fired thermal power plants leads to increased CO_2 emissions. In examining the economics, the cost associated with CO_2 emissions is not factored into the calculation. However, it is possible that cost bearing commensurate with CO_2 emissions be required in the future. In that case, the economic advantage of imported coal-fired thermal power plants will go down. Furthermore, imported coal-fired power plants emit more substances into the air such as SO_x, NO_x, and dust; if stringent environmental regulations are enforced in the future, the costs for those energy sources may go up due to necessary countermeasures.

In terms of the risks, as the government has already indicated its policy to gradually reduce the share of natural gas, for which the country depends on imports, to 30% or below, it is necessary to place emphasis on avoiding energy security risks.

Taking all of these points into consideration, it is concluded that the optimal development scenario is either Scenario C with 50% each of imported coal thermal and gas C/C thermal power plants or Scenario B with 75% development of imported coal thermal power plants.

(7) Other considerations

This study focuses on the economics and energy security and compares imported coal-fired power plants and gas C/C thermal power plants as base supply capacity. As base supply capacity, domestic coal-fired thermal power plants fall within the scope of study. Although domestic coal has limited reserves, it is an excellent way to avoid energy security risk. Therefore, if it is exploitable at a comparable cost as the imported coal-fired power plants, it is desirable to give higher priority to domestic coal-fired generation than imported coal-fired generation in the development initiatives.

6.2.3 Comparison of Peak Supply Capacity

(1) Relationship between plant maximum capacity and supply capacity of PSPP

Relationships between plant maximum capacity and supply capacity of PSPP in 2021 and onward are shown in Figure 6. 6.

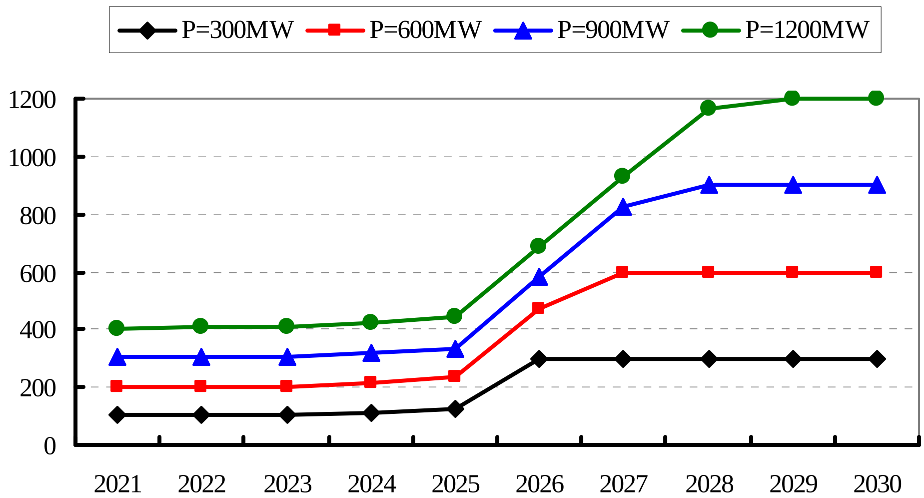


Figure 6. 6 Relationship between Plant Maximum Capacity and Supply Capacity of PSPP

Prior to the year of 2025, supply capacity which is only a third of plant maximum capacity can be expected. This is closely related to the residual demand profile after dispatching the conventional hydropower plants.

The residual demand profiles in 2025 and 2029 after dispatching conventional hydropower plants are shown in Figure 6. 7.

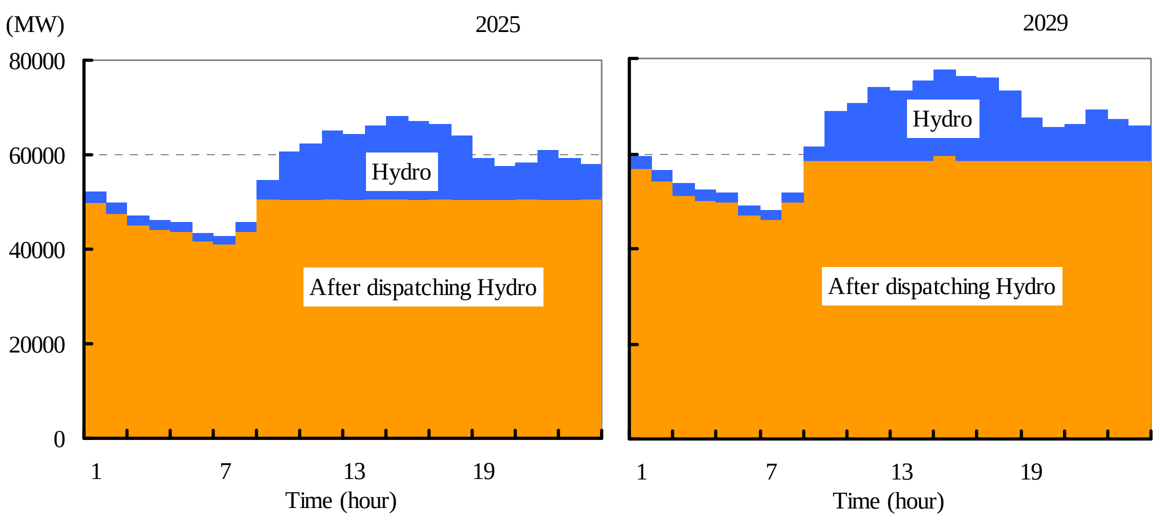


Figure 6. 7 General hydro power plants dispatch（in 2025 and 2029）

In 2025, since the ratio of conventional hydropower plants is high relative to the scale of demand, the entire peak demand is met by conventional hydropower plants and the demand profile after dispatching conventional hydro will be completely flat between 9:00 and 24:00. Furthermore, after dispatching the conventional hydro, the demand profile does not show major differences between daytime and nighttime and hours when pumping is possible are not many. On the other hand, in 2029, since the demand profile does not become completely flat after dispatching conventional hydro, the supply capacity of PSPP can be expected to be equal to their plants' maximum capacity. In addition, the difference between daytime and nighttime becomes larger and hours during which pumping is possible are longer.

A result of dispatching PSPP to the residual demand profile after dispatching conventional hydropower plants in 2025 and 2029 is shown in Figure 6. 8.

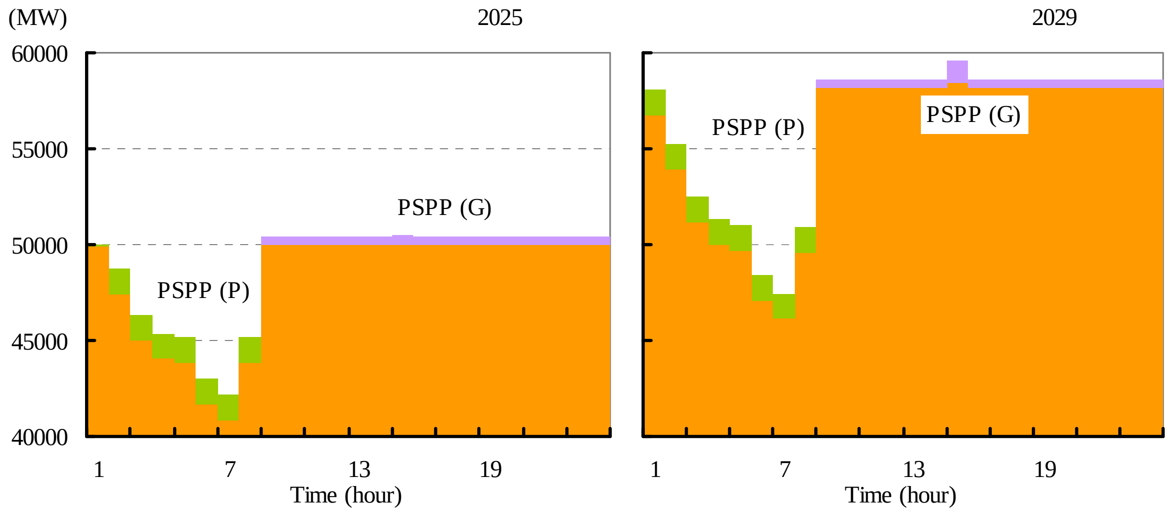


Figure 6. 8 Dispatching PSPP （in 2025 and 2029）

In terms of PSPP supply capacity, about a third of the plant maximum capacity, or a mere 443 MW, can be expected in 2025, while 1,200 MW, which is equivalent of the plant maximum capacity, can be expected as a supply capacity in 2029.

(2) Development planning scenarios

The construction of PSPP is considered to take more than 10 years in a case of adopting simple processes. (Refer to Section 7.2.4.) These processes include many uncertainties such as negotiations with parties concerned. Based on these viewpoints, with 2021 as the earliest possible period of developing PSPPs, the economics of five different scenarios by changing the development ratio of PSPP and gas turbine thermal power plants are compared as shown in Figure 6. 9.

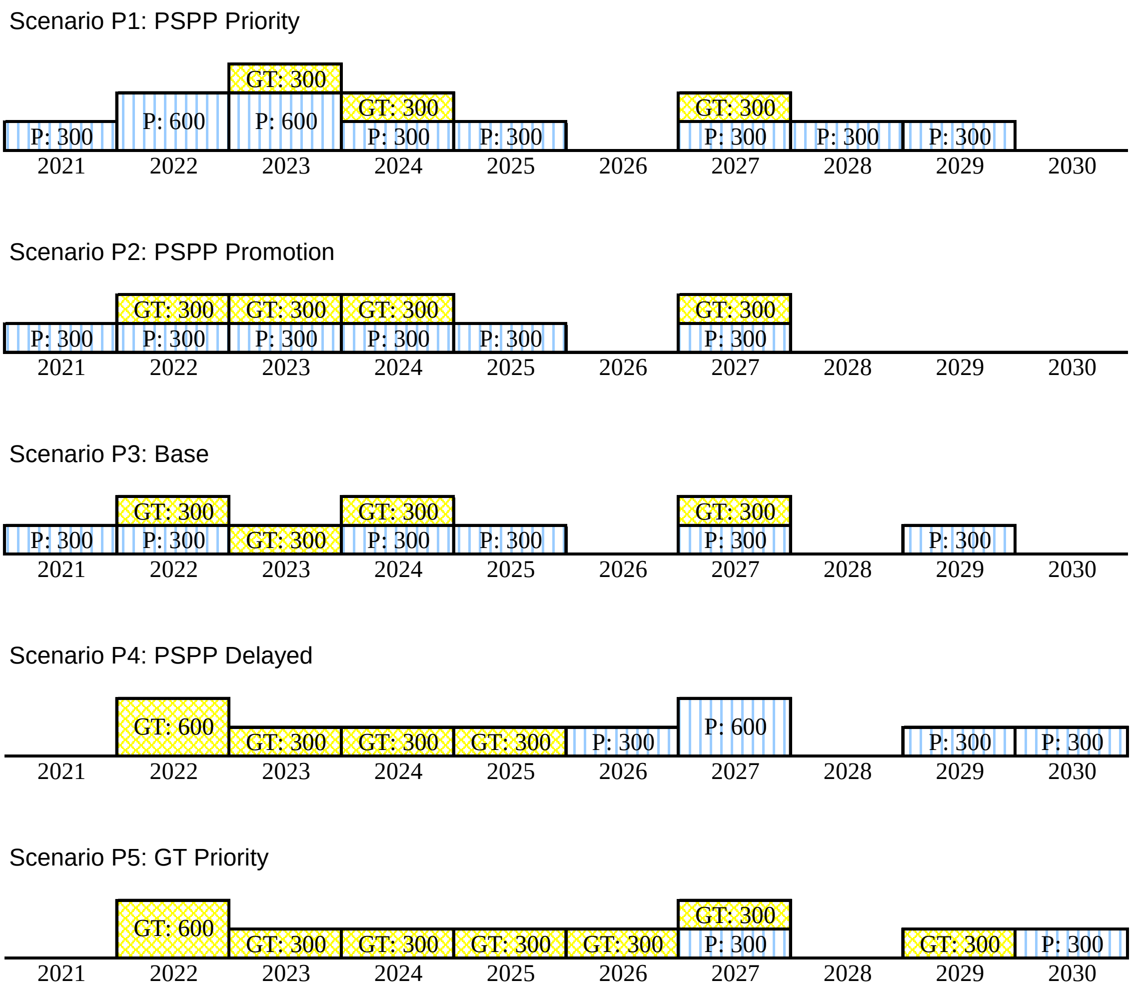


Figure 6. 9 Comparison of Different Scenarios（In terms of Peak Supply Capacity）

(3) Economics

Comparison is made between the base scenario and four different scenarios in terms of the cumulative cost during 10 years from 2021 to 2030 by using the present value as of 2021.

Table 6. 8 Value comparison as of 2021

(Million USD)

	Fixed cost	Fuel cost	Total
Scenario P1: PSPP Priority	230.0	- 4.7	225.2
Scenario P2: PSPP Promotion	84.9	1.3	86.2
Scenario P3: Base	Base	Base	Base
Scenario P4: PSPP Delayed	- 156.7	6.4	- 150.3
Scenario P5: GT Priority	- 149.0	10.3	- 138.7

It was found that Scenario P4, in which GT is preferentially developed until 2025 and from 2026 PSPP will be developed, is the most economical as peak capacity. Among any scenarios, gap of fuel cost is not so great while fixed cost shows big differences. This is because under scenarios with early operation start of PSPP, supply capacity equivalent of the plant maximum capacity cannot be expected, and in order to secure the same reserve capacity rate, more plant development will be necessary. In other words, if supply capacity equivalent of the plant maximum capacity can be expected, PSPP is more economical than GT, and it is beneficial to start developing PSPP in 2026 and thereafter, when the supply capacity equivalent of plant maximum capacity can be expected.

(4) Other considerations

This study compared gas turbine with PSPP as peak supply capacity by focusing on the economics. As peak supply capacity, reservoir-type hydropower plants are also subjects of the study. Since the economical efficiency of peak supply capacity is largely influenced by the fixed cost, if the construction cost of reservoir type is cheaper than PSPP (kW unit price), it will be better to preferentially develop a reservoir-type hydropower plant. However, in a case where a reservoir volume is not so large, there is a possibility that supply capacity equivalent of the plant maximum capacity cannot be expected depending on the demand profile.

In addition, in a case where development is being studied with an expectation of frequency adjustment and other functions during off-peak periods, which are advantages of PSPP, there is a possibility that it may be beneficial to develop PSPP prior to 2025 depending on the value of the function.

6.3 Proposal of Optimal Power Development Plan

(1) Draft of optimal power development plan

As a result of the last chapter, we propose the following draft of optimal power development plan for 2016–2030. (The content of the plan is the same as Scenario 1 in the projection made by TEIAS in the period between 2011 and 2015.)

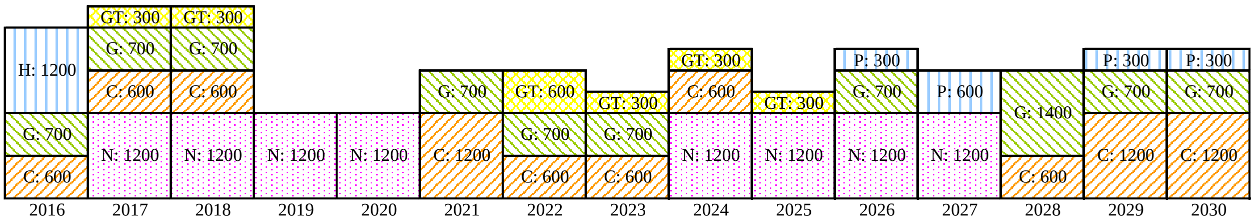


Figure 6. 10 Optimal Power Development Plan

In addition, the following developments are also under consideration:

- Wind: Develop 800 MW every year
- Conventional hydro: Develop 200 MW every year
- Small-scale gas-fired thermal: Develop 100 MW every year
- Geothermal: Develop 100 MW every 5 years

(2) Plant-type composition ratio（generated energy）

The transition of plant-type composition ratio is shown in Figure 6. 11.

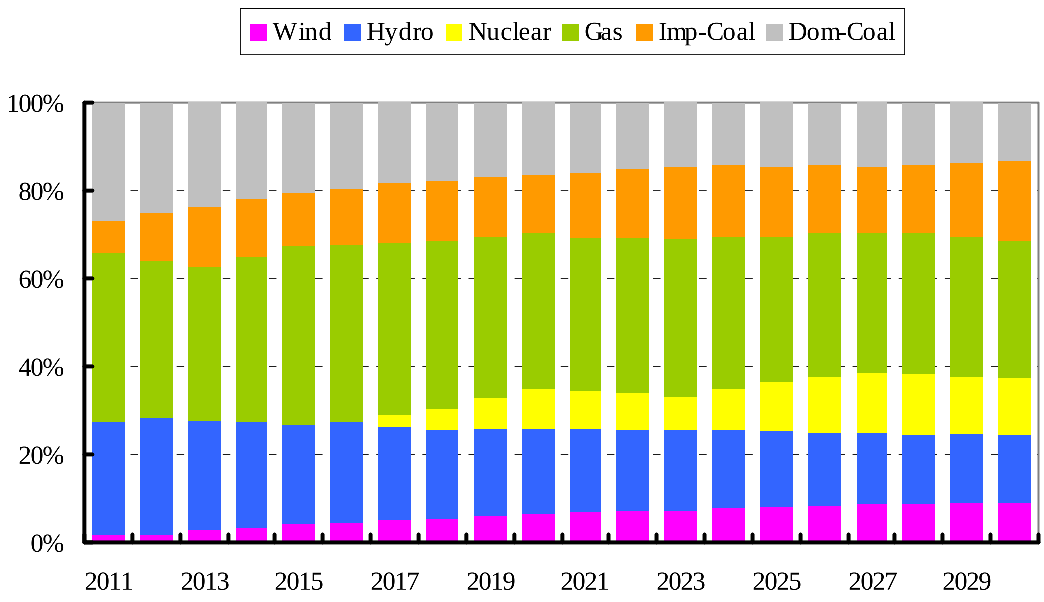


Figure 6. 11 Transition of Plant Type Composition Ratio

Looking at the plant-type composition in 2030, semi-domestic energy (nuclear, hydro, and wind combined) which emits no CO_2, gas, and coal (domestic and imported) respectively account for a third of the total generated energy, which shows that energy diversity has been achieved.

(3) Generation cost

The transition of generation cost is shown in Figure 6. 12.

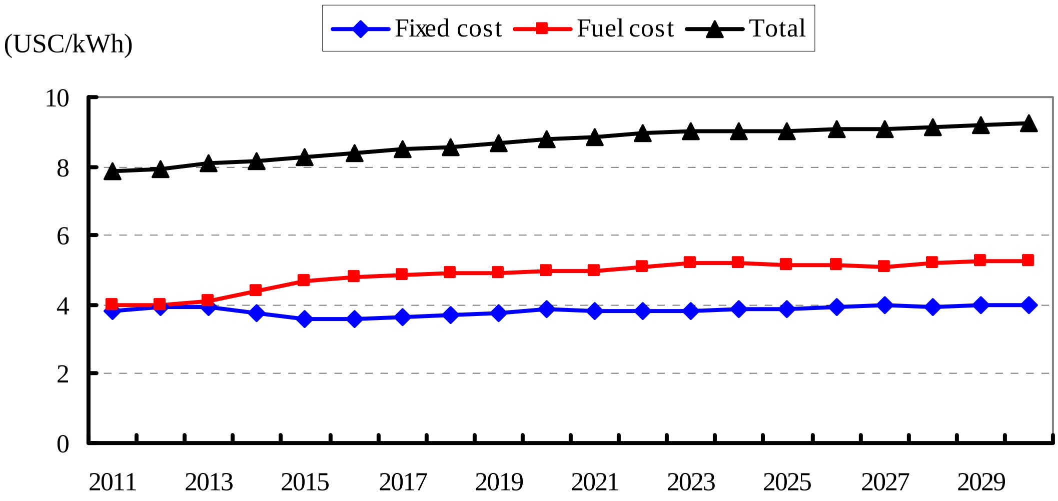


Figure 6. 12 Transition of Generation Cost

Fixed cost will remain constant at around 0.04 USD/kWh. On the other hand, fuel costs will gradually go up as unit prices of fossil fuels increase. As a result, the total generation unit cost will gradually go up and become around 0.01 USD/kWh higher in 2030 compared to that in 2011.

(4) CO_2 emissions

The trend of CO_2 emissions is shown in Figure 6. 13.

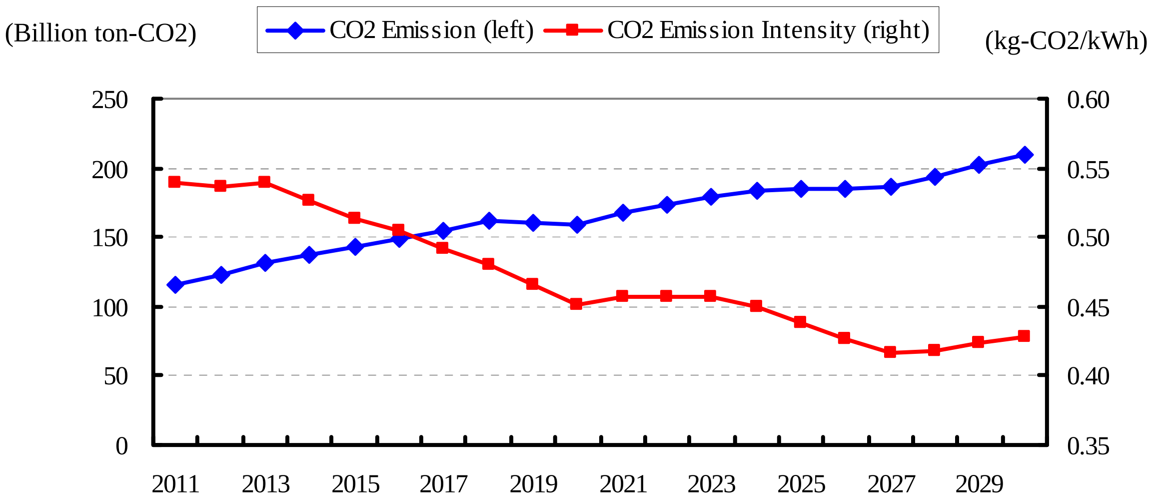


Figure 6. 13 Trend of CO_2 Emissions

Although nuclear and wind power which emit no CO_2 are being developed, as demand increases, CO_2 emissions will gradually go up as well, reaching in 2030 about double the amount of 2011. On the other hand, in terms of emission intensity, they will gradually decline toward 2030 because of fast growth rate of demand.