Uzbekenergo Joint-stock Company
The Republic of Uzbekistan

PREPARATORY SURVEY (F/S)
FOR
TASHKENT THERMAL POWER COGENERATION PLANT CONSTRUCTION PROJECT
AND
MASTER PLAN STUDY
IN
THE REPUBLIC OF UZBEKISTAN

Vol.1
PREPARATORY SURVEY (F/S) FOR TASHKENT THERMAL POWER COGENERATION PLANT CONSTRUCTION PROJECT

May 2016

Japan International Cooperation Agency (JICA)

Yachiyo Engineering Co., Ltd.
Tohoku Electric Power Co., Inc.

3R
JR
16-019

The exchange rates applied in this Study are:
USD 1.00 = Yen 123.20
USD 1.00 = UZS* 2580.19
UZS* 1.00 = Yen 0.0478
(Exchange rate applied in January 2015)

*UZS: Uzbekistan Sums

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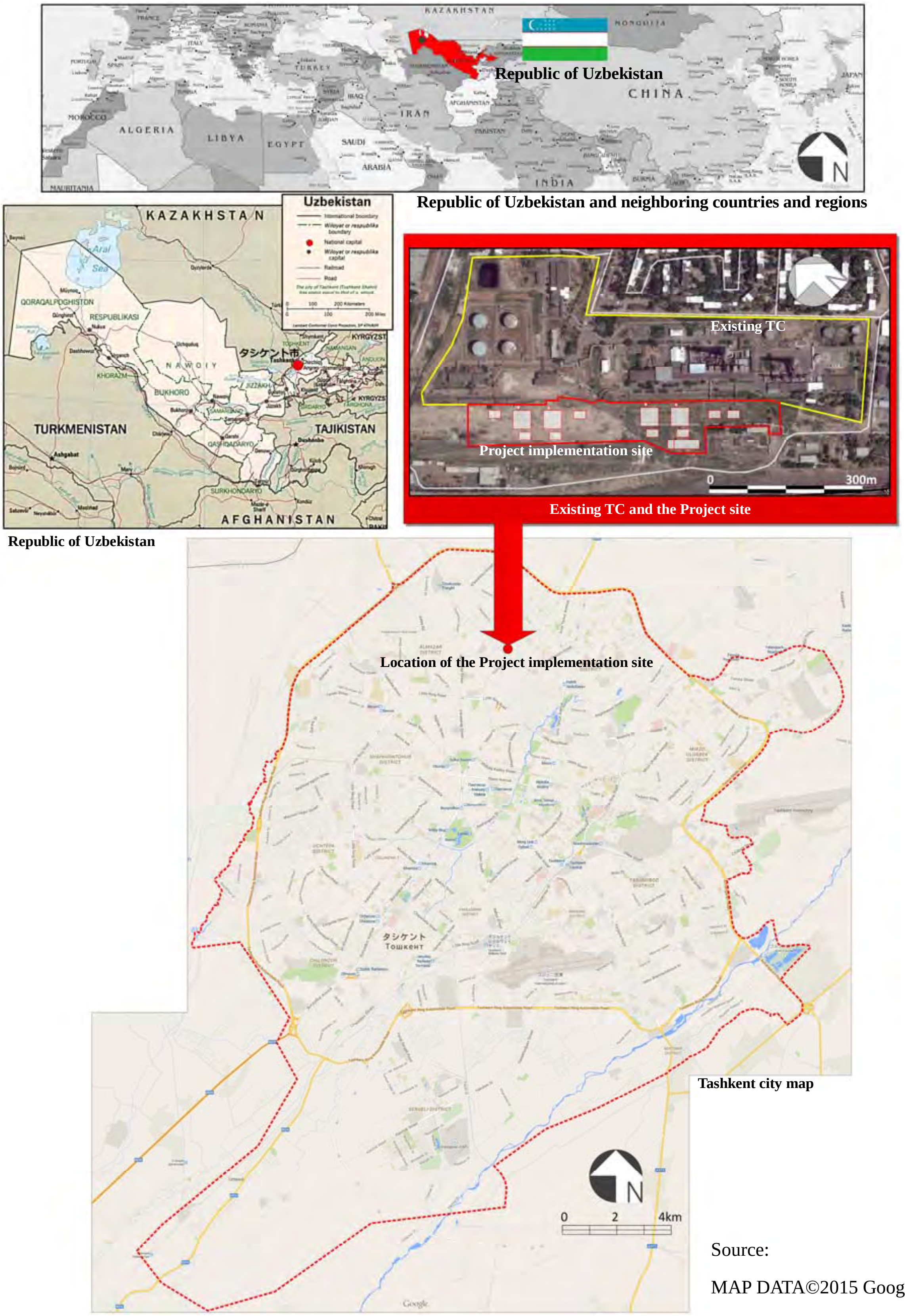


Republic of Uzbekistan and neighboring countries and regions

Republic of Uzbekistan

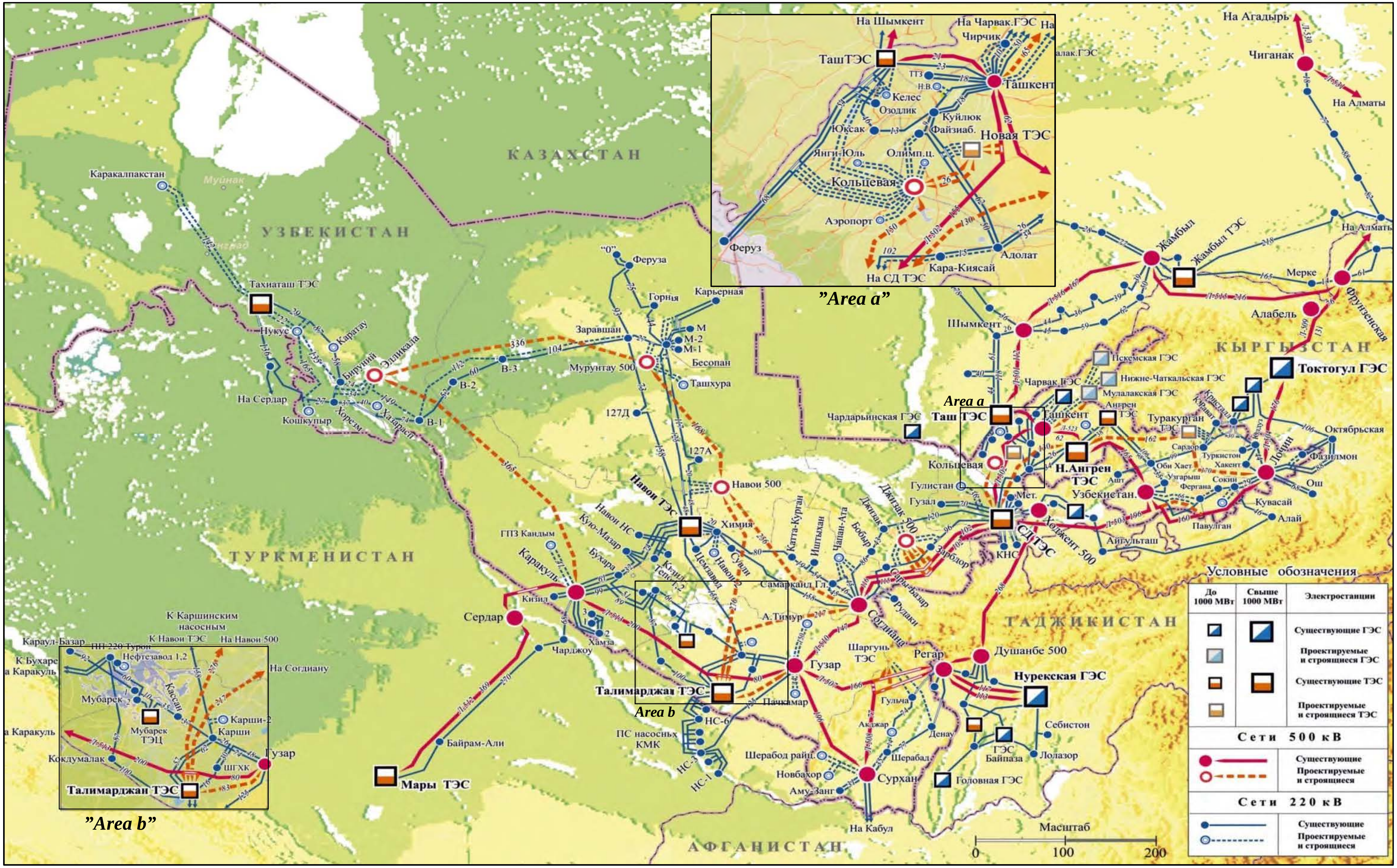
Existing TC and the Project site

Tashkent city map

Source:

MAP DATA©2015 Google

Location of the Project implementation site



Source: Prepared by JICA Study Team on the basis of materials provided by Uzbekenergo JSC

Power network map of the Republic of Uzbekistan

Current State of the Survey Area (1/2)

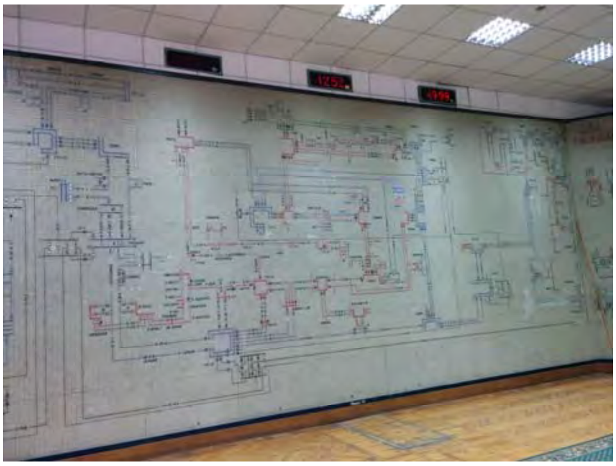
Uzbekenergo JSC and Conditions in Tashkent city

Holding a workshop on the project

Total of 15 representatives of Uzbek side, including concerned ministries and agencies, has participated in the workshop and discussed key points of the project implementation. The questioning has continued even in the afternoon which shows high level of expectations for the project.

Joint meeting of responsible parties

The meeting has been held in order to promote the project progress. The meeting gathered all the persons responsible for the project. During the meeting the project implementation structure has been reconfirmed, the responsible persons of each department have promised to provide all the necessary information and materials.



National Dispatch Center (NDC)

The NDC conducts load dispatching of 500kV and 220kV networks all over Uzbekistan. The network diagram, presented on the wall, shows 500kV network (red) and 220kV network (blue). There are similar diagrams in regional dispatch centers and 110kV network control center.

Air conditioners installed in apartment houses

During many years the hot water supply helped to keep off the cold in winter when sometimes temperature falls 20 degrees below zero. However, at the present time air conditioner fan motor units can be seen on apartment houses here and there. It is assumed that consumer demand for electricity will increase in future.

Hot-water pipeline

U-shaped above-ground pipelines can be seen throughout the city. The pipelines are distinguished by color. Steam pipelines are orange, gas pipelines are yellow.

Residents of Tashkent

The Tashkent marketplace, commonly known as bazaar. merchants. The bazaar prices are lower than store prices. In the days off many city residents come here to do shopping.

Current state of the survey area (2/2)

Project Site and Existing Facilities

Situation in the northern part of the site

The north-west part of the candidate site is mainly covered with 2-5m layer of domestic and construction wastes.

Situation in the central part of the site (railway lines)

The freight transportation railway lines cross the candidate site from east to west. These railway lines have been used for materials transportation and lead to unloading point within TC-4.

Situation in the southern part of the site
(hot-water supply pipe)

There are 2 pipelines for transportation of hot water produced by TC-4 in the south-eastern part of the candidate site. The pipelines cross the site and run to the rail sidings which are situated in the south-west of the site and used for railway company vehicles shunting.

Situation in the western part of the site
(existing transmission line)

There is a transmission line in the western part of the candidate site. The transmission line runs from Substation “Beshkurgan” to Substation “Chukursay”. There is also the rail sidings running parallel to the transmission line. The rail sidings are used for railway company vehicles shunting and constructed on 4m high embankment.

Existing Cogeneration power plant (for reference)

Cogeneration power plant of Tashkent Cogeneration power plant (TashTETs), construction of which was completed in 2013 within the NEDO Project. Design conditions of this facility are important in terms of comparison with design conditions of new cogeneration power plant.

Interior of the existing Cogeneration power plant (for reference)

Interior of the existing Cogeneration power plant. The area for steam cooling duct is dominant with respect to the entire structure and the largest one.

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ABBREVIATIONS

ACB	Air Circuit Breaker
ADB	Asian Development Bank
UEES	*Upravleniyem Ekspluatatsii Elektricheskikh Setey* [Administration of Electric Grids Operation]
AS	Steel-Aluminum
ASO	Steel-Aluminum Lightweight structure
ASU	Steel-Aluminum Reinforced structure
B/C Ratio	Benefit Cost Ratio
BAU	Business As Usual
BP	British Petroleum
CAGR	Compound Annual Growth Rate
CER	Center for Economic Research
CIS	the Commonwealth of Independent States
CHP	Combined Heat and Power Plants
CNGFS	Compressed Natural Gas Filling Stations
CNPC	China National Petroleum Corporation
DAC	Development Assistance Committee
EIA	U. S. Energy Information Administration
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPC	Engineering, Procurement and Construction
EPS	Environmental Protection Service
EWS / OPS	Engineering Work Station
F/S	Feasibility Study
FA	Factory Automation
FAO	Food and Agriculture Organization
FIRR	Financial Internal Rate of Return
GCB	Gas Circuit Breaker
GDP	Gross Domestic Product
GIS	Gas Insulated Switchgear
GTCC	Gas Turbine Combined Cycle
GTCS	Gas Turbine Cogeneration System
GTG	Gas Turbine Generator
GTL	Gas To Liquid
HPP	Hydro Power Plant
HRG	Heat Recovery Boiler
HRSG	Heat Recovery Steam Generator

IEA	International Energy Agency
IFMR	Institute of Forecasting and Macroeconomic Research
IMF	International Monetary Fund
IRR	Internal Rate of Return
ISO	International Organization for Standardization
IUCN	International Union for conservation of nature and natural resources
JICA	Japan International Cooperation Agency
JSC	Joint-Stock Company
LNG	Liquefied Natural Gas
MCC	Motor Control Center
MFERIT	Ministry of Foreign Economic Relations, Investments and Trade
MPC	Maximum Permissible Concentration
NDC	National Dispatch Center
NEDO	New Energy and Industrial Technology Development Organization
NPV	Net Present Value
OCB	Oil Circuit Breaker
ODA	Official Development Assistance
ODE	Gross Domestic Expenditure
OECD	Organization for Economic Co-operation and Development
OPS	Operator Station
PMU	Project Management Unit
POEE	Proizvodstvennie Obʹyedineniya Energetiki i Elektrifikatsii [Production Power and Electrification Associations]
PTE	*Pravila Tekhnicheskoy Ekspluatatsii Elektricheskikh Stantsiy i Setey* [Rules of technical operation of power plants and grids]
PUE	*Pravila Ustroystva Elektroustanovok* [Rules for electric installations]
RDC	Regional Dispatch Center
SEE	Statement of Environmental Effects
SJSC	State Joint-Stock Company
SPES	*Spravochnik po Proyektirovaniyu Elektricheskikh Setey* [Handbook for designing of electrical grids]
SPZ	Sanitary-Protective Zone
TC	Teplocentral
TETS	*Teploelektrocentral* [Combined Heat and Power Plants (CHP)]
TGTKEO	*Tashkentskoe Gorodskoe Territorialʹnoe Kommunalʹno-Ekspluatatsionnoe Obʹyedinenie* [Tashkent City Territorial Municipal Maintenance Association]
TOR	Terms of Reference
TPP	Thermal Power Plant
UEES	*Upravleniyem Ekspluatatsii Elektricheskikh Setey* [Administration of Electric Grids Operation]
UFRD	Uzbekistan Fund for Reconstruction and Development

UNDP	United Nations Development Programme
UNSTAT	United Nations Statistics Division
UTY	*Uzbekiston Temir Yollari* [State Railway Company]
VAT	Value Added Tax
WASP	Wrap Around Simulation Program

Chapter 1　Introduction

Chapter 1 Introduction

1.1 Study Background

(1) Study objectives

The Republic of Uzbekistan is the most populated nation in Central Asia (28.9 million people by a UNFPA estimate) and has risen into a leadership role since the Soviet times. The Republic of Uzbekistan is rich in natural gas, uranium, useful ore minerals and other natural resources. In recent years Uzbekistan has enjoyed robust economic growth of 8–9%. This is due to the achievement of progress in the development of natural resources by the Government, increased exports of natural gas, gold and cotton, which are the main exported goods, as well as the effect of a long-period public investment.

However, obstacles against maintaining this strong economic growth in Uzbekistan are a series of unresolved issues related to wear and tear of the soviet-era transport, energy and other economic sector infrastructures, lack of human resources to support the industry after the country’s transition to the market economy, legislative system, etc. There is a number of issues, especially in the energy sector related to the wear and tear of many facilities of thermal power plants (producing more than 80 % electric energy of the total installed capacities), which were built 40–50 years ago, low level of thermal efficiency and insufficiency of the existing installed capacities. According to the International Energy Agency statistics, Uzbekistan emitted 4.41 kg of CO_2 per unit of GDP in 2012, the highest CO_2 emissions in the world, well ahead of Turkmenistan which is in the second place (3.77 kg) and Mongolia in the third place (3.12 kg).

Due to the fact that the minimum temperature in the Republic of Uzbekistan in the winter falls below zero degrees in the capital (Tashkent) and other cities, heat generated by heat and power plants is used for supplying hot water and heating. However, as indicated above, reconstructing the worn facilities important for stabilizing power and heat supply systems, and improving the energy efficiency are the urgent tasks.

It is against the above background that Uzbekistan requested a yen loan from Japan in July 2014 for the Tashkent Cogeneration Plant Project, a priority project that is part of the nation's long-term power development plan called the Power Industry Development Concept of Uzbekistan.

The Cogeneration Plant Project is the target of this study, and the study aims to introduce a cogeneration facility comprised of a single-cycle gas turbine with output of 27 MW and an exhaust heat recovery boiler for the existing heat supply facilities in Tashkent. Based on the above request, the study is carried out in order to collect the information necessary for the evaluation of the project as a cooperation project on a cost-recovery scheme of financial assistance under the Japanese ODA.

(2) Study structure and desired results

This study consists of two kinds of work which should be implemented simultaneously: "Preparatory study on the project of construction of the Tashkent Heat and Power Plant", and "Development of a master plan for the development of the power sector”. Given the urgent nature of this study, a phased handover of the required documents should be implemented, as indicated in Table 1.1-1, the work implementation schedule.

Table 1.1-1 Proposed Work Implementation Schedule and Description of Outputs

Scope of Works:	Draft Final Report End of April, 2015.	Final report End of May 2016.
Preparatory Survey of the Tashkent Cogeneration Plant Project	Covers the following information required for the review of a yen loan for the Tashkent Cogeneration Plant Project. (1) Relevance of project (2) Scope of yen loan project (3) Overall design (4) Work plan (5) Overall project cost (6) Implementation system, operation and maintenance system (7) Environmental and social considerations (8) Project evaluation	Same as on the left side
Drafting of the Power Sector Master Plan	Proposes identification of issues and countermeasures for short-term power development plans through 2020 (specific to a priority project)	A power sector master plan that includes power demand projections through 2020, optimal power development plans, power transmission system development plans, long-term investment plans, environmental and social considerations and policy recommendations

1.2 Work Implementation Methods

This study comprises a total of six field studies (Field Study 1, Field Study 2, Field Study 3, Field Study 4, Field Study 5 and Field Study 6) and analysis work done in Japan. Figure 1.2-1 shows the workflow of the overall study.

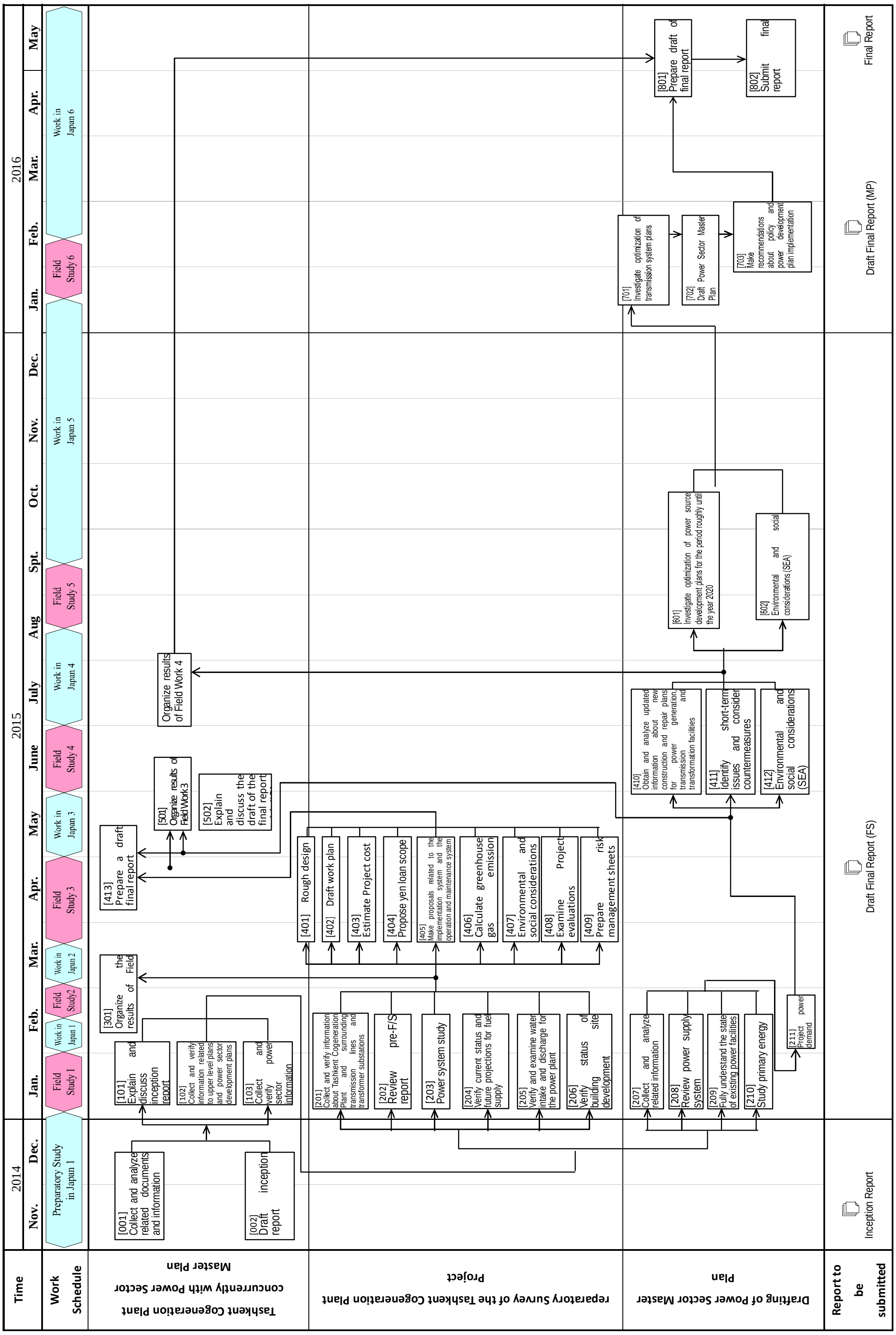

Figure 1.2-1 Study work flow

1.3 Composition of Study Team

Table 1.3-1 contains the names and responsibilities of the members of the study group (hereinafter the Team).

Table 1.3-1 Composition of study team

Full name	Scope of responsibility	Place of work
Mr. Kyoji Fujii	Team leader / power generation development plan	Yachiyo Engineering Co., Ltd.
Mr. Masahiko Takemura	Electric network analysis	Yachiyo Engineering Co., Ltd. (Assist.)
Mr. Chew Chong Siang	Electricity demand forecasting	Yachiyo Engineering Co., Ltd. (Assist.)
Mr. Shigeru Matsuoka	Plan for power generation at thermal power plant	Tohoku Electric Power Co., Inc.
Mr. Nobuyuki Kinoshita	Electrical network planning	Yachiyo Engineering Co., Ltd. (Assist.)
Mr. Yoshitada Sakai	Fuel supply plan / evaluation of primary energy	Yachiyo Engineering Co., Ltd. (Assist.)
Mr. Yuji Miura	Machinery and equipment	Tohoku Electric Power Co., Inc.
Mr. Takashi Kumambara	Electrical equipment and control systems	Tohoku Electric Power Co., Inc.
Mr. Hirohide Goto	Civil engineering in electric power industry-1	Tohoku Electric Power Co., Inc.
Mr. Toshihiko Aizawa	Civil engineering in electric power industry-2	Yachiyo Engineering Co., Ltd.
Mr. Masao Yamakawa	Transmission system planning	Yachiyo Engineering Co., Ltd.
Mr. Toshiaki Ojima	Substation planning	Tohoku Electric Power Co., Inc.
Mr. Yuichi Tachibana	Boiler and water heating equipment, heating plan for hot water supply	Tohoku Electric Power Co., Inc.
Mr. Masaya Sugita	Strategic environment assessment (SEA)	Yachiyo Engineering Co., Ltd.
Mr. Hiroyasu Kudo	Social and environment consideration	Yachiyo Engineering Co., Ltd.
Mr. Choso Yoshiyuki	Analysis of financial and economic situation	Yachiyo Engineering Co., Ltd.
Mr. Sato Masataka	Assistance for electric network analysis	Yachiyo Engineering Co., Ltd.

Chapter 2 Social and Economic Situation

Chapter 2 Social and Economic Situation

2.1 Political and Social Structure in General

The basic information of Uzbekistan is shown in Table 2.1-1.

Table 2.1-1 Key Indicators of Uzbekistan

Political and Social	
Official Name	Republic of Uzbekistan
Area	447,400 km^2
Population	30.24 Million (2013, previous year 2%)
Capital	Tashkent City (Population 2.35 Million in 2014)
Political System	Republic, Bicameral System (Senate: 100, Oliy Majlis: 150), five-year terms
Sovereign	President (Islam A. Karimov) (77) 7-year terms, Start from December 1991, 4th term from March 2015
Ethnic Groups	Uzbek (80%), Russian (5.5%), Tajik (5%), Kazakh (3%), Others (6.5%)
Office Langue	Uzbek
Macroeconomic Indicators (2013)	
Gross Domestic Product (Nominal)	56.795 Billion USD
GDP Growth Rate (previous)	8.0% (year-on-year)
GDP Per Capita	1,878 USD
Inflation Rate	14%
Currency	Sum, 1 USD ≒ 2,200 Sum (January 2015)
Energy Indicators	
Total Primary Energy Supply	48,284 ktoe (2012)
Final Energy Consumption	35,458 ktoe (2012)
Domestic Generation	55,586 GWh (2014)
Electricity Consumption	54,807 GWh (2014)
Energy Self Sufficiency	117.5% (2012)

Source: World Bank, International Energy Agency, Uzbekenergo JSC

(1) Political trend

Uzbekistan became independent from the former Soviet Union in December 1991. Islam A. Karimov became the first President of the Republic in 1991 for 5-year term. But the presidential election was postponed to January 2000 by referendum, and Islam A. Karimov was re-elected as a President in January of the same year. Constitutional provisions relating to presidential election in Uzbekistan was amended in January 2002, and the term extended to seven years. President Islam A. Karimov was again re-elected in December 2007 with 90.8% votes and became 25-year long-term administration by his cabinet. The president won the fourth presidential election held on 29 March 2015 and became the president fourth term.

The political management system migrated in December 2004 to a bicameral system consisting of 100-member Senate and 150-member Chamber (Oliy Majlis) elected for five-year term. The Cabinet of Ministers is formed in the lead of the incumbent Prime Minister Shavkat Miromonovich Mirziyoyev and runs the government.

After its Independent initially, Uzbekistan strengthen its diplomatic relation with the Western countries in order to reduce its over-dependence on Russia. However, after the Andijan incident of May 2005, Uzbekistan relationship with the Western countries has worsened, and subsequently the foreign policy has shifted toward Russia. In late of 2005 signed an alliance treaty with Russia has signed, and it participated in the joint military exercise of the six nations of Shanghai Cooperation Organization (SCO) in 2007. Cooperative relationship between Uzbekistan with Russia and China has developed in many areas including military, economy and energy sectors. However, since 2010 the relations between Uzbekistan with western countries have shown improvement, and the cooperation with international organization has been increasing, and the number of assistance by Western countries has been gradually increasing.

(2) Social situation

Most of the Uzbekistan cities prospered as relay points of the ancient East-West trade route, Silk Road. The East-West culture, South Asian culture, and Middle East Arab culture have s strongly influenced the cultural formation of the Central Asian region. The culture of this region has undergone a unique development. Islamic culture introduced in the eight century by the advance of the Arabians, and spread all over the region. Since it came under the rule of the former Soviet Union, a high acceptance of the Eastern Orthodoxy and other religions has been observed, and secular religion policy is implemented. Although about 90 percent of Uzbekistan's population is currently Muslim, Karimov regime has implemented a restrictive policy against Islamic extremists. In particular, wary of extremist Islamic fundamentalism spread in its border areas with Kyrgyzstan, Tajikistan, and Afghanistan, the Uzbekistan government is actively monitoring the border areas to reduce the movement of Islamic militants and to keep the social stability.

Uzbekistan is the most populous country of the five Central Asian countries. According to the statistics of 2013, the population grew by 2.0% compared to previous year and reached 30.24 million peoples. The largest ethnic group is Uzbeks (80%), followed by Russian (5.5%), Tajiks (5%) and many other ethnic minorities. During the Former Soviet Union era, literacy rate of population over 15 year-olds in Uzbekistan reached 99.0%, diffusion of the social infrastructures such as railway, road, electric power, and gas pipeline is high. Among them, access rate to the energy is almost 100% for electric power and 80% for gas.

In recent years, political, economic and social situation is relatively stable, and the tourism industry is becoming an important industry to earn foreign currency.

(3) International Cooperation

1) Relations with Japan

Bilateral relations between Japan and Uzbekistan have been progressing since the establishment of diplomatic relations, 28 December 1991. Starting from mutual visits of the government officials of the two countries, exchanges between private institutions of the two countries are conducted at a good pace, as well. As Japan is a major country of assistance based on the ODA, it has contributed to the development of Uzbekistan's economy and society. According to the data of the Ministry of Foreign

Affairs, Japan provided 177.92 billion yen loan assistance, 22.65 billion yen grant aid, and 16.52 billion yen technical cooperation from 2009 to 2013 to Uzbekistan[1].

2) Other International Relations

In addition to Japan, Germany, South Korea, the United States, Switzerland, and the United Kingdom have provided support to Uzbekistan. Especially Germany and South Korea have been the most important donors to Uzbekistan. The two countries have deep relations with Uzbekistan for historical background, and they have greatly influenced Uzbekistan's economy. In 1930s, about 200 thousand Koreans were forced to emigrate from the Far East coastal areas to Uzbekistan. The descendants of Koreans and Volga Germans live in major cities such as Tashkent City and they are the groups who have made the economic activities in urban areas. Also they have a strong human relationship and network with the two countries.

Table 2.1-2 ODA Achievement by DAC[2] Members (2008–2013)

(Net Disbursement Base, Unit: Million USD)

	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Total DAC
2008	Japan 48.6	Germany 29.5	USA 18.0	Switzerland 4.1	Korea 4.0	113.2
2009	Germany 32.1	Japan 20.4	USA 9.9	Korea 5.9	France 2.9	77.3
2010	Korea 32.2	Germany 25.0	USA 13.4	Japan 7.0	France 2.3	84.1
2011	Korea 21.9	Germany 16.4	USA 7.7	Switzerland 2.2	France 1.9	50.3
2012	Germany 39.4	Korea 19.1	USA 9.3	Switzerland 2.6	United Kingdom 2.6	70.0
2013	Germany 32.2	Japan 30.1	USA 25.4	Korea 10.7	Switzerland 3.4	106.8

Source: International Development Statistics, http://stats.oecd.org/, accessed on 11 May 2015

2.2 Macroeconomics

(1) Economic Development

Uzbekistan became independent from the former Soviet Union in December 1991. Although the government is trying to reform the economy to a market economy, the progress is relatively slow because of the slow deregulation and policy intervention. Particularly, for several years after the independence, the country has suffered from serious inflation and difficulties in establishing the credit of the national currency. Since 2000, the domestic market has gradually become stable; especially after 2004, the inflation level has decreased to 7% and remained stable until 2013. Currency management policy that was carried out in cooperation with the World Bank has shown its effects, and the national currency started to penetrate into the domestic market and began to become a reliable currency.

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[1] Ministry of Foreign Affairs of Japan, "Basic Data of Uzbekistan", accessed 11th May 2015. http://www.mofa.go.jp/mofaj/area/uzbekistan/data.html

[2] Development Assistance Committee (DAC) was established in January 1960 base on the proposal of United State America and active as a lower agency of OECD.

Source: Asian Development Bank, ADB, "Key Indicators for Asia and the Pacific 2014", September 2014[3]

Figure 2.2-1 Consumer Price Index (CPI) of Uzbekistan (1996– 2013)

Since 2004, when the price level began to stabilize, the economic activity has gradually resumed, the growth rate of each sector has been expanding at more than 5% compared to previous year. Especially in the service sector, the growth rate has continued to grow by more than 10 percent since 2007. The GDP growth rate from 2004 has excessed 7% increase over the previous year, and continued until 2013. Uzbekistan's external debt is gradually shrinking by the stabilization of economic growth and currency. The external debt was above 50% of GDP in 2004, and declined to 8.5 percent of GDP in 2013. The inflation suppression policy has gradually begun to appear, and the domestic demands are driving the growth of the Uzbekistan GDP. In 1990, before independence from the former Soviet Union, the share of service sector in the GDP was 30.5%. In 2013, the share of service sector expanded to 43.3%, and became the largest sector in Uzbekistan. On the other hand, because of the division of labor in Central Asia under the reign of the former Soviet Union, Uzbekistan had mainly focused on agricultural production (mainly grow cotton). This single industrial structure is gradually improving, and the share of agricultural sector in GDP was reduced from 33.0% in 1990 to 17.9% of 2013.

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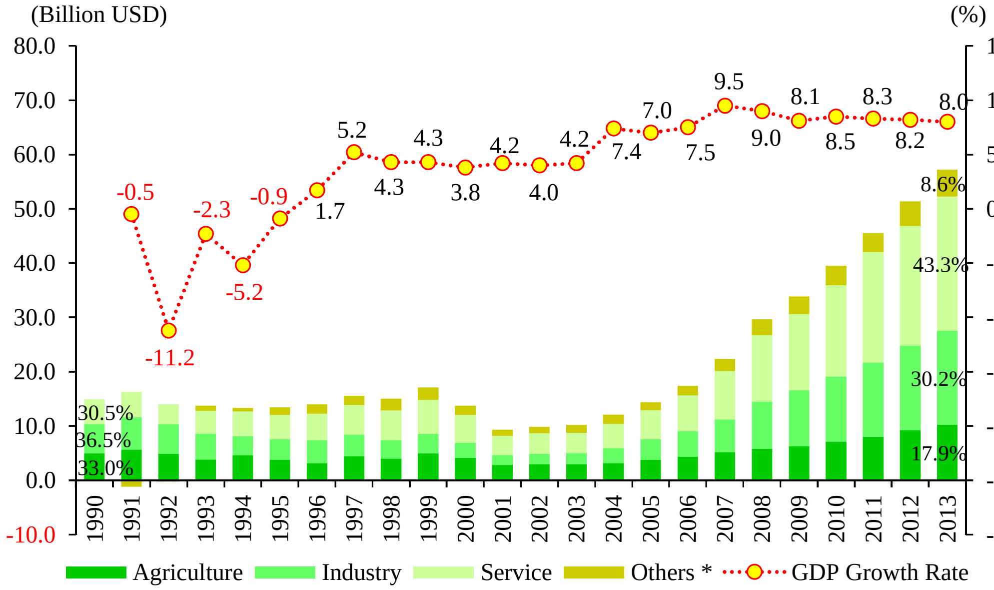
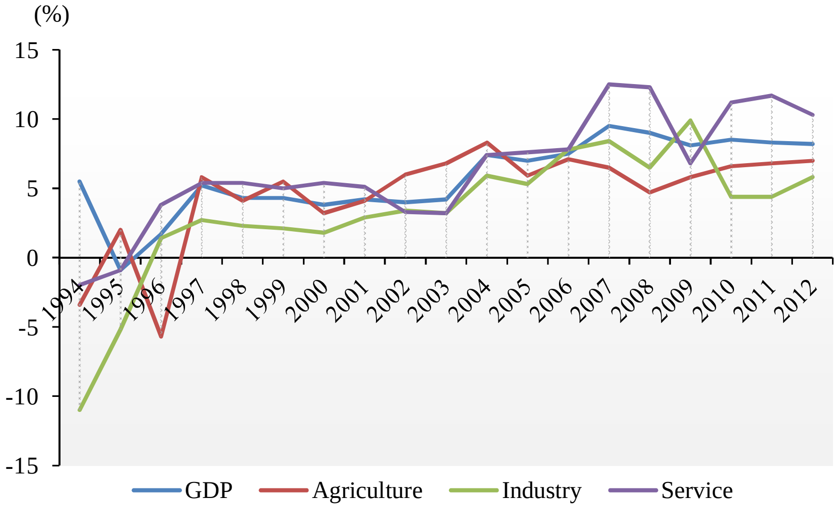
[3] "Key Indicators for Asia and the Pacific 2014", September 2014, accessed on 11 May 2015. http://www.adb.org/publications/key-indicators-asia-and-pacific-2014



Note: * Net taxes on product.

Source: United Nation Statistic Division, UNSTAT, http://data.un.org/Explorer.aspx?d=UNIDO, accessed on 11 May 2015.

Figure 2.2-2 Uzbekistan’s GDP by Sector at Current Prices and Growth Rate (1994–2013)



Source: Asian Development Bank, ADB, “Key Indicators for Asia and the Pacific 2014”, September 2014

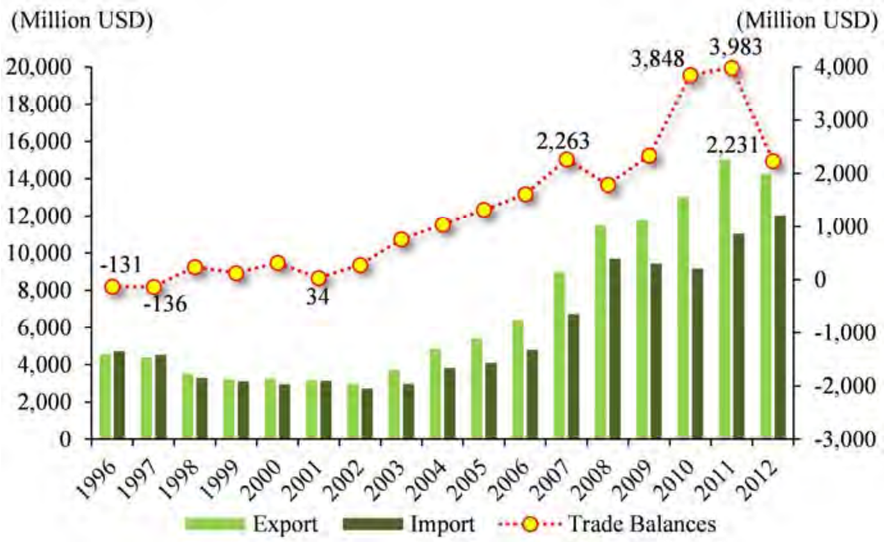
Figure 2.2-3 Uzbekistan's GDP Growth Rate by Sector (1994–2012)

GDP growth in the industrial sector showed a negative growth from 1991 to 1995, and the growth rate of the sector slightly remained at an average of 1% from 1996 to 2000. The share of industrial sector in GDP decreased in the same period and became 19.9% in 2001. Since 2001, the industrial structure was reformed, and natural mineral resources such as oil, natural gas, gold, copper, precious metals were actively developed, and investment in the mining industry has expanded to almost 60% of the government expenditure. As a result, the development of mining has progressed rapidly, and contribution of the mining industry to the economy has become increasingly large and pushed up the share of the industrial sector. In 2013, the share of industrial sector in GDP was restored up to 30.2%.

In recent years, Uzbekistan government is trying to attract much more foreign investment in to the manufacturing sector, and is working to diversify its industrial structure.

(2) External Trade

Except 1996 and 1997, the trade balance of Uzbekistan has always maintained a surplus. Especially since 2001, the trade balance surplus has been expanding year by year and has reached 3.98 billion USD in 2011. It is the highest surplus amount of the past records of Uzbekistan. The trade surplus decreased slightly in 2012 and become 2.23 billion USD. According to the statistics of 2012, the export value was 14.26 billion USD (5.1% decrease over the previous year) and the import value became 12.03 billion USD.



Source: Asian Development Bank, ADB, “Key Indicators for Asia and the Pacific 2014”, September 2014

Figure 2.2-4 Uzbekistan's Trade Balance and Trade Amount Trend (1996– 2012)

The most important trading partners for Uzbekistan are Russia, China, Kazakhstan, South Korea and Turkey. Especially, for many years Russia has been the largest trading partner which is strongly related to its economy for Uzbekistan. However, in 2013, China has become the largest trading partner for Uzbekistan on export overtaking Russia. The trade with Russia is expected to decrease further in 2014 because of the declining Russian economy. The economic relationship with China is expected to grow further in the short-term, and the Uzbekistan economy could become dependent on China instead of Russia.

Table 2.2-1 Changes in the Top 10 Trade Partners of Uzbekistan (2000–2013)

		2000	2005	2010	2011	2012	2013
Export (Million USD)							
1	Russia	602	820	1,376	1,044	1,264	1,203
2	China	11	410	1,181	733	992	1,744
3	Turkey	78	236	783	854	739	741
4	Kazakhstan	64	231	430	701	743	782
5	Ukraine	162	187	74	585	99	83
6	Bangladesh	14	163	518	432	445	509
7	Kyrgyzstan	68	55	162	181	189	199
8	Turkmenistan	32	63	122	136	142	150
9	Iran	46	124	95	109	122	136
10	Japan	71	113	157	44	96	91
Import (Million USD)							
1	Russia	302	947	1,830	2,117	2,557	2,799
2	China	43	253	1,296	1,495	1,962	2,875
3	Korea	253	542	1,583	1,891	1,943	2,165
4	Kazakhstan	147	267	1,209	1,297	1,478	1,557
5	Germany	233	313	771	736	548	607
6	Turkey	91	166	311	390	495	619
7	Ukraine	125	166	251	389	480	387
8	Kyrgyzstan	98	19	284	318	331	349
9	United State	183	81	112	110	313	353
10	Italy	53	68	132	160	154	129

Source: Asian Development Bank, ADB, “Key Indicators for Asia and the Pacific 2014”, September 2014

(3) Economic Development Vision 2030

Uzbekistan has drafted the economic development vision of 2030 (hereinafter referred to as “Vision 2030”) by the assistance of United Nations Development Programme (UNDP) and World Bank[4]. “Vision 2030” is submitted to the Council of Ministers in January 2015, and it is undergoing a final review by the cabinet[5]. The entire contents of “Vision 2030” have not yet been published, according to the information provided by the related agencies, the main numerical targets are as follows.

Table 2.2-2 Economic Development Vision 2030 Target

GDP Growth Rate	8% (2013–2030, Average)
Share by Sector	
Industry	37% (8.3%, Average Annual Growth Rate)
Agriculture	7.0% (2.6%, Average Annual Growth Rate)
Service	56% (9.2%, Average Annual Growth Rate)

Source: Center for Economic Research, (CER2014), “Uzbekistan 2030 – Defining the Pattern of Growth and Policies for Accelerated Transformation”, 18 December, 2014

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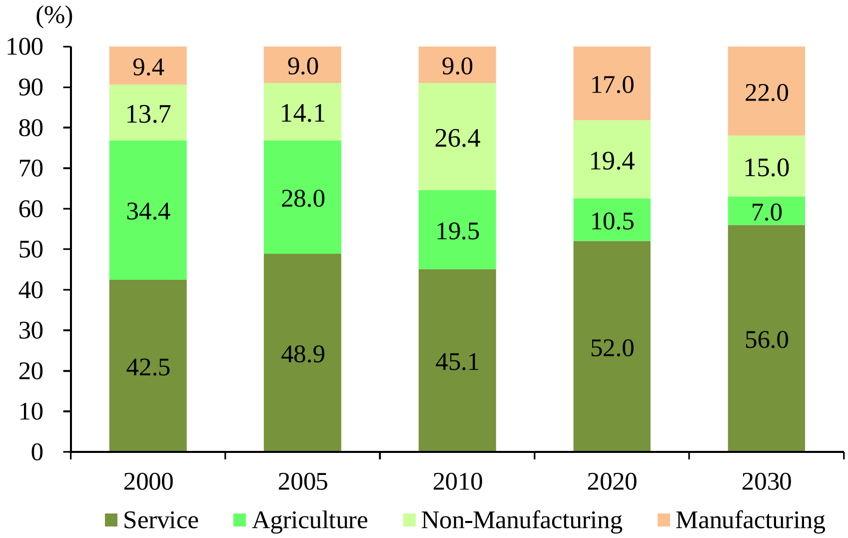
[4] The project started in August 2013 and it is expected completed in April 2015. There are several agencies which have taken part in the process. The Center for Economic Research (CER) (under Ministry of Economic) and Institute of Forecasting and Macroeconomic Research (IFMR), which is under the cabinet, are the two agencies who is in charge of the energy sector development and efficient use of resources planning for the Vision 2030. The project started in August 2013 and continued until April 2015, UNDP and World Bank has supported part of the budget and dispatched expert to Uzbekistan. The detail of the project can be found at the following website address: http://www.cer.uz/en/projects/2190

[5] Interview with Ministry of Economic on 21 January 2015.

According to the Vision 2030, the country's economic growth rate is to maintain an 8.1% compound annual growth until 2030. In order to maintain this high growth, the expansion of the investment by the government in infrastructure construction should continue. It is particularly necessary to promote and focus on investing in energy resource development or related industries. All other plans like infrastructure construction, social welfare, energy resources development (including the power development plan, refer to Chapter 5) has prepared base on the 8% growth rate.



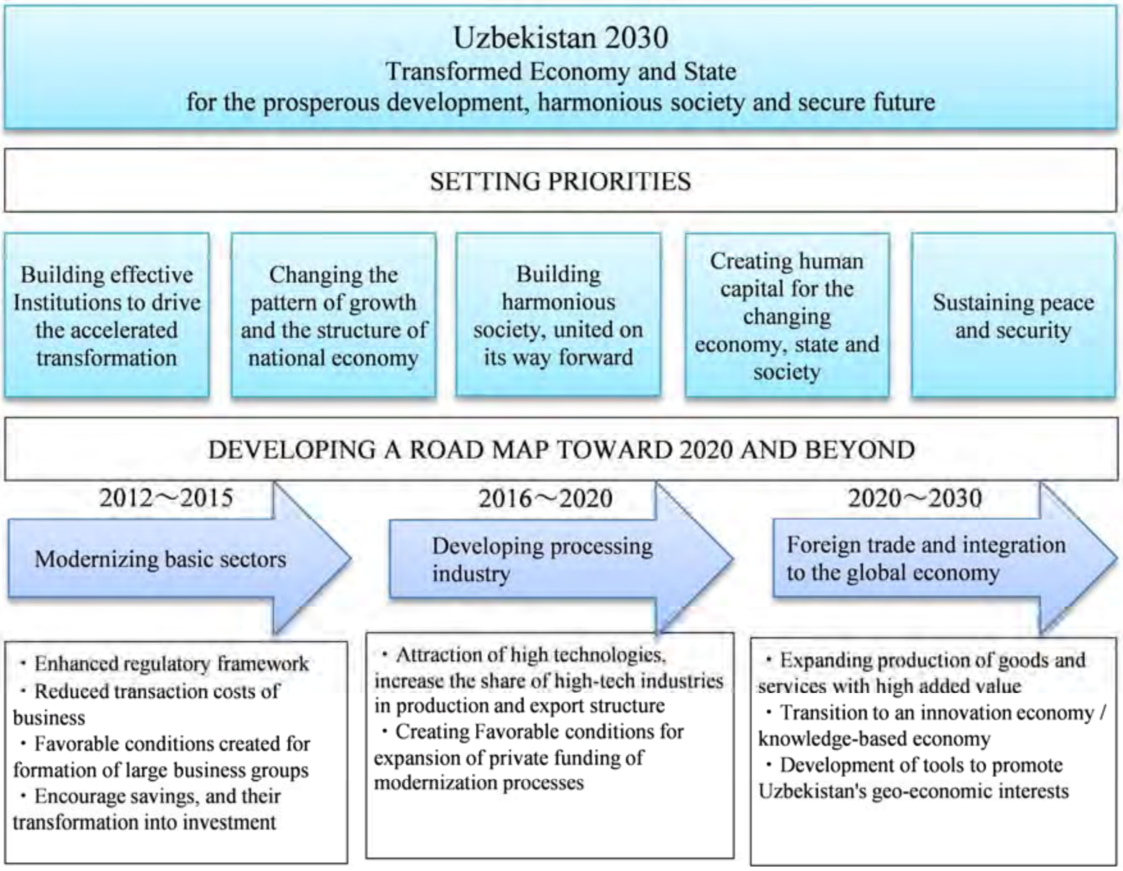
Source: Center for Economic Research, (CER2014), “Uzbekistan 2030 – Defining the Pattern of Growth and Policies for Accelerated Transformation”, 18 December 2014

Figure 2.2-5 Forecast of Structural Transition of Uzbekistan’s GDP by Sector (2000–2030)

In order to achieve the targets, the following priority settings are required:

a) Building effective Institutions to drive the accelerated transformation
b) Changing the pattern of growth and the structure of national economy
c) Building harmonious society united on its way forward
d) Creating human capital for the changing economy, state and society
e) Sustaining peace and security

Based on these five priorities, a roadmap of three steps has been developed to achieve the target. First, the basic sector in the economy has to be promoted by modernization and efficiency by 2015, and then the industrial sector has to be advanced by 2020, and in the third step the economy of Uzbekistan has to be integrated with that of the world by 2030.



Source: Center for Economic Research, (CER2014), “Uzbekistan 2030 – Defining the Pattern of Growth and Policies for Accelerated Transformation”, 18 December 2014

Figure 2.2-6 Road Map of Economic Development Vision 2030 of Uzbekistan

2.3 Financial Balance and External Debt

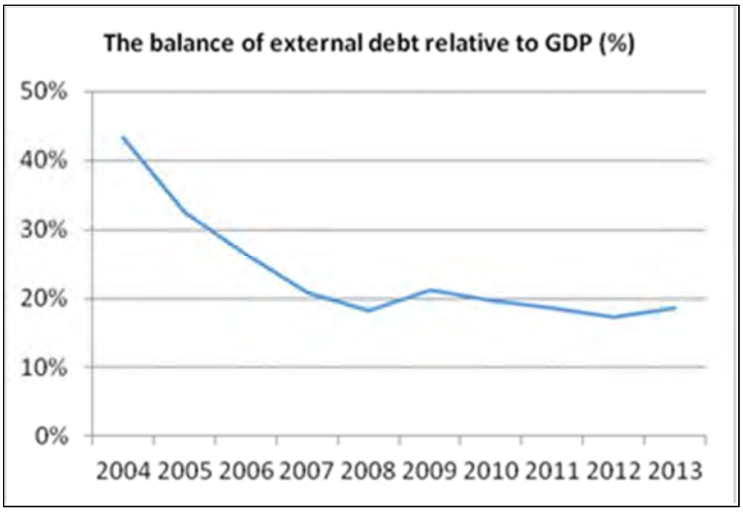
Financial balance of Uzbekistan in recent years continued to register plus (table 2.3-1). At the same time, the balance of external debt relative to GDP over the past 10 years declined from 40% to almost 20% (Figure 2.3-1), and for the most part, remains in a stable condition.

Table 2.3-1 Financial balance of Uzbekistan

(units: billion sums)

	2010	2011	2012	2013	2014
Total Annual income	13,596.7	17,061.3	21,295.7	26,223.0	31,729.6
Direct taxes	3,546.8	4,497.0	5,414.2	6,353.7	7,433.1
Indirect taxes	6,858.5	8,225.0	10,434.5	13,398.6	16,851.8
Property and resources tax	2,095.5	2,626.2	3,312.5	3,888.2	4,311.6
Other income	1,095.9	1,713.1	2,134.4	2,582.5	3,133.1
Total Costs	13,386.9	16,726.0	20,882.0	25,825.9	31,425.0
Social security programs	7,835.9	9,704.9	12,299.9	15,147.0	18,490.8
Charity (NGOs, charities)	4.5	5.0	6.0	7.0	8.2
Economic cost	1,513.5	1,931.6	2,317.0	2,749.8	3,364.9
Investment in central planning	860.0	1,096.1	1,131.7	1,439.6	1,616.5
Government expenditures	490.1	629.6	852.8	1,149.8	1,414.2
Other costs	2,682.8	3,358.7	4,274.6	5,332.7	6,530.5
Budget surplus	209.8	335.3	413.6	397.1	304.6

Source: Ministry of Finance of the Republic of Uzbekistan



Source: Prepared by JICA Study Team based on the World Bank data

Figure 2.3-1 Balance of external debt of the Republic of Uzbekistan and its relationship to GDP

Chapter 3 Electricity Sector Overview and Heat Supply Scope

Chapter 3 Electricity Sector Overview and Heat Supply Scope

3.1 Situation in the Electricity Sector

3.1.1 Structure of Electric Power Industry

(1) Uzbekenergo JSC

Uzbekenergo Company was formed after the independence of the Republic of Uzbekistan as the government power company, taking over the functions of the Ministry of Energy and Electrification, which had previously administered the power industry. In the period prior to independence of the Republic of Uzbekistan, production, transmission and distribution of electric energy had been carried out by Production Power and Electrification Associations (PPEA), which existed in each region. Uzbekenergo Company included in its composition the PPEA of all regions.

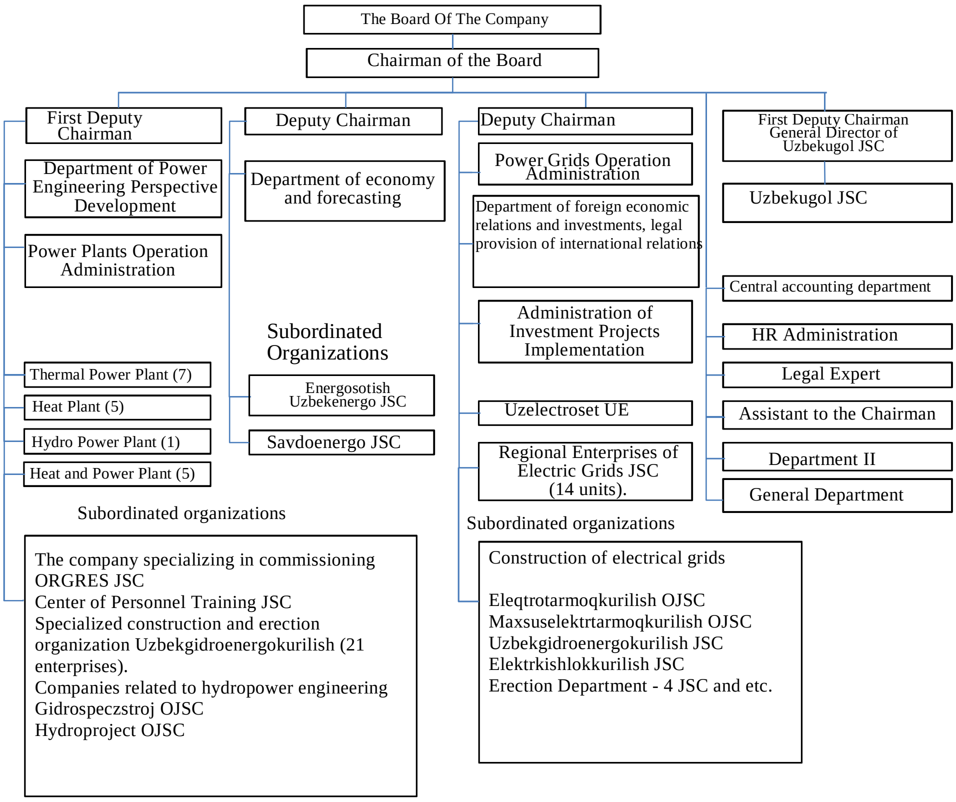
In 2002 the company was transformed into a state joint-stock company where the government owns 100 % of shares. At the same time the Ministry of Energy and Electrification was abolished, and the company assumed management of all electric power sector.

The Decree on Power Sector Reforming dated 2004 included in its composition the company, the enterprises producing and distributing electricity, and other enterprises. The company has in total 54 enterprises and organizations. Some of the shares of the companies that produce and distribute electricity were sold to private individuals. However, this part is only 15 %. The shares of companies that transmit electricity were not sold to private individuals, and the company continues to own 100 % of the shares.

The company, although the name has changed to a joint-stock company in 2015, has no plan to privatize in present.

The organizational structure of Uzbekenergo JSC is shown in Figure 3.1.1-1.

The Structure of the Executive Apparatus of Uzbekenergo State Joint-stock Company



Source: Compiled on the basis of documents representing the activities of Uzbekenergo JSC.

Figure 3.1.1-1 Organizational structure of Uzbekenergo JSC

Uzbekenergo JSC has a controlling interest in 54 enterprises engaged in the production, transmission and distribution of electricity. Energosotish JSC, which is a branch and a 100 % subsidiary of Uzbekenergo JSC, acts as a counter-part for conclusion of contracts related to electric energy with these enterprises. In accordance with the Decree No. 255, 2010 of the Cabinet of Ministers, Energosotish is the unified buyer of electric energy in the country accountable to Uzbekenergo JSC, the Ministry of Finance and the Ministry of Economics. Energosotish does not have its own separate financial reporting. Financial reports on transactions ofelectricity are included in the consolidated financial statements of Uzbekenergo JSC.

Department of investments of Uzbekenergo JSC does not compile investment programs, but it executes projects in accordance with the developed and approved investment program. It is the Teploelektroproekt JSC is involved in development of studies on investments instead of the Department of Investments, and submits reports to the government, and conducts negotiations with lenders about the terms of financing. Teploelektroproekt JSC is an autonomous organization which does not belong to any specific ministry or department. However, Uzbekenergo JSC owns 30 % of the shares of this design organization; therefore, Uzbekenergo JSC and the Government have the opportunity to exert influence on its activities. Moreover, in accordance with the Decree No. 927, 2008 on the order of formation of investment program, the Ministry of Economy develops the annual investment program and the medium-term development program by industries and regions. Issues concerning the attraction of foreign credits and investments and emerge in the process of developing an investment program are governed by Decree of the Cabinet of Ministers No. 395 dated 2003. The developed investment program is approved by the relevant ministries and departments. Final approval is carried out by the Cabinet of Ministers.

1) Financial activity of Uzbekenergo JSC

The profit and loss statement of Uzbekenergo JSC is shown in Table 3.1.1-1.

Table 3.1.1-1 Profit and loss statement of Uzbekenergo JSC

(million sums)

	2010	2011	2012	2013
Net sales revenue	2, 067, 215	2, 486, 307	2, 703, 538	3, 546, 861
Cost price of sold products	1, 646, 701	2, 125, 173	2, 394, 392	2, 947, 767
Gross profit from sold products	420, 515	361, 134	309, 145	599, 094
Expenses of the period	42, 290	63, 908	99, 488	207, 794
Operating profit	380, 002	297, 434	212, 332	421, 447
Income from financial activities	48, 331	41, 492	41, 481	405, 402
Costs of financial activities	37, 169	32, 208	67, 809	328, 252
Profit from general economic activities	391, 164	306, 717	186, 004	498, 597
Profit before tax	391, 164	306, 717	186, 004	498, 597
Other taxes and taxes on profit	62, 896	50, 499	30, 858	81, 138
Net profit of the reporting period	328, 268	256, 217	155, 145	417, 458
Annual growth in revenues from sales of products		20 %	9 %	31 %
Operating return on sales	18 %	12 %	8 %	
Rate of return from sold products	16 %	10 %	6 %	12 %
Share of cost price of sold products in revenue from products sale	80 %	85 %	89 %	83 %
The ratio of the proceeds from sales of products to the expenses of the period	2 %	3 %	4 %	6 %

Source: Uzbekenergo JSC

Net revenue from sales of products grows every year; the average annual growth rate of sales of products from 2010 to 2013 was 20 %. The proportion of production costs and expenses in the same period was steadily kept at around 90 % of the revenue of sales. Profitability of sold products was also steadily kept approximately at 10 %, and it was also a high in 2013, amounting to 12 %. As a result, there has been continued growth in operating profit; the company's financial status is stable.

Statement of cash flows of Uzbekenergo JSC is presented in Table 3.1.1-2.

Table 3.1.1-2 Cash flows of Uzbekenergo JSC

(million sums)

	2010	2011	2012	2013
Cash flows from operational activities				
Income from main activities	2, 113, 826	2, 603, 213	3, 122, 263	3, 499, 587
Expenses for procurement of raw materials and materials	1, 815, 950	2, 232, 467	2, 725, 272	3, 686, 931
Personnel expenses	2, 088	2, 451	3, 265	5, 053
Total cash flows from operating activities	122, 688	171, 409	226, 815	371, 042
Cash flows from operational activities				
Acquisition of fixed assets		24	19	
Other investment expenses	640, 645	343, 274	381, 445	270, 263
Total cash flows from investment activities	-640, 645	-344, 100	-384, 464	-275, 263
Cash flows from financial activities				
Long-term loans	847, 654	175, 643	509, 237	1, 119, 796
Repayment of long-term loans	37, 424	57, 518	180, 023	233, 542
Total cash flows from financial activities	780, 860	85, 270	268, 847	813, 441
Payment of taxes	-46, 009	-100, 737	-116, 280	-125, 248
Increase in cash and cash equivalents	216, 617	-172, 173	-1, 973	60, 629
Balance of cash and their equivalents at the beginning of reporting periods	16, 627	233, 244	61, 072	59, 099
Balance of cash and their equivalents at the end of reporting periods	233, 244	61, 072	59, 099	119, 728
Free cash flow	-517, 957	-172, 691	-157, 648	95, 779

Source: Uzbekenergo JSC

Together with the increase in the income and expenditure, the sum of the cash flows from operating activities also increases. Free cash flow, which is the difference between the cash flow from operating activities and cash flow from investing activities, was negative until 2012; but it was covered by the annual cash flows from financial activities. The balance of cash and cash equivalents at the end of the reporting period increased compared to the balance at the beginning of the period, indicating a secure cash flow management.

2) Balance sheet of Uzbekenergo JSC

Balance sheet of Uzbekenergo JSC is presented in Table 3.1.1-3.

Table 3.1.1-3 Balance sheet of Uzbekenergo JSC

	2010	2011	2012	2013
Asset				
Current assets	2, 357, 103	2, 599, 702	2, 673, 380	3, 404, 721
Long-term assets	1, 674, 826	2, 391, 883	3, 159, 881	4, 219, 560
Total asset balance sheet	4, 031, 929	4, 991, 585	5, 833, 261	7, 624, 281
Liabilities				
Current liabilities	1, 711, 255	2, 019, 096	1, 944, 484	2, 525, 036
Long-term liabilities	1, 088, 088	1, 535, 439	2, 239, 335	3, 005, 565
Net assets				
Net worth	1, 232, 586	1, 437, 049	1, 649, 553	2, 093, 680
Total liability and net assets	4, 031, 929	4, 991, 585	5, 833, 261	7, 624, 281
Current liquidity ratio	138 %	129 %	137 %	135 %
Capital adequacy ratio	31 %	29 %	28 %	27 %
Ratio of fixed assets to equity	136 %	166 %	192 %	202 %
Ratio of fixed assets to the amount of long-term liabilities and net worth	72 %	80 %	81 %	83 %

Source: Uzbekenergo JSC

Increase of ratio of fixed assets to equity is observed. Ratio of fixed assets to the amount of long-term liabilities and equity does not exceed 100 % and is kept at around 80 %, and long-term assets are sufficiently covered by own capital and long-term commitments. Current liquidity ratio, which reflects the ratio of current assets to short-term liabilities, exceeds 100 % that in combination with cash flows from operating activities ensures normal cash flow management. Capital adequacy ratio remained about 30 %, without significant changes. All this suggests that the energy company, Uzbekenergo JSC, maintains a stable balance between assets and liabilities.

(2) Management structure of Uzbekenergo JSC and Regional Enterprises of Electric Grids

Power system operation and management of electricity grid facilities is exercised by the National Dispatch Center (NDC) and Administration of Electric Grids Operation (UEES, for its Russian acronym, *Upravleniyem Ekspluatatsii Elektricheskikh Setey),* comprising Uzbekenergo JSC.

The NDC operates the electric energy system and controls load distribution nationwide. Meanwhile, it is required to manage enormous facilities, and it has a permanent operational control. Therefore, network management of 220 kV and 500 kV is the responsibility of 5 Regional Dispatch Centers (RDC)[1]. Balance management of electric supply and consumption is carried out through RDC. Management of 110 kV and energy distribution is carried out by 14 regional enterprises of electric grids located in each region.

Management of electrical network activity throughout the Republic is carried out by the UEES. Initially the UEES used to manage all electric grids. Currently, however, the UEES only manages 110 kV and 35 kV networks through 14 territorial enterprises of electric grids. Management of grid facilities of 500 kV and 220 kV networks is independently carried out by Uzelektroset UE.

Electric energy distribution is carried out by regional enterprises of electric grids which are located in each region and are subsidiaries of Uzbekenergo JSC. Each regional enterprise of electric grids manages electric network facilities of 110 kV and 35 kV receiving instructions from the UEES.

Management structure of Uzbekenergo JSC and regional enterprises of electric grids are shown on the schematic figure below (Figure 3.1.1-2).

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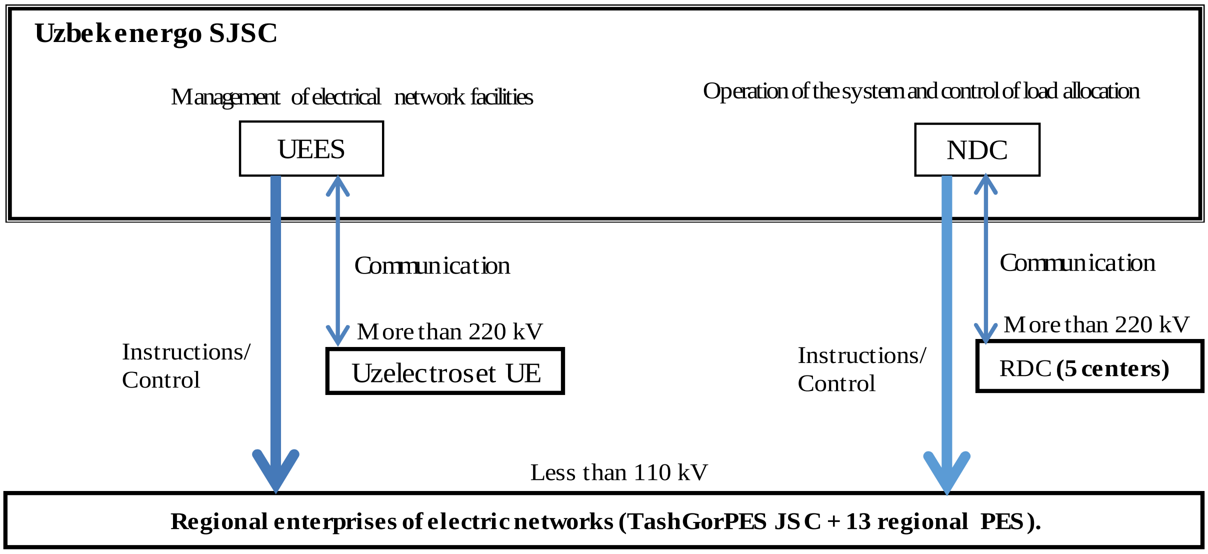
[1] The 1st RDCis responsible forTashkent, Samarkand, Ferghana, Takhiatash and South regions.



Source: Uzbekenergo JSC

Figure 3.1.1-2 Management structure of Uzbekenergo JSC and regional enterprises of electric grids

Operation of electrical networks and management of grid management in Tashkent is performed by Tash Gor PES[2] JSC. Thus, Tash Gor PES JSC will also manage the electricity transmission grid which will be commissioned within the framework of this project.

There are 14 regional enterprises of electric networks spread across 5 areas of electricity supply (Table 3.1.1-4).

Table 3.1.1-4 Distribution of the regional enterprises of electric grids by power supply areas

Power supply area	Region	Regional enterprise of electric grids
Tashkent (Central area)	Tashkent city Tashkent region Syrdarya Region Jizzakh region	1. Tash Gor PES JSC 2. Tash Obl PES JSC 3. Syrdarya PTES JSC 4. Djizzakh PTES JSC
Samarkand (South-eastern area)	Samarkand region Bukhara region Navoi region Kashkadarya region	5. Samarkand PTES JSC 6. Bukhara PTES JSC 7. Navoi PTES JSC 8. Kashkadarya PTES JSC
Fergana (Eastern area)	Ferghana Region Andijan region Namangan region	9. Ferghana PTES JSC 10. Andijan PTES JSC 11. Namangan PTES JSC
Takhiatash (North-western area)	The Republic of Karakalpakstan Khorezm Region	12. Karakalpak PTES JSC 13. Khortezm PTES JSC
Southern area	Surkhandarya region	14. Surkhandarya PTES JSC

Source: Uzbekenergo JSC

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[2] PES means Regional Electric Network Enterprise in Russian.

(3) Related organizations

There are 4 design organizations associated with Uzbekenergo JSC, including Teploelektroproekt JSC, Sredazenergosetproekt JSC. These design organizations are involved in the implementation of design and survey works and are attracted to complete works by Uzbekenergo JSC.

Uzbekenergo JSC, together with the Ministry of Economy and the Ministry of Finance, is developing a master plan for the development of the power industry. The Department of Fuel and Energy Complex Development, in the Ministry of Economy, is responsible for preparation of master plans. There is also another department, in the Ministry of Finance, involved in the planning of the power industry; however, it is not directly involved in our case.

3.1.2 Electric Power Supply and Demand

(1) Power Demand-Supply Balance

The total power supply of Uzbekistan in 2014 reached 56,232 GWh. 96.7 % of the total power supply is provided by Uzbekenergo JSC. About 2.6 % (or 1,165 GWh) of the total electric power generation is produced by other government agencies and a state-owned company. On the other hand, Uzbekistan imported 647 GWh of electric power from the Republic of Kyrgyz in 2014. The imported electric power accounted for 1.1 % of the total power supply.

Regarding the electric power demand electricity sale in 2014 was 43,044 GWh, accounting for 76.6 % of the total electric power demand. Loss and own use was 11,763 GWh, accounting for 20.9 % of the total demand. Uzbekistan exported 1,426 GWh to Afghanistan in the same, accounting for 2.5 % of the total demand.

Table 3.1.2-1 Power supply-demand balance sheet of Uzbekistan (2005–2015)

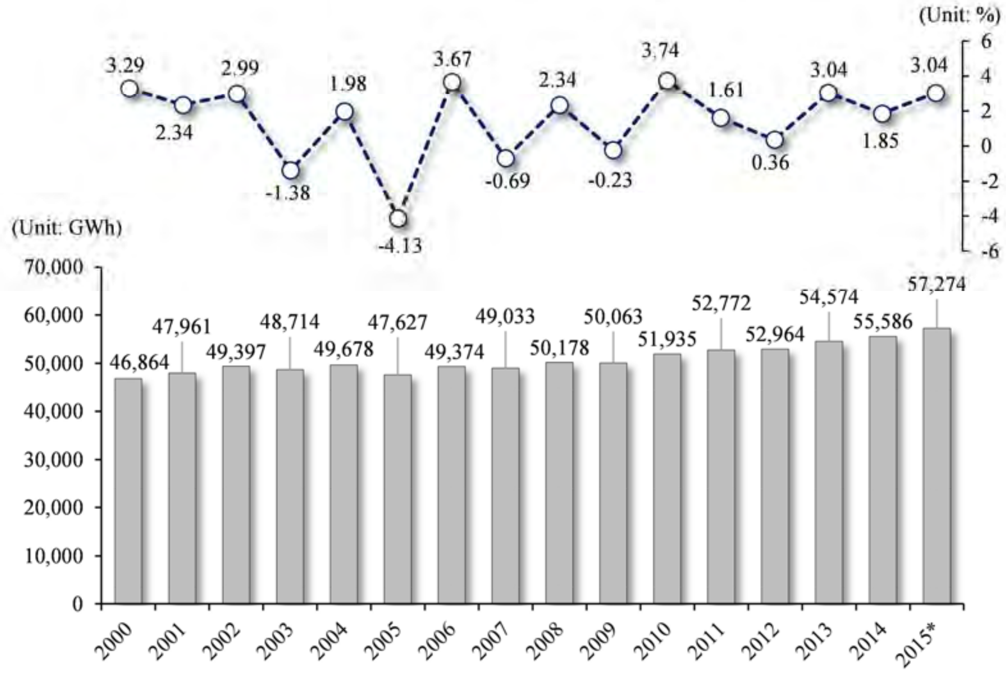
	Descriptions	Actual						Estima-tion	CAGR (%)	
		2005	2010	2011	2012	2013	2014	2015(1)	2014/ 2010	2014/ 2005
A	**Total Electricity Supply (1+2)**	**48,301**	**51,935**	**53,430**	**53,653**	**54,980**	**56,232**	**57,274**	**2.01**	**1.70**
1	Domestic Generation	47,627	51,935	52,772	52,964	54,574	55,586	57,274	1.71	1.73
	1.1 Uzbekenergo JSC	46,213	50,063	51,435	51,201	53,183	54,401	55,751	2.10	1.83
	Thermal	40,174	43,515	46,838	46,095	48,642	49,272	50,587	3.15	2.29
	Hydro	6,039	6,548	4,597	5,107	4,541	5,130	5,164	-5.92	-1.80
	1.2 Others	1,394	1,852	1,317	1,743	1,372	1,165	1,503	-10.95	-1.98
	Thermal (Tahiatash)	161	208	193	195	210	219	200	1.39	3.48
	- Almalyl MMC	160	205	191	195	210	219	200	1.76	3.54
	- Uzvinprom Holding Co.	1	3	2	0	0	0	0	-	-
	Hydro (MOA)(2)	1,233	1,644	1,124	1,548	1,161	945	1,303	-12.92	-2.91
	1.3 Self-Generation	20	20	20	20	20	20	20	0.00	0.00
2	Import	674	0	658	689	406	647	0	-	-0.46
B	**Total Electricity Demand (1+2)**	**48,301**	**51,935**	**53,430**	**53,653**	**54,980**	**56,232**	**57,274**	**2.01**	**1.70**
1	Domestic Demand	47,487	50,771	52,037	52,295	53,687	54,807	55,774	1.93	1.61
	1.1 Losses and Own Use(3)	10,515	11,294	11,267	11,146	11,721	11,763	10,491	1.02	1.25
	1.2 Electricity Sales(4)	36,972	39,477	40,770	41,149	41,965	43,044	45,282	2.19	1.70
	Industry	15,830	15,783	16,250	16,554	16,942	17,894	-	1.79	1.37
	Construction	130	169	198	159	171	230	-	0.41	6.48
	Transportation	1,353	1,193	1,181	1,201	1,214	1,262	-	0.45	-0.77
	Agriculture	9,920	8,592	8,770	8,308	8,792	8,568	-	0.58	-1.61
	Residential and Commercial	9,466	13,449	14,105	14,653	14,568	15,091	-	2.02	5.32
2	Export	815	1,164	1,393	1,358	1,293	1,426	1,500	5.20	6.41
	Afghanistan	149	843	1,375	1,358	1,293	1,426	1,500	14.0	28.5
	Others Countries	666	321	18	0	0	0	0	-	-

Note: (1) 2015values are predicted by Uzbekenergo JSC; (2) Generation by hydropower plants operated by MOA (Ministry of Agriculture and Water Resources); (3) About 16 % are losses; (4) Electricity consumption by sector in 2014 is preliminary value.
Source: Uzbekenergo JSC

On the other hand, the documents of “Power Development Plan 2030” prepared by Uzbekenergo JSC shows that the country always faces shortage of electricity supply. The document also states that the power shortage in 2011 was 5,300 GWh and 7,300 GWh 2012, accounting for 9.9 % and 13.6 % of the total power demand, respectively. Half of the power shortage (about 3,500 GWh) in 2012 happened in the residential sector. The electricity consumption per capita in Uzbekistan is approximately 1,800 kWh, and it is the lowest of the CIS countries (Kazakhstan about 5,100 kWh, Turkmenistan about 2,500 kWh). The population growth is expanding, especially since 2007, at an average annual rate of 2.0 %, and this has increase the potential of the power demand by residential sector.

(2) Electric Power Generation

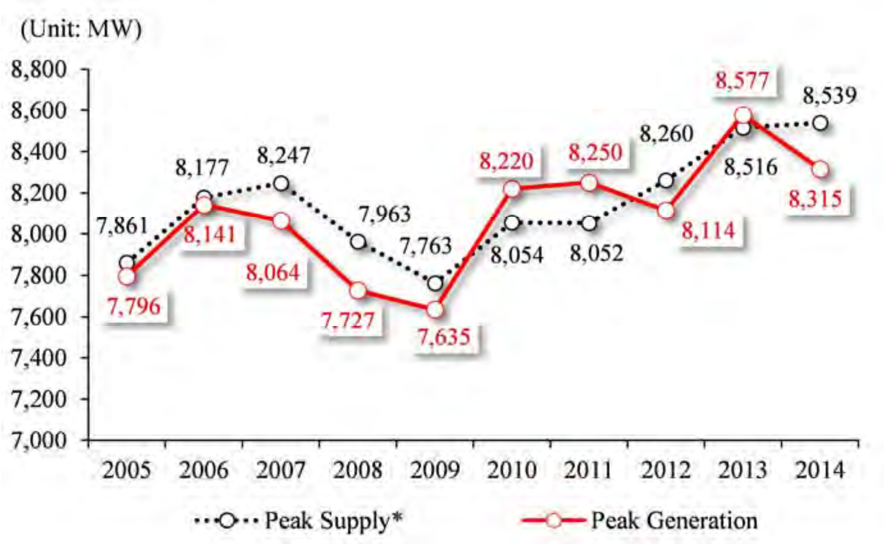
The electricity generation of Uzbekistan has reached 55,586 GWh in 2014, increasing by 1.85 %from previous year. As a long-term trend, the average annual electricity generation has grown at an average annual rate of only 1.2 % since 2000 (14 years). Especially in the early 2000s the electricity generation only increased at average annual rate of 0.7 % until year 2009. The increase of Power generation was relatively stable during the period 2009 to 2014. In this period, electricity generation has grown at an average annual rate of 2.1 %. In 2014 the thermal power accounted for 87.0 % of the electricity generation, while hydropower accounted for 9.7 % and others for the remaining 3.3 %. According to the Uzbekenergo JSC, electricity generation in 2015 is expected to reach 57,274 GWh, with 3.0 % increase the 2014.



Note: * 2015 value is predicted by Uzbekenergo JSC.
Source: Uzbekenergo JSC

Figure 3.1.2-1 Trend of electricity generation and increase rate (2000–2015)

The figure below shows the annual peak demand at sending end and generating end of Uzbekenergo JSC from 2005 to 2014. Before 2010, Uzbekistan power supply was supported by imported electricity, and the difference between the peak demand between sending end and generating end reached 236 MW in 2008. The lowest peak demand of 7,763 MW (sending end) was recorded in 2009, and from then until 2014 it grew at an average annual rate of 1.9 %. The peak demand of electricity reached 8,539 MW in 2014.

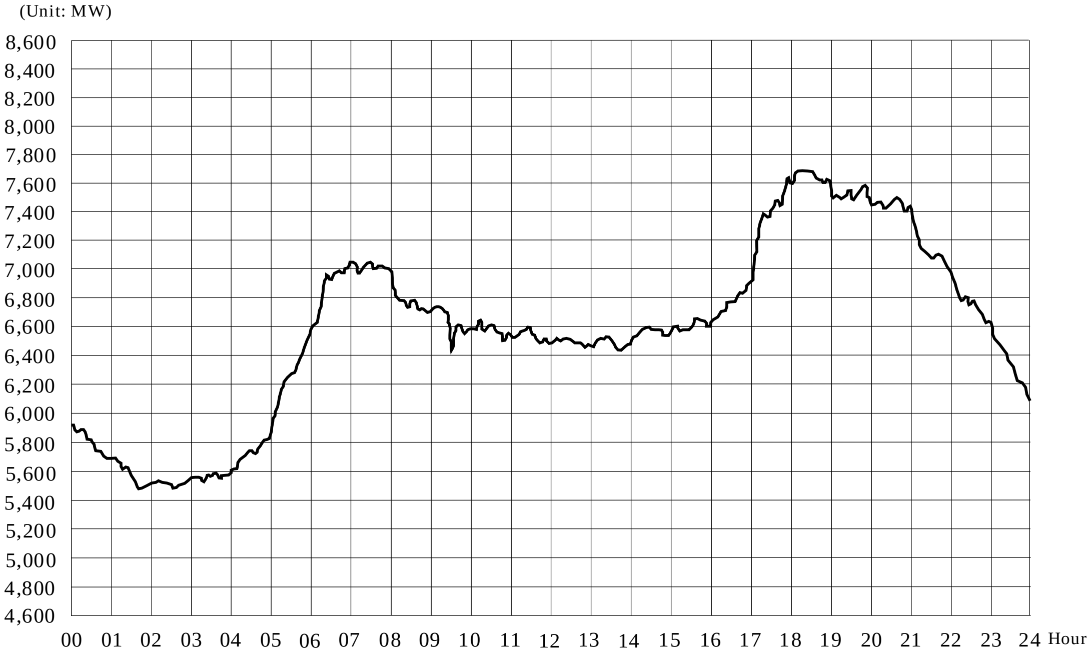


Note: * Imported electricity included.
Source: Uzbekenergo JSC

Figure 3.1.2-2 Peak demand at sending-end and generating-end of Uzbekistan (2005–2014)

Uzbekistan monthly peak demand for power primarily occurs in the winter, January and December. The peak demand in the winter increases because the indoor activities become longer than other seasons. The lowest throughout of the peak demand of the year is observed in May and September, with about 30 % gap between highest and lowest peak demand. Due to such seasonal differences, the efficiency of equipment declines and the cost to deliver the electric power to the consumer rises. Because of the increase of use of air conditioning equipment in urban areas, electricity demand in July and August slightly increases; nevertheless, the gap is still large compared to the peak demand in winter.

The figure below shows hourly demand on 15 January 2015, in the winter season, of Uzbekenergo JSC. Two peak demands occurred, one at 7–8 am and another at 6–7 pm. The residential sector (including commercial sector in statistics of Uzbekistan) accounts for a large share of power demand in Uzbekistan. The tendency of expansion of the electricity demand in the residential sector of Uzbekistan can be confirmed from the country's electric power sales.

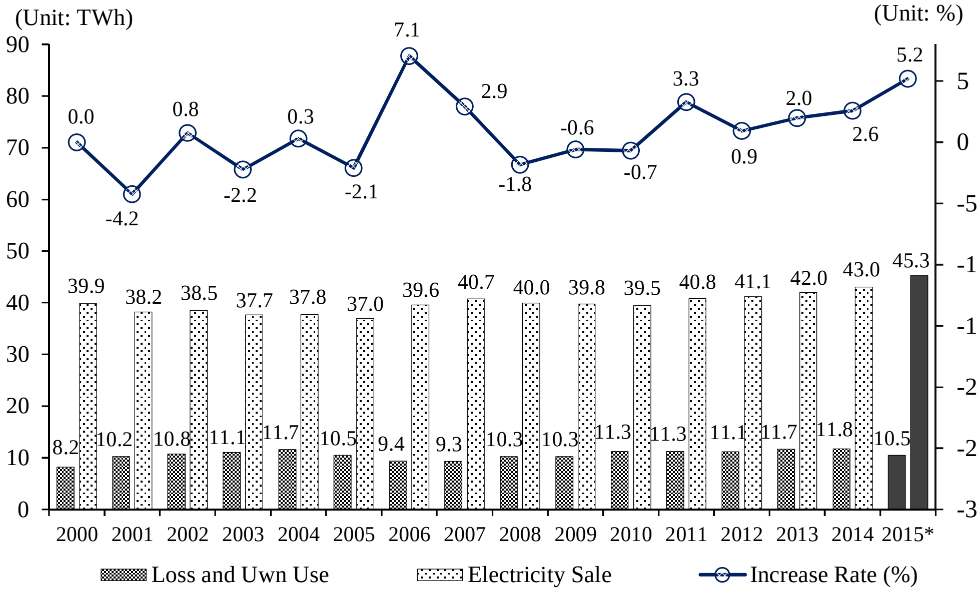


Source: Uzbekenergo JSC

Figure 3.1.2-3 Electricity demand curve of January 15, 2015

(3) Electricity Sale

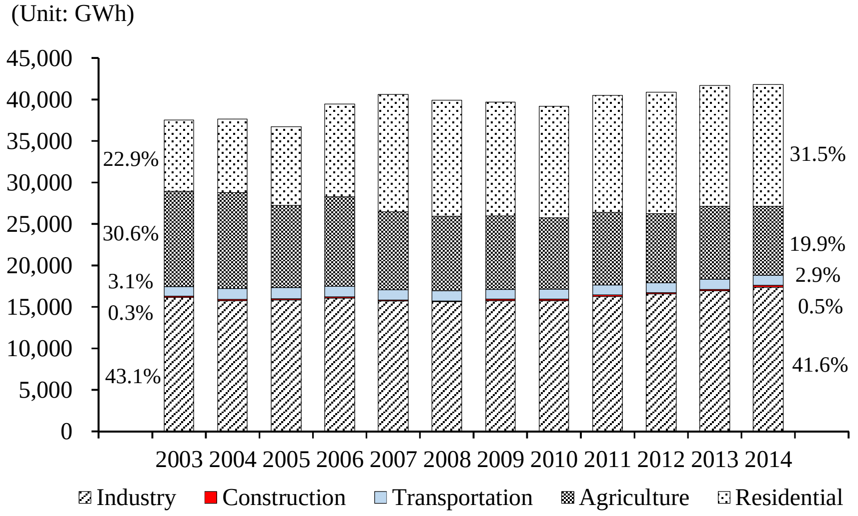
Electricity sales of Uzbekenergo JSC did not increased for 10 years, from 2000 to 2010. Electricity sales in 2010 were reduced by 431 GWh compared to 2000. However, electricity sales began to increase after 2010, expanding at an average annual rate of 2.2 %, and reached 43,044 GWh in 2014. In recent years, with the high economic growth, inflation rate is stable at around 6 % and private consumption is activated, and this condition has increased the demand for electricity.



Note: * The 2015 value is a predicted by Uzbekenergo JSC
Source: Uzbekenergo JSC

Figure 3.1.2-4 Trend of electricity sale, loss and own use (2000– 2015)

Industry sector was the largest electricity consumer in 2014. But when we look at the share change, industry sector's share has decreased by 1.5 point compared to 2003 and became 41.6 %. It means that the electricity consumption in manufacturing sector has stagnated. The share of the agriculture sector dropped by 10.7 points in the same period and became 19.9 % in 2013. In contrast, the residential sector (including services and commercial sectors) has expanded its share from 22.9 % in 2003 to 31.5 % in 2014. Residential and commercial electric power demand boosted the overall power consumption. In some provinces, problems such as shortage of power supply, power grid blackout happened frequently, and the potential demand for power in the residential sector is still large. According to Uzbekenergo JCS documents, the potential of power demand is approximately 10 % of the existing power demand.



Note: The 2014 final electricity consumption by sector is preliminary value. According to the Uzbekenergo JSC, the total amount of the residential consumption is included in the commercial electricity consumption.
Source: Uzbekenergo JSC

Figure 3.1.2-5 Final electricity consumption by sector (2003 ~ 2014)

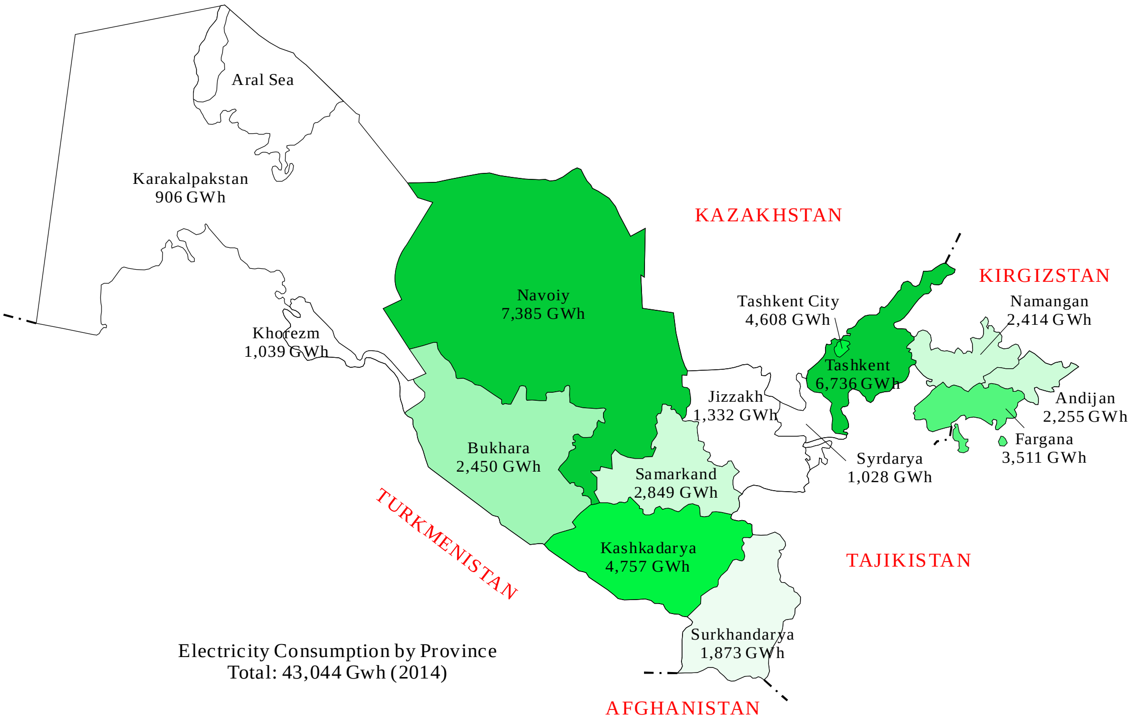
Table 3.1.2-2 shows the power consumption (electricity sales volume) from 2009 to 2014 by provinces and regions. Navoi province (17.2 %), Tashkent province (15.6 %), Kashkadarya province (11.1 %), and Tashkent province (10.7 %) were the largest consumers of electricity in the country in 2014. These four provinces accounted for 54.6 % of the total power consumption in 2014. Navoi province is one of the important economic development zones where the industrial park construction is underway.

On the other hand, Syrdarya province (2.73 %), Republic of Karakalpakstan (2.22 %), Jizzakh province (2.01 %), and Tashkent city (1.88 %) recorded the fastest increase in electricity demand from 2009 to 2014, and major cities are located in these regions. The increase of electricity consumption in these regions is mainly because of the activities of residential and commercial sector.

Table 3.1.2-2 Electricity consumption by province (2009–2014)

No.	Region	2009	2010	2011	2012	2013	2014*	CAGR (2009–2014) (%)
1	Karakalpakstan	788.0	777.9	855.3	859.6	876.8	906.4	2.84
2	Andijon	2,329.1	1,997.0	2,101.1	2,093.6	2,142.0	2,154.6	-1.55
3	Bukhara	2,179.5	2,263.0	2,228.2	2,217.2	2,403.0	2,450.0	2.37
4	Jizzakh	1,170.4	1,239.1	1,235.2	1,228.9	1,288.7	1,332.5	2.63
5	Kashkadarya	4,454.3	4,294.3	4,527.3	4,544.3	4,690.5	4,757.2	1.32
6	Navoiy	6,620.4	6,787.8	7,023.7	7,000.5	6,978.3	7,385.5	2.21
7	Namangan	2,175.0	2,101.8	2,107.1	2,237.1	2,368.7	2,413.7	2.10
8	Samarkand	2,532.6	2,573.0	2,623.0	2,614.4	2,750.5	2,849.0	2.38
9	Surkhandarya	1,824.4	1,831.4	1,939.3	1,857.6	1,887.1	1,873.1	0.53
10	Syrdarya	872.3	909.4	952.4	990.9	996.0	1,028.2	3.34
11	Tashkent	6,413.0	6,262.3	6,504.2	6,554.7	6,446.9	6,736.4	0.99
12	Tashkent City	4,073.4	3,973.3	4,215.5	4,417.4	4,472.0	4,607.9	2.50
13	Fargana	3,324.9	3,283.7	3,268.7	3,311.4	3,378.4	3,511.3	1.10
14	Khorezm	920.8	891.7	924.3	947.9	1,007.9	1,038.6	2.44
	Total	39,678.1	39,185.7	40,505.3	40,875.5	41,686.8	43,044.3	1.64
Share by Region (%)								
1	Karakalpakstan	2.0	2.0	2.1	2.1	2.1	2.1	
2	Andijon	5.9	5.1	5.2	5.1	5.1	5.0	
3	Bukhara	5.5	5.8	5.5	5.4	5.8	5.7	
4	Jizzakh	2.9	3.2	3.0	3.0	3.1	3.1	
5	Kashkadarya	11.2	11.0	11.2	11.1	11.3	11.1	
6	Navoiy	16.7	17.3	17.3	17.1	16.7	17.2	
7	Namangan	5.5	5.4	5.2	5.5	5.7	5.6	
8	Samarkand	6.4	6.6	6.5	6.4	6.6	6.6	
9	Surkhandarya	4.6	4.7	4.8	4.5	4.5	4.4	
10	Syrdarya	2.2	2.3	2.4	2.4	2.4	2.4	
11	Tashkent	16.2	16.0	16.1	16.0	15.5	15.6	
12	Tashkent City	10.3	10.1	10.4	10.8	10.7	10.7	
13	Fargana	8.4	8.4	8.1	8.1	8.1	8.2	
14	Khorezm	2.3	2.3	2.3	2.3	2.4	2.4	
	Total	100.0	100.0	100.0	100.0	100.0	100.0	

Note: * 2014 is preliminary value.
Source: Uzbekenergo JSC



Note: 2014 is preliminary value.
Source: Prepared by JICA Study Team on the basis of data provided by Uzbekenergo JSC.

Figure 3.1.2-6 Electricity consumption by province in 2014

1) Power Demand Status of Tashkent Province

In 2014, electricity consumption of Tashkent Province reached 6,736 GWh, a 4.5 % increase from the previous year. Electricity consumption in Tashkent Province increased at an average annual rate of 1.0 % from 2009 to 2014. Industry sector is the largest consumer of electricity in the province, consuming more than 70 % of the total electricity consumption. Tashkent province has undergone industrialization since ancient times, and it is the most concentrated industrial area in Uzbekistan. The electricity consumption of the industry sector has increased at an average annual rate of 1.3 %, leading the power demand in the province. Agriculture sector is also one of the major industries in the province, especially the production of cotton by irrigation. Electric power is consumed to operate the water pump for irrigation. Electricity consumption of agricultural sector in recent years has remained stable at 3.2– 3.7 %of the total electricity consumption in the province.

On the other hand, electricity consumption in residential sector slightly decreased at an average annual rate of 0.3 % from 2009 to 2014. The share of residential sector dropped by 1.6 points from 2009 and became 23.4 % of the total consumption in 2014. Due to the expansion of the adjacent Tashkent City, part of the demand is considered likely to have moved from Tashkent Province to the urban area.

Table 3.1.2-3 Electricity consumption of Tashkent Province by sector (2009–2014)

	2009	2010	2011	2012	2013	2014	CAGR (%)
Final Electricity Consumption (GWh)							2014/2010
Industry	4,548.5	4,257.0	4,348.0	4,517.1	4,612.0	4,860.1	1.3
Construction	1.1	1.2	0.3	0.2	2.0	2.1	13.4
Transportation	55.6	52.1	65.1	72.1	77.7	81.8	8.0
Agriculture	206.0	219.2	238.6	226.4	217.1	213.5	0.7
Residential	1,601.8	1,732.8	1,852.3	1,738.7	1,538.2	1,578.8	-0.3
Total	6,413.0	6,262.3	6,504.3	6,554.5	6,447.0	6,736.4	1.0
Share by Sector (%)							
Industry	70.9	68.0	66.8	68.9	71.5	72.1	
Construction	0.02	0.02	0.005	0.003	0.03	0.03	
Transportation	0.9	0.8	1.0	1.1	1.2	1.2	
Agriculture	3.2	3.5	3.7	3.5	3.4	3.2	
Residential	25.0	27.7	28.5	26.5	23.9	23.4	
Total	100.0	100.0	100.0	100.0	100.0	100.0	

Note: 2014 is preliminary value.
Source: Uzbekenergo JSC

2) Power Demand Status of Tashkent City

The electricity consumption of Tashkent city increased at an average annual rate of 2.5 % from 2009 to 2014andreached 4,608 GWh in 2014. The residential sector (including commercial and service sectors) is the largest consumer on electricity in the city. The residential sector consumed 3,120 GWh of electricity in 2014 or 67.7 % of total electricity consumption. The industry sector consumed 1,199 GWh in the same year, about 26.0 % of total electricity consumption. The industry sector's electricity consumption decreased from 1990s until 2010, but started to grow in 2011. The electricity consumption increased at an average annual rate of 3.7 % from 2009 to 2014.

Table 3.1.2-4 Electricity consumption of Tashkent City by sector (2009–2014)

	2009	2010	2011	2012	2013	2014	CAGR (%)
Final Electricity Consumption (GWh)							2014/2010
Industry	999.2	884.9	943.0	1,028.8	1,197.4	1,199.2	3.7
Construction	56.5	55.6	58.1	67.3	65.4	89.1	9.5
Transportation	157.6	180.4	184.3	183.0	184.9	193.2	4.2
Agriculture	7.2	9.2	7.8	8.5	5.7	5.9	-3.8
Residential	2,852.9	2,843.1	3,022.3	3,129.8	3,018.5	3,120.4	1.8
Total	4,073.4	3,973.2	4,215.5	4,417.4	4,471.9	4,607.9	2.5
Share by Sector (%)							
Industry	24.5	22.3	22.4	23.3	26.8	26.0	
Construction	1.4	1.4	1.4	1.5	1.5	1.9	
Transportation	3.9	4.5	4.4	4.1	4.1	4.2	
Agriculture	0.2	0.2	0.2	0.2	0.1	0.1	
Residential	70.0	71.6	71.7	70.9	67.5	67.7	
Total	100.0	100.0	100.0	100.0	100.0	100.0	

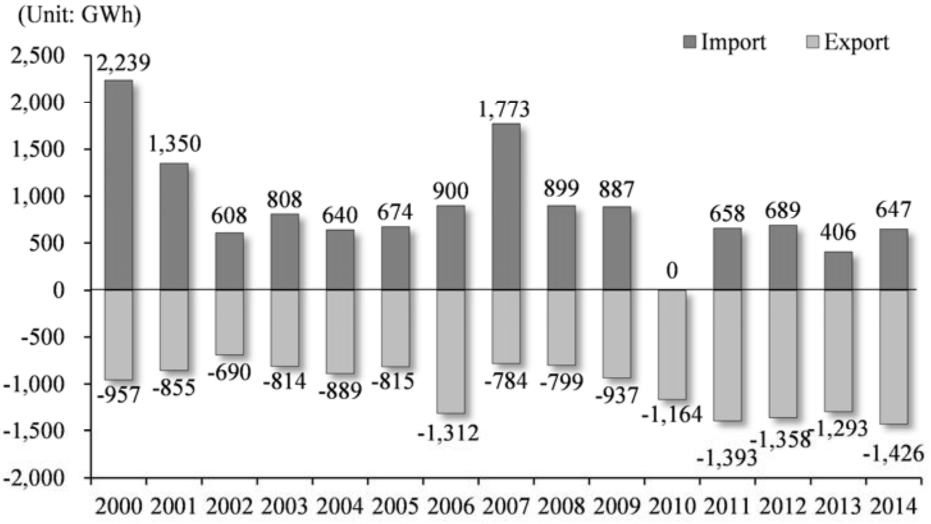
Note: 2014 is preliminary value.
Source: Uzbekenergo JSC

(4) Electricity Import and Export

Uzbekistan's power transmission network is designed and constructed as a part of the power supply system connecting five countries in the Central Asia during the Soviet era. Uzbekistan is located in the middle of the Central Asian region, and it is connected to the power grid of the five neighboring countries. Currently, only Kazakhstan, Republic of Kyrgyzstan, and Afghanistan are connected grid and have electricity trade.

Uzbekistan had mutual power interchange with Tajikistan, and it imported about 500 GWh electricity during the summer, and the same amount of power was exported to Tajikistan during the winter until 2010. But this mutual power interchange between the two countries stopped in 2011 because of the boosting power generation capacity in Tajikistan. On the other hand, Uzbekistan started to export 59.4 GWh power to Afghanistan in 2002. Electricity export to Afghanistan is increasing, and it reached 1,425 GWh in 2014. Afghanistan has been the only export destination for Uzbekistan since May 2011.

Uzbekenergo JSC has signed a contract to import 500 GWh electricity power per year from Republic of Kyrgyzstan. This amount of power is supplied to the Fergana region which faces supply shortage during the winter. According to Uzbekenergo JSC, the purchase price of the agreement is 3.38 US cents / kWh (approximately 2.6 Yen / kWh[3]).[4]



Source: Uzbekenergo JSC

Figure 3.1.2-7 Electricity import and export trend (2000–2014)

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[3] Exchange rate on 22 November 2011, average price (TTM):1 USD = 77 Yen.

[4] http://www.timesca.com/news/6597-uzbekistan-to-import-electricity-from-kyrgyzstan, accessed on 15 April 2015.

3.1.3 Brief Description of Existing Generating Facilities

(1) Thermal power plants and heating plants

a. Brief description of thermal power plants and heating plants

The installed capacity of power plants of Uzbekistan is 12,468 MW, of which 85 % is occupied by thermal power stations, 14 % by hydroelectric power stations, and the remainder by the solar power plant in Samarkand.

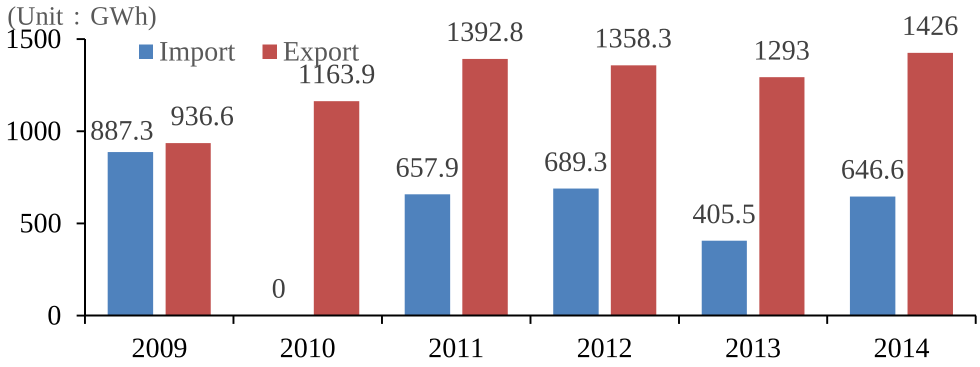
According to Uzbekenergo JSC, the main fuel of the thermal power plants (TPP) is natural gas (80 %), but coal (20 %) is also used. At most of the power plants the co-firing of fuel oil is foreseen, as the reserve fuel type, in case of, for instance, examining the gas supply equipment. Also, coal-fired power plants often use fuel oil as reserve fuel.

Most of the thermal power plants of Uzbekistan were built in 1950–1970, in the Soviet period 40–60 years ago, and are obsolete. Amid a peak demand for electricity reaching 8,000 MW, the real ability power supply has stopped at 8,200 MW, in view of the planned stops during periodic inspections, and virtually there are no spare capacities.

Moreover, the majority of equipment is becoming more obsolescent, except for relatively new gas turbine combined-cycle[5] of Navoi TPP, GTCC of Talimardjan thermal power plant, gas turbine Cogeneration System[6] of TashTC. As shown in Tables 3.1.3-1, the efficiency of the gas thermal power plants is even lower than that of during 1990–1994 when combined-cycle plants were practically not introduced. This all suggests the need for planned development and renovation of power stations.

Mutual power interchange with Kazakhstan, Kyrgyzstan and Afghanistan is carried out in Uzbekistan for electricity shortages recovery and stabilizing the power grid. The energy exchange with Turkmenistan and Tajikistan has been discontinued.

Over the past five years (2009–2013) the average import volume totaled 528 GWh, and the average volume of exports amounted to 1,229 GWh. The condition of electric energy in 2009–2014 is shown in Figure 3.1.3-1.



Source: Uzbekenergo JSC

Figure 3.1.3-1 State of electricity exchange (2009–2014)

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[5] GTCC（Gas Turbine Combined Cycle）

[6] GTCS（Gas Turbine Cogeneration System）

Table 3.1.3-1 Uzbekenergo JSC Heating plants (including TC)

	No.	Year of entry into service	Boiler type	Turbine type	Installed capacity [MW]	The available capacity [MW]	EFFICIENCY-generating side (%)		Accumulated operational time (h)
							Station	Block	
Name of thermal power plant					11,096	8242			
Tashkent TPP	1	1,963	TGM-94	K-150-130	150	1665	30.3	29.5	314096
	2	1964	—	—	150			29.8	320688
	3	1965	—	—	150			30.0	304023
	4	1965	—	—	150			29.8	296129
	5	1966	TGM-94	K-150-130	150			30.1	257997
	6	1967	TGM-94	K-160-130	155			29.2	263034
	7	1967	TGM-94	K-165-130	165			30.3	257421
	8	1968	TGM-94	K-165-130	165			29.8	268120
	9	1969	TGM-94	K-150-130	150			29.8	271787
	10	1970	TGM-94	K-165-130	165			30.0	252255
	11	1970	TGM-94	K-110/150-130	155			31.5	271606
	12	1971	TGM-94	K-110/150-130	155			31.4	263899
TashTC	1	1954	TP-170	AP-25-2 (M)	30	49.5	85.6	86.2	459081
	2	2013	BKZ-160	H-25	27			67.2	9068
Angren TPP	1	1,957	TP-230-2	K-50-90-2	52.5	197	31.4	31.4	294179
	2	1958	TP-230-2	K-50-90-2	54.5			31.4	297527
	3	1958	TP-230-2	K-50-90-2	53			31.4	237469
	4	1958	TP-230-2	K-50-90-2	52			31.4	202032
	5	1960	TP-230-2	K-100-90-6	68			31.4	278491
	6	1961	TP-45	K-100-90-6	68			31.4	265305
	7	1962	TP-45	K-100-90-6	68			31.4	259291
	8	1,963	TP-45	K-100-90-6	68			31.4	158937
Novo-Angren TPP	1	1985	P-64-2	K-300-240-3	300	1320	29.5	29.2	132402
	2	1985	P-64-2	K-300-240-3	300			29.5	137764
	3	1986	P-64-2	K-300-240-3	300			28.8	115544
	4	1987	P-64-2	K-300-240-3	300			29.5	141083
	5	1988	P-64-3	K-300-240	300			29.8	132500
	6	1991	P-64-3	K-300-240	300			31.1	57438
	7	1995	P-64-3	K-300-240	300			30.6	94334
Navoi TPP	3	1964	TGM-94TKZ	PVK-150DTKZ	150			26.6	372519
	4	1965	TGM-94TKZ	PVK-150DTKZ	150			27.3	333787

	No.	Year of entry into service	Boiler type	Turbine type	Installed capacity [MW]	The available capacity [MW]			Accumulated operational time (h)
	8	1968	TGM-94TKZ	PVK-160-I0HTGZ	160	1300	33.5	27.2	349935
	9	1969	TGM-94TKZ	K-160-130HTGE	160			28.6	338898
	11	1980	TGME-206TKZ	K-210-130LMZ	210			24.4	250355
	12	1981	TGME-206TKZ	K-210-130LMZ	210			25.1	240816
	1	1,963	TGM-151	-	25			16.7	No data
	2	1,963	TGM-151	VPT-24-4	25			16.7	366987
	5	1966	TGM-84	P-50-130/13	50			33.4	364817
	6	1967	TGM-84	-	60			33.4	No data
	7	1971	TGM-84	P-50-130/21	50			33.4	337137
	PGU-1	2012	TSF-40	M701F4	450			52.1	15314
Syrdarya TPP	1	1972	TGMP-114 (C)	K-300-2	300	2020	33.7	33.0	267120
	2	1973	TGMP-114 (C)	K-300-2	300			32.7	266422
	3	1974	TGMP-114 (C)	K-300-2	300			33.3	275022
	4	1975	TGMP-114 (C)	K-300-2	300			34.3	267864
	5	1976	TGMP-114 (C)	K-300-2	300			33.6	164469
	6	1977	TGMP-114 (C)	K-300-2	300			33.7	240097
	7	1978	TGMP-114 (C)	K-300-2	300			35.7	221879
	8	1979	TGMP-114 (C)	K-300-2	300			34.9	235201
	9	1980	TGMP-114 (C)	K-300-2	300			33.4	236214
	10	1981	TGMP-114 (C)	K-300-2	300			32.4	241317
Takhiatash TPP	1	1967	TGM-151	K-100-90-6	100	540	26.8	22.3	297416
	2	1968	TGM-151	K-100-90-6	100			22.3	237277
	3	1974	TGM-151B	K-110-90-7	110			22.3	355794
	7	1987	TGME-206	K-210-130	210			28.4	171136
	8	1990	TGME-206	K-210-130	210			29.1	178165
FerganaTC	1	1956	TP-170	VPT-25-ZM	25	250	57.0	No data	299183
	7	1979	TGM-84	VPT-50-2	55			17.6	288985
	3	1961	BKZ-160	PT-60-130/13	60			No data	254535
	4	1966	TGM-84	R-50-130/13	60			No data	270908
	5	1967	TGM-84	P-100-130/15	50			15.2	119703
	6	1977	TGM-84	P-100-130/15	55			16.2	105995
Mubarek TC	1	1984	TGME-464	R-50-130	30	120	77.9	44.2	136292
	2	1985	TGME-464	R-50-130	30			48.0	139135
Talimardjan TPP	1	2004	TGP-805/SZ	K-800-240-5	800	780	37.8	37.8	73336

Source: Uzbekenergo JSC

※2013 year data are not available for the empty columns of “Efficiency-generating side”

Table 3.1.3-2 Efficiency of gas thermal power plants

Efficiency of generating side[*] (%)

	USA	Russia	Japan
1990	36.60	34.40	43.20
1991	34.70	30.80	43.40
1992	34.70	31.20	43.40
1993	35.80	32.70	43.10
1994	36.30	30.40	43.50

*It is based on calculation of low calorific value

Source: RITE

b. Description of equipment of power stations

Power plants of Uzbekistan are located as shown in Figure 3.1.3-2. These locations have been developed in accordance with the requirements of power sources in 1970–1980, in the Soviet period, and it does not reflect the current needs. Because of this, most power plants are concentrated in Tashkent region to transmit power to Fergana Valley, which has a large demand for electricity which usually occurs at large distances.

Below is the location of power plants.

Source: Uzbekenergo JSC

※It is planned to build a Turakurgan TPP, New Syrdarya TPP, Syrdarya TPP.

Figure 3.1.3-2 Generating capacities of the Republic of Uzbekistan

- Syrdarya Thermal Power Plant
  - ✓ Ten (10) power generating units were built at Syrdarya TPP in 1972–1981, each generating 300 MW, giving the plant a total capacity of 3,000 MW.
  - ✓ The main fuel for all units is natural gas, reserve fuel is fuel oil.
  - ✓ Useful power of the equipment is 2,020 MW, and one unit is planned to be replaced with the latest installation.
  - ✓ In order to increase the efficiency of the modernization of outdated generating capacities, stabilization for the long period of electric energy transmission and efficiency increase, the Government of the Republic of Uzbekistan applied for the yen loan in July 2004 for engineering services designed for preparation of feasibility study, detailed design and preparation of documents related to social and environmental aspects for introduction of combined-cycle plants (450 MW x 2) at Syrdarya TPP.
  - ✓ Equipment utilization ratio:

2009	75.0 %
2010	73.2 %
2011	69.5 %
2012	73.9 %
2013	71.7 %
2014	68.8 %

- Novo-Angren Thermal Power Plant
  - ✓ Novo-Angren TPP was built in 1985-1995, and it is a relatively new plant. The total capacity is 2,100 MW and ranks second among the power plants of Uzbekistan. 7 units were built, each with 300 MW capacity.
  - ✓ The main fuel for units Nos. 1-5 is Angren coal (brown coal) and natural gas from Bukhara deposit, and the main fuel for unit 6 and unit 7 is natural gas of Bukhara deposit. Reserve fuel for all units is fuel oil. Also, there is a plan to change the fuel of unit No. 6 and No. 7 to the burning of coal in the future.
  - ✓ Useful power of the plant is 1,320 MW.
  - ✓ Equipment utilization ratio:

2009	68.1 %
2010	67.8 %
2011	66.3 %
2012	66.1 %
2013	62.1 %
2014	62.1 %

- Tashkent Thermal Power Plant
  - ✓ Tashkent TPP was built in 1963-1971 and is obsolete. There are 12 power generating units; however, only 10 with a total capacity of 1,860 MW are operational.
  - ✓ The main fuel for all units is natural gas; the reserve fuel is fuel oil.
  - ✓ Useful power of the plant is 1,665 MW.
  - ✓ Equipment utilization ratio:

2009	74.6 %
2010	74.3 %
2011	74.1 %
2012	71.3 %
2013	74.3 %
2014	74.2 %

- Navoi Thermal Power Plant
  - ✓ Navoi TPP is a cogeneration plant of modern combined-cycle plants of M701F type produced by MHPS; however, the remaining power generating units were built in the 60s. The total capacity of the plant is 3,000 MW, and heat and electricity is supplied to Navoi, Bukhara and Samarkand.
  - ✓ The main fuel for all units is natural gas; the reserve fuel is fuel oil.
  - ✓ Useful power of the plant is 1,300 MW.
  - ✓ In August 2013 the Government of Uzbekistan and the Government of Japan signed exchange notes regarding granting a yen loan amounting to 34 billion 877 million yens for the modernization project of Navoi Thermal Power Plant. The aim of this project is to increase the efficiency and reliability of heat and electricity supply, develop the economy and reduce the cost of natural gas in the long-term, contribute to reducing CO^2 emissions through the introduction of combined cycle power plants to replace obsolete equipment.
  - ✓ Equipment utilization ratio:

2009	81.2 %
2010	80.9 %
2011	80.5 %
2012	71.6 %
2013	74.3 %
2014	76.2 %

- Takhiatash Thermal Power Plant
  - ✓ Takhiatash TPP is situated in the Northwest of the Republic of Uzbekistan and supplies electricity to the Republic of Karakalpakstan and Khorezm Region. The new equipment was built in 1990, but most of the equipment was put into operation in 1960–1970, and it was already obsolete. The total power capacity of the equipment is 3,000 MW.
  - ✓ The main fuel for all units is natural gas; the reserve fuel is fuel oil (grade M-40) from Ferghana Oil Refinery Plant and Bukhara Oil Refinery Plant.
  - ✓ Useful power of the plant is 540 MW.
  - ✓ Equipment utilization ratio:

2009	68.8 %
2010	69.9 %
2011	69.9 %
2012	67.7 %
2013	69.2 %
2014	68.9 %

- Angren Thermal Power Plant
  - ✓ Most of the Angren TPP equipment was built in 1957–1963, and is obsolete. The station supplies heat and electricity to the town of Angren. Angren TPP heat supply is determined by Angren town needs, and the total plant capacity is 484 MW.
  - ✓ The main fuel for all units is Angren coal (lignite), natural gas and gas of underground gasification; the reserve fuel is oil fuel.
  - ✓ Net power is 197 MW.
  - ✓ Equipment utilization ratio:

2009	58.2 %
2010	57.1 %
2011	59.9 %
2012	55.2 %
2013	61.3 %
2014	56.3 %

- Mubarek TC
  - ✓ Mubarek TC is a relatively new plant in Uzbekistan which supplies steam to Mubarek gas processing plant. The total power capacity of the plant is 120 MW.
  - ✓ Load of Mubarek TPP is determined by steam consumption volumes by Mubarek gas processing plant. The amount of steam is 250–420 t/h.
  - ✓ Equipment utilization ratio:

2009	54.8 %
2010	55.2 %
2011	55.5 %
2012	46.3 %
2013	45.8 %
2014	60.1 %

- Ferghana TC
  - ✓ Ferghana TC was built to provide heat and electricity to nearby factories. The produced steam is consumed by “Ferghana Azot and Ferghana Oil Refinery plants, and others”. A large part of the capacity of the plants is for heat production. The equipment, which was built in 1950-1980, is badly outdated. The total capacity is 305 MW, of which 250 MW is net power.
  - ✓ The main fuel for all units is natural gas; the reserve fuel is fuel oil.
  - ✓ Equipment utilization ratio:

2009	68.8%
2010	70.0%
2011	69.5%
2012	50.7%
2013	68.1%
2014	52.1%

- Tashkent TC
  - ✓ A gas turbine unit of H-25 produced by MHPS was introduced at Tashkent TC in 2013 under NEDO project; the remaining part of the plant was built in 1930–1950, and is badly outdated. The total capacity is 57 MW.
  - ✓ The main fuel for all units is natural gas; the reserve fuel is fuel oil.
  - ✓ Usable capacity is 49.5 MW; power output is determined by the needs of districts.
  - ✓ Equipment utilization ratio:

2009	75.0 %
2010	73.2 %
2011	69.5 %
2012	73.9 %
2013	71.7 %
2014	68.8 %

- Talimardjan Thermal Power Plant
  - ✓ Talimardjan TPP is located in the south of Uzbekistan, and it is the newest power station, which was put into operation in 2004. The rated power of the plant is 800 MW.
  - ✓ On May 1, 2010, the Japanese International Cooperation Agency (JICA) signed an agreement on granting a loan in yens amounting to 27 billion 427 million yens for the project of Talimardjan TPP expansion. This project, which will be implemented for the first time in Central Asia according to the scheme of the accelerated co-financing together with the Asian Development Bank (ADB), is planned to build two combined-cycle plants of 450 MW by 2017.
  - ✓ The primary type of fuel is natural gas.
  - ✓ Net power is 780 MW.
  - ✓ Equipment utilization ratio:

2009	88.9 %
2010	90.3 %
2011	89.1 %
2012	90.5 %
2013	89.8 %
2014	93.6 %

(2) Hydropower plants and electric power plants on renewable power source

Hydro power plants of Uzbekenergo JSC are listed below. As most HPS are derivative due to the use of water for irrigation during summer, utilization ratio is low. Uzbekenergo JSC plans to construct new HPP of 1,046 MW, as well as reconstruction of existing HPP, before 2030, and the total increase in power will be 1,152 MW.

Table 3.1.3-3 Hydropower plants of Uzbekenergo JSC

	HPP name	Plant type	Installed capacity (MW)	Year of entry into service	Efficiency (%)
1	Urta-Chirchik HPP	Damb	920.5	1970 - 1980	38.0
2	Chirchik HPP	Derivative	190.7	1941 - 1943	63.0
3	Kadyrin HPP	Derivative	44.6	1933 - 1946	81.3
4	Tashkent HPP	Derivative	29.0	1926 - 1954	47.0
5	Nijne-Bozsu HPP	Derivative	50.9	1943 - 1960	34.0
6	Farkhad HPP	Derivative	126.0	1943 - 1948	33.0
7	Ferghana HPP	Derivative	40.1	1945 - 1962	7.3
8	Samarkand HPP	Derivative	27.9	1943 - 1965	6.0
	Total		1429.7		

Source: Uzbekenergo JSC

3.1.4 Review of Existing Electricity Network Facilities

(1) Facilities of electricity system used in Uzbekistan

In Uzbekistan voltage of 500 kV and 220 kV is used in main power transmission lines, and electricity distribution is carried out with voltages of 110 kV, 35 kV, 10 kV, 6 kV and 0.4 kV. Voltage classes and stretch of electric grids for each class are presented in Table 3.1.4-1.

Table 3.1.4-1 Voltage classes and stretch of electric grids for each voltage class in Uzbekistan

Voltage class	500 kV	220 kV	110 kV	35 kV	10-6 kV	0.4 kV
OL	2, 257 km[1]	6, 076 km	17, 308 km	13, 025 km	87, 880 km	104, 006 km
Underground cable lines			-[2]	280 km	7, 040 km	3, 504 km

Source: Uzbekenergo JSC, Uzelectroset UE

Note 1:Data for grids of 500 kV and 220 kV have been obtained from Uzelectroset UE. A more detailed breakdown is unknown.

Note 2:According to the information of Uzbekenergo JSC, Tash Gor PES JSC and Sredazenergosetproekt JSC, subsurface lines are currently being used at 3 sites within Tashkent and at some sites of regional cities (towns).

The electrical grids in Uzbekistan are joined together by two or more substations. Large-scale power outages have not happened for the past 10 years. However, due to the fact that much of the equipment is outdated equipment installed during the Soviet Union, from 1940 to the 70s, problems related to interruptions in electricity transmission and increased maintenance costs occur. Urgent action is needed to replace and improve the reliability of the existing equipment.

In Uzbekistan, networks with voltage above 110 kV usually use overhead lines. Examples of used metal and concrete transmission line towers are presented in Tables 3.1.4-2 (1)–3.1.4-2 (4). In Uzbekistan, networks with voltage of 110 kV sometimes use concrete posts.

Table 3.1.4-2(1) Metal transmission line towers (110 kV)

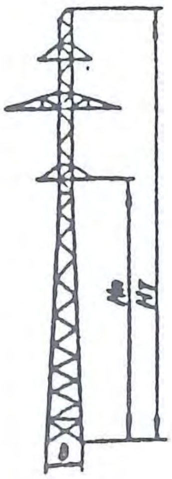
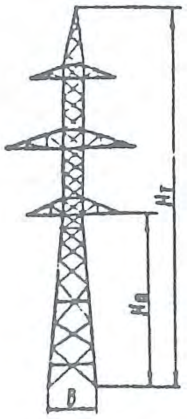
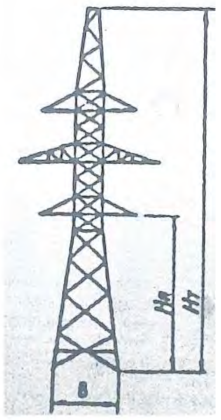
Name	Straight tower	Anchor angle tower (1)	Anchor angle tower (2)
Drawing			
Height (H)	H_T: 31.0 m H_L: 19.0 m	H_T: 23.0 m H_L: 10.5 m	H_T: 24.7 m H_L: 10.5 m
Base width (B)	2.5 m	2.8 m	4.8 m
Maximum wind load	29 m/s	29 m/s	29 m/s
Wires	AS-70/11–AS-95/15	AS-120/19	AS-70/11–AS-240/32
Angle	-	0°-60°	0°-60°
Mass	2.74 tons	4.65 tons	7.79 tons

Table 3.1.4-2(2) Concrete transmission line towers (110 kV)

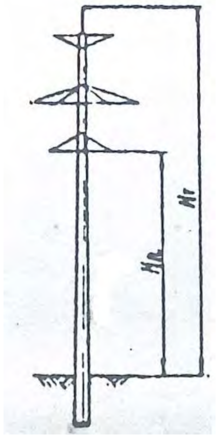
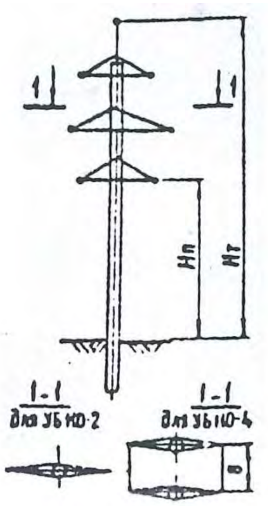
Name	Concrete straight tower	Concrete anchor angle tower
Drawing		
Height (H)	H_T: 22.2 m H_L: 13.5 m	H_T: 19.0 m H_L: 9.5 m
Maximum wind load	29 m/s	29 m/s
Wires	AS-70/11–AS-120/19	AS-70/11–AS-240/32
Angle	-	0°～38°
Mass	0.52 tons	0.89 tons

Table 3.1.4-2(3) Metal transmission line towers (220 kV)

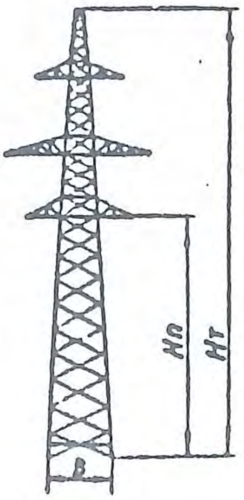
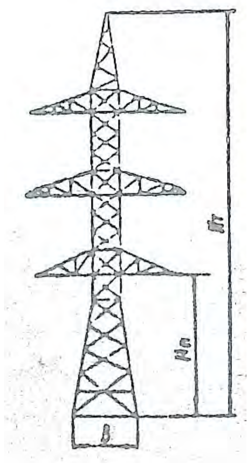
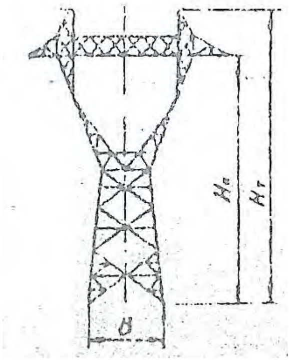
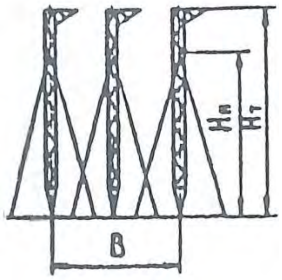
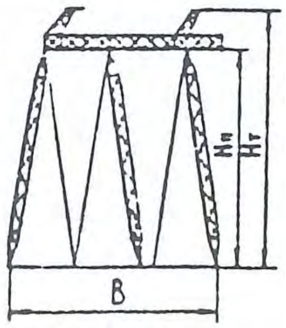
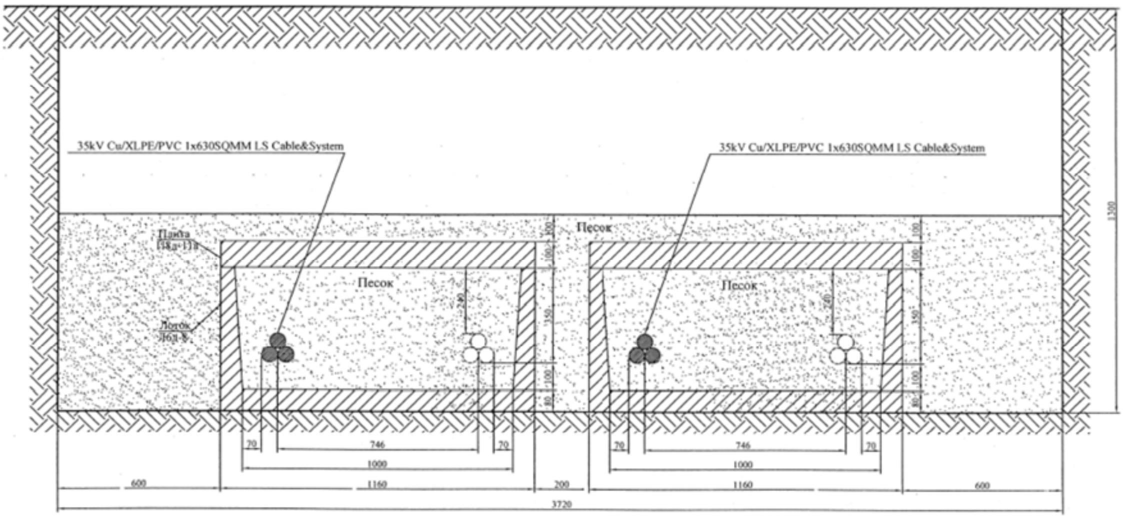
Name	Straight tower	Anchor angle tower
Drawing		
Height (H)	H_T: 41.0 m H_L: 22.5 m	H_T: 31.6 m H_L: 10.5 m
Base width (B)	5.4 m	5.2 m
Maximum wind load	29 m/s	29 m/s
Wires	AS-300/39	AS-300/39
Angle	-	0°–60°
Mass	6.21 tons	14.4 tons

Table 3.1.4-2(4) Metal transmission line towers (500 kV)

Name	Straight tower	Anchor angle tower	Angle tower
Drawing			
Height (H)	H_T:38 m H_L:32 m	H_T: 27.2 m H_L: 22.0 m	H_T: 32.0 m H_L: 27.0 m
Base width (B)	9.05 m	28 m	37.9 m
Maximum Wind load	35 m/s	35 m/s	35 m/s
Wires	3xASO-400, 3xASO-500	3xASO-400, 3xASO-500	3xASO-400, 3xASO-500
Angle	0°	0°-60°	5°-20°
Mass	13.90 tons	15.18 tons	13.274 tons

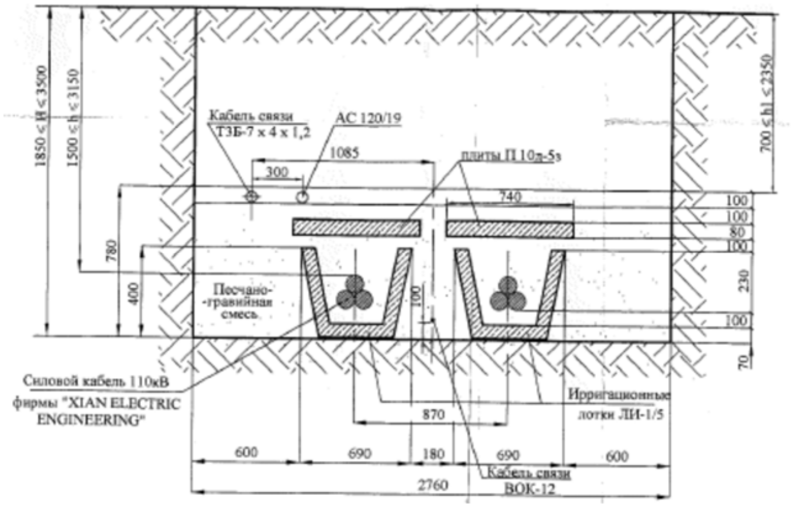
For overhead transmission lines, steel-aluminum wires of grade AS[7]are mostly used. In addition, wires of grades ASO[8] and ASU[9]are also used. Wire strength increases in the following order: AS → ASO → ASU. In particular, wires of grade ASU are used in conditions of deserts and other areas where it is difficult to perform maintenance. In Tashkent, the grids with voltage of 110 kV, 220 kV and 500 kV, sometimes use one-phase two-conductor power transmission lines with conductors section from 95 mm^2 to 500 mm^2.

Underground cable lines are used in Tashkent and some cities (towns) in different regions of the country. The maximum voltage of the underground cable lines is 110 kV. For gaskets both oil-filled cables and cables with xlpe insulation are used. In Uzbekistan, underground cable lines with voltage of 110 kV are laid in trays and filled with sand. Underground cabling without trays or in trays without backfill sand is applied in case of cable lines with voltage of up to 10 kV. Cabling examples are presented in Figure 3.1.4-1 and 3.1.4-2.



Source: Sredazenergosetproekt JSC

Figure 3.1.4-1 Example of laying underground cable of voltage 35 kV



Source: Sredazenergosetproekt JSC

Figure 3.1.4-2 Example of laying underground cable of voltage 35 kV

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[7]Steel-Aluminum(AS) Wire in English.

[8]Steel-Aluminum Lightweight structure(ASO) Wire in English.

[9]Steel-Aluminum Reinforced structure(ASU) Wire in English.

According to Tash Gor PES JSC which manages electric facilities in grids up to 110 kV in Tashkent, only Tash Gor PES JSC makes the round and examination of underground cable lines, and it is planned to involve foreign companies when any problems are detected to perform repair works. However, since the cables laying up to now no problems have been encountered.

(2) Regulatory documents regarding electricity grid facilities

Planning, design, construction and operation of electricity grid facilities are carried out in accordance with the following documents and relevant regulations of the Cabinet of Ministers.

- Handbook for designing of electrical grids (SPES)[10] (ed. 2012).

  The content of the handbook includes the following:

  Information on electrical grids of the Russian Federation and other countries; the modern level of electricity consumption and loads (Russia); transmission power lines; electrical grid diagrams; electrical equipment; design of electrical grids; approximate costs, etc.
- Rules for electric installations (PUE[11]), ed. 2007.

  The content of the handbook includes the following:

  Protection of electrical grids; electric grids design (wire types, design conditions, laying methods, etc.); conditions of installation for distribution and transformer equipment; equipment standards, etc.
- Rules of technical operation of power plants and grids (PTE)[12] (ed. 1989).

  The content of the handbook includes the following:

  Rules of technical operation of main equipment, including methods for periodic and daily technical inspection, operational documentation storage rules, rules for firefighting measures, operation rules, environmental standards and norms, etc.

  Standards for power plants: equipment, necessary for the implementation of the operation and maintenance (access roads; lightning protection; signs indicating the location of underground utilities, etc.), measures for the protection of the environment (measures to reduce air emissions, wastewater discharges, noise), maintenance of buildings and equipment standards (inspection of premises, etc.).

  Rules for operation and maintenance of hydroelectric power plants, thermal power plants and electrical equipment.

Classes of voltage and frequency in electric grids of Uzbekistan are presented in Table 3.1.4-3.

Table 3.1.4-3 Parameters of electric condition in Uzbekistan

Name	**Voltage classes**		
Rated voltage	500 kV	220 kV	110 kV
Maximum voltage	525 kV	252 kV	126 kV
Frequency	50 Hz（±0.2 Hz）[1]		

Source:Rules for electric installations, Tash Gor PES JSC.

Note 1:Allowed short-term deviations to ±0.4 GHz.

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[10] SPES: *Spravochnik po Proyektirovaniyu Elektricheskikh Setey* [Handbook for designing of electrical grids] in Russian.

[11] PUE: *Pravila Ustroystva Elektroustanovok* [Rules for electric installations]in Russian.

[12] PTE: *Pravila Tekhnicheskoy Ekspluatatsii Elektricheskikh Stantsiy i Setey* [Rules of technical operation of power plants and grids]in Russian.

As can be seen from the table below, Uzbekistan provides great security zone along the high voltage lines, within which there must be no residential houses. However, this does not apply to facilities such as orchards, fields, garages. In the case of highways and railways the following rules (see Table 3.1.4-4) shall be followed. Through the adoption of measures such as erecting high walls between private houses and power lines, the norms of safety distances can be mitigated within the city of Tashkent in exceptional cases.

Rules of safe distances from high voltage lines are shown in Table 3.1.4-4.

Table 3.1.4-4 Standards for safe distances from high voltage lines

Name	500 kV	220 kV	110 kV	35 kV
(1) Height of power transmission line wires				
Usual places [m]	8	8	7	7
Highways [m]	9	8	7	7
Railways [m]	-	6.5	6	-
Waterways [m]	8	7	6	-
(2) Protection zone (distance from extreme wires)	30	25	20	15
(3) Safe distance from wires to residential houses [m]	-	5	4	3
(4) Safe distance from lines of 500 kV voltage [m]	15	7	5	-
(5) Safe distance from power transmission line towers to the central road line [m]	10	5	5	-
(6) Safe distance from power transmission line towers to railways [m]	9.5	8.5	7.5	7.5

Source: Rules for electrical installations, Decree No. 93 of the Cabinet of Ministers of the Republic of Uzbekistan dated May 17, 2010 on Approval of Rules for Electric Facilities Protection.

According to Sredazenergosetproekt JSC which deals with design of electric grids, special attention is paid to the points shown in Table 3.1.4-5 when laying underground cable lines. Designing is done on the basis of the standards established in the above-mentioned regulatory documents, taking into account local conditions[13].

Table 3.1.4-5 Items requiring attention when laying subsurface cable lines (from 110 kV and above)

Items needing attention	Source
(1) Lay the cables in concrete trays, and trays shall be filled with sand. The thickness of a layer of sand under the cable should be about 100 mm (except cables with voltages up to 35 kV).	At the discretion of Sredazenergosetproekt JSC
(2) Cables depth: cables must be laid at a depth of not less than 1.5 m from the ground surface (1 m in case of cable voltage 35 kV).	PUE standard
(3) The distance between the cable lines should be at least 500 mm (250 mm for 35 kV lines, 100 mm for 10 kV lines).	PUE standard
(4) Stacking each cable line in a separate tray is desirable (to protect the other cables in the event of an accident).	At the discretion of Sredazenergosetproekt JSC
(5) The distance between the cable and the wall of the tray, the distance between the trays, as well as the distance between the tray and the slope of the excavation shall be established taking into account the produced construction works.	At the discretion of Sredazenergosetproekt JSC

When choosing a route for laying underground cable line, it is necessary to clarify the existing scheme of underground utilities of the area proposed for laying the cable line with UzGASHKLITI SUE, which manages underground utilities data nationwide. After concluding a contract with UzGASHKLITI SUE,

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[13] As you can see from the sources listed in table 3.1.4-5, REI standards are commonly used. In the absence of relevant guidelines in the REI, Sredazenergosetproekt JSC sometimes independently makes decisions on design standards.

first a survey of underground utilities is conducted based on the existing diagrams and maps, and then a survey is conducted along the planned laying route at an interval5 meters using subsurface utilities detectors. Usually the design of subsurface cable lines is conducted by Sredazenergosetproekt JSC; therefore, UzGASHKLITI SUE and Sredazenergosetproekt JSC together determine the route taking into account the existing subsurface utilities.

In case underground cable line has to cross railways, it is necessary to address the issue to State Railway Company(UTY, for its Russian acronym, *Uzbekiston Temir Yollari*) and obtain the approval. According to the information of the State Railway Company, it is impossible to lay a cable line directly under the railway tracks. However, laying cables in parallel to backfilling slopes of railway tracks is allowed provided that the soil has sufficient bearing capacity.

(3) Operational conditions of existing electricity network facilities

Information on current state of electric grid facilities in grids 500 kV and 220 kV (including 110 kV substation system) was clarified with Uzelectroset UE.

According to information received from Uzelectroset UE, repairs and replacements are made as and when problems arise with equipment, taking into account the potential budget, and when the wear of the equipment increases. Except for the wear and tear of grid facilities, there are currently no technological problems that require urgent solutions.

① Wear and tear

- A large part of transformer equipment was produced in the Soviet times and has already served for 30–40 years. There are also oil circuit breakers(OCB with lifespan of about 50 years.

② Problems in the field of maintenance

- Old equipment, for which it is difficult to get spare parts, is used. Replacement parts have to be produced locally.
  In the event of a breakdown of the oil circuit breaker, it is not repaired but replaced with gas circuit breaker (GCB).

③ Technical inspection plan

- Technical inspection of equipment is carried out periodically in accordance with the rules of technical operation of power plants and grids, which set standards for maintenance of electrical equipment.

④ Repair plan and replacement of equipment

- Due to the presence of a large number of old equipment that requires development of plan for its repair and replacement, Sredazenergosetproekt is attracted additionally. However, due to the limited budget the works do not always run according to the plan, resulting in a situation where it is required to perform an emergency repair at occurrence of malfunctions.
- Selection of old equipment to be replaced is carried out on the basis of competitive bidding. Chinese-made equipment often becomes a winner in the competitive biddings.
  The most important condition for the admission to biddings is compatibility with the existing equipment.

⑤ Transformers replacement

- The lifespan of the transformers is 25 years. However, many transformers have been served for 30–35 years. Normally, the transformers continue to be used until they come into disrepair.

⑥ Types of switches

- Among the switches for voltages of 110 kV and above, air circuit breaker (ACB) make up a significant portion, with the lifespan over 30 years.
- Retiring switches are replaced by GCB (one of the main suppliers of GCB-Siemens).

⑦ Gas Insulated Switchgear (GIS)

- Since there are no completed projects on site, we can say that the experience is missing.

3.1.5 Power and Transmission Network Development Plan

3.1.5.1 Power Development Plan

(1) Power plants construction plan

The Uzbekenergo JSC power plants construction projection shown in Table 3.1.5.1-1 are based on the terms of the Republic of Uzbekistan President’s DecreeNo.PP-1442" On the priorities of industrial development of Uzbekistan in 2011-2015" dated December 15, 2010 and No.PP-1668 "On investment program of Uzbekistan for 2013" dated November 27, 2012.Moreover, Table 3.1.5.1-1includesUnit 2 of Navoi TPP, Turakurgan TPP, Takhiatash TPP, which are included in Appendix No.2 to the DecreeNo.UP-4707of the President of the Republic of Uzbekistan "On the Program of measures to reduce energy consumption, introduction of energy saving technologies and systems in the fields of economy and social sphere in 2015-2019" dated March 4, 2015,as a part of investment program.

Table 3.1.5.1-1 Power plants construction projects

Facility	Power output (MW), Type	Start of operation	Source of financing
Syrdarya TPP	50 MW Steam TPP	2014	UFRD
Takhiatash TPP	370 MW GTCC	2015	UFRD, Uzbekenergo JSC’s own funds, local banks, foreign investors
TalimarjanTPP	900 MW GTCC (450 MW×2)	2016	UFRD, ADB, JICA, Uzbekenergo JSC’s own funds, public funds
Angren TPP	130-150 MWSteam TPP	2016	PRC’s loan for SCO member states, Uzbekenergo JSC’s own funds
Unit 2 of Navoi TPP	450 MW GTCC	2017	UFRD, JICA, Uzbekenergo JSC’s own funds, public funds
Turakurgan TPP	900 MW GTCC (450 MW×2)	2017	UFRD, JICA, Uzbekenergo JSC’s own funds, public funds
Takhiatash TPP	250 MW×2 units GTCC	2020	UFRD, JICA, Uzbekenergo JSC’s own funds, public funds

Source: Uzbekenergo JSC

Appendix No.1 to the UP-4707 identifies targets of industrial development of the republic in the 2015–2019, and AppendixNo.2 lists investment projects on modernization, technical and technological renewal of manufacture in Uzbekistan, starting in 2015–2019. While Appendix No.2 includes investment projects with already identified foreign capital, Appendix No.3 lists priority investment projects proposed for implementation with participation of foreign investments and loans. The Ministry of Foreign Economic

Relations, Investments and Trade (MFERIT), together with the Fund for Uzbekistan Reconstruction and Development (UFRD), private banks, all government agencies, large enterprises and others are entrusted to search for specific sources of foreign investment and potential partners for joint ventures on a systematic basis.

The table below shows the projects for development of power plants. The draft of a new thermal power plant, for which a feasibility study is underway, is listed under the No.22 as a potential project.

In addition to the development projects of power plants, 36 projects for the construction of the necessary infrastructure for the of power plants construction, the project of construction of a 220 kV "Takhiatash TPP - Substation Beruni" overhead power line, the project of construction of a 500 kV "Turakurgan TPP - Substation Lochin" overhead power line, and others, are also included into the priorities.

Table 3.1.5.1-2 The projects for development of power plants

(million US Dollars)

No.	Name of project initiator and project name	Planned capacity	Estimated cost of the project		Implementation period
			Total	Foreign capital (including loans)	
	Uzbekenergo JSC		5639.2	3139.8	
	Construction of new power plants		4690.8	2514.7	
17	"Tashkent HPP Cascade" unitary enterprise, construction of a new HPP-1	Increase of capacity of the HPP of 4 MW (from 2 MW to 6 MW)	28.6	20.0	2016 - 2018
19	construction of a TC, 2 GTCCs of 450 MW each in Syrdarya region	900 MW	910.0	500.0	2016-2018
20	Construction of a new GTCC at Ferghana TC	57,7 MW	80.0	50.0	2016-2018
21	Construction of the 3rd GTCC at Navoi TPP, 450 MW	450 MW	500.0	340.0	2019-2021
22	Tashkent TC, construction of 4 GTCSs of 27MW each	4×27 MW	167.3	100.0	2015-2017
23	Development of solar power plants (second stage) in Samarkand region	100 MW	210.0	100.0	2017-2019
24	Construction of "Kamolot" HPP	8 MW	12.1	8.2	2016-2017
25	Construction of 2 GTCCs of 450 MW each, Talimarjan TPP	900 MW	910.0	400.0	2018-2021
26	Construction of 2 GTCCs of 450 MW each, Turakurgan TPP	900 MW	910.0	400.0	2018-2021
27	Construction of GTCS -2 and GTCS -3 of 27 MW each, reconstruction and expansion of TashTETs	54 MW	100.0	65.0	2018-2020
28	Expansion of Angren TC, construction of thermal power plants burning high-ash coal, 130-150 MW (second stage)	130-150 MW	242.7	172.7	2019-2021
29	Construction of the solar power plant (100 MW) in the Surkhandarya region, Sherabad	100 MW	210.0	100.0	2019-2021
	Modernization and Reconstruction		948.4	625.0	
31	Modernization of Samarkand HPP (HPP -2B)	Increase of capacity of the HPP of 4.7 MW	54.9	37.0	2016-2018

No.	Name of project initiator and project name	Planned capacity	Estimated cost of the project		Implementation period
			Total	Foreign capital (including loans)	
		(from 21.9 MW to 26.6 MW)			
32	Modernization of Shakhrikhan HPP (HPP-FSA-1)	Increase of capacity of the HPP of 0.8 MW (from 1.5 MW to 2.3 MW)	17.0	12.0	2016-2018
33	Modernization of Chirchik HPP (HPP-10)	Increase of capacity of the HPP of 5 MW (from 24 MW to 29 MW)	41.4	30.8	2016-2018
35	Expansion of Mubarek TC, construction of GTCS, 140 MW	140 MW	140.0	100.0	2016-2019
36	Transfer of Unit 6 and 7 of Novo-Angren TC to coal; construction of the conveyor belt and the coal storage facility 2	The plant produces 74 mlrd. kw-h.	204.2	128.0	2018-2020

Source: Appendix No.3 to the Decree No.UP-4707 of the President of the Republic of Uzbekistan

As shown in Figure 3.1.3-2, power plants in the Republic of Uzbekistan are concentrated in the Tashkent region. High demand for electricity of the Ferghana Valley is covered by Ferghana TC and the Republic of Kyrgyzstan, via the united energy system, and central regions of Uzbekistan. In this regard, in order to reduce losses due to transmission of power over long distance, to increase security of supply, as well as to meet the demand of its own capacities, construction of several 450 MW GTCCs and decommissioning of obsolete equipment is planned until 2030in the concept of development of electric power industry of Uzbekistan.

The concept of development of electric power industry until 2030 by Uzbekenergo JSC, adopted in this situation, is reflected in Table 3.1.5.1-2.

Schedule for decommissioning of the existing equipment by Uzbekenergo JSC is displayed in Table 3.1.5.1-3. Firstly, development of power around Tashkent as the area with the highest demand for electricity is planned, together with the increase of reliability of power supply and the gradual decommissioning of capacities to improve the efficiency of power generation in the Tashkent region. A gradual introduction of efficient GTCCs and decommissioning of inefficient equipment in other regions is planned as well.

Table 3.1.5.1-3 The concept of development of electric power industry by Uzbekenergo JSC until 2030 (including reconstruction of the existing HPPs)

No.	Facility	Type	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	[MW]
1	Talimarjan TPP	GTCC		450	450				450	450							450	450	2700
2	Navoi TPP	GTCC			450				450										900
3	Syrdarya TPP	GTCC	50																50
4	Tashkent TPP	GTCC		370								450	450	450	450	450		450	3070
5	Angren TPP	GTCC		150					150										300
6	Novo-Angren TPP	GTCC										300							300
7	Takhiatash TPP	GTCC					250	250											500
8	Turakurgan TPP	GTCC			450	450			450	450									1800
9	New Syrdarya TPP	GTCC				450	450												900
10	Mubarek TC	GTCC					140												140
11	Ferghana TC	GTCC				57.7													57.7
12	Tashkent TC	GTCC						2×27											54
13	Tashkent TC	GTCC				4×27	←The project												108
	TPPs in total		50	970	1350	1065.7	840	304	1500	900	-	750	450	450	450	450	450	900	10879.7
	Total for 5 years		50	4529.7					3600					2700					
14	Reconstruction of the existing HPPs		45	17.3	6.9	8.7	11.8	2.4	10.8	2.1	1.3	0.4	0.3						107
			1 item	2items	3 items	4 items	3 items	3 items	2items	3 items	3 items	2 items	2 items						
	Total for 5 years		45	47.1					14.9										
15	«Kamolot» HPP				8														8
16	«Irgayliksay» HPP									13.6									15
17	Nijne-Koksuyskaya HPP										20								20
18	Nijne-Chatkalskaya HPP											100							100
19	Hodjikentskaya HPP												200						200
20	Mullakskaya HPP														240				240
21	Akbulakskaya HPP															60			60
22	Pskemskaya HPP																404		404
	New HPP in total			8					333.6					704					1045.6
	HPP in total		45	17.3	14.9	8.7	11.8	2.4	10.8	15.7	21.3	100.4	200.3	-	240	60	404	-	1152.6
	Total for 5 years		45	55.1					348.5					704					
23	Solar power plants			100			100			100			100			100			500
24	Wind power plants								50			50		50			50		200
	RES in total			200					300					200					700
	Power plants of "Uzbekenergo" in total		95	1087.3	1364.9	1074.4	951.8	306.4	1560.8	1015.7	21,3	900.4	750.3	500	690	610	904	900	12732.3
	Total for 5 years		95	4784.8					4248.5					3604					

Source:Uzbekenergo JSC; The construction of power plants is specified in the data under the years, and the reconstruction of HPPs and their power increase data is marked in yellow.

Table 3.1.5.1-4 Schedule of decommissioning of existing power plants of Uzbekenergo JSC.

	Unit	Start of operation	Power output [MW]	Estimated year of decommissioning															
				2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Tashkent TPP	1	1963	150												decom.				
	2	1964	150												decom.				
	3	1965	150										decom.						
	4	1965	150										decom.						
	5	1966	150									decom.							
	6	1967	155									decom.							
	7	1967	165								decom.								
	8	1968	165								decom.								
	9	1969	150						decom.										
	10	1970	165						decom.										
	11	1970	155				decom.												
	12	1971	155				decom.												
Navoi TPP	3	1964	150					decom.											
	4	1965	150					decom.											
	8	1968	160																decom.
	9	1969	160																decom.
	11	1980	210																
	12	1981	210																
	1	1963	25	decom.															
	2	1963	25					decom.											
	5	1966	50							decom.									
	6	1967	60							decom.									
	7	1971	50							decom.									
Takhiatash TPP	1	1967	100							decom.									
	2	1968	100							decom.									
	3	1974	110							decom.									
Angren TPP	1	1957	52.5			decom.													
	2	1958	54.5			decom.													
	3	1958	53			decom.													
	4	1958	52			decom.													
	5	1960	68						decom.										
	6	1961	68						decom.										
	7	1962	68						decom.										

Source: Uzbekenergo JSC

3.1.5.2 Network Development Plan

(1) Present Power Transmission Network

The network in Uzbekistan consists of 500 kV, 220 kV and 110 kV networks, and 500 kV and 220 kV configure the main grid to interconnect the area networks mutually, and 110 kV plays a role in supplying power to local areas.

Because Uzbekistan has exported and imported the electricity to and from its surrounding countries since the era of Soviet Union, the networks are interconnected to Kazakhstan, Kyrgyz, Tajikistan and Turkmenistan, as shown in Figure 3.1.5.2-1. Uzbekistan has made a contract of importing electricity with Kazakhstan, and also with Kyrgyz which has affluent hydro power.

Turkmenistan, however, cut off the interconnection to Central Asian countries in 2001 to sell the power to Iran and Afghanistan. Moreover, Uzbekistan stopped exporting because of delay of payment and the conflict on the international river. Uzbekistan has supplied the power to the north part of Afghanistan, where power stations do not exist, but the main grids are not interconnected.

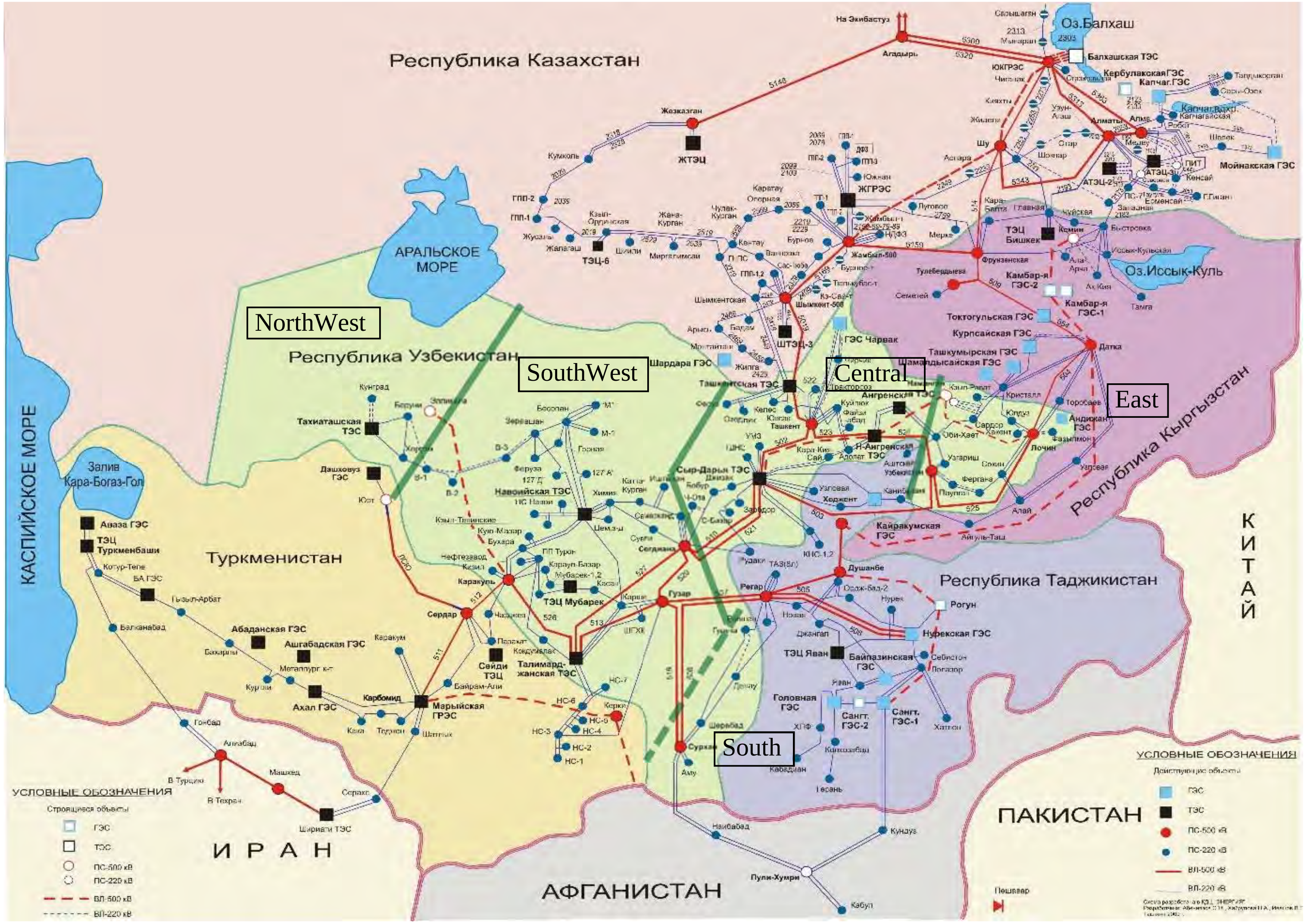
As mentioned above, Uzbekistan network is interconnected to Kazakhstan, Kyrgyzstan and Russia via Kazakhstan; therefore, the scale of interconnected networks is sufficiently large.

Due to the absence of large scale hydro power, Uzbekistan has to depend on Russia for controlling network frequency; as a result, obtaining their own ability to control the frequency is the network operators' earnest desire.

(2) Area-wise classification of network

As shown in the heavy light green line in Figure 3.1.5.2-1 and Figure 3.1.5.2-2, Uzbekistan is divided into 5 areas, and the network also can be simultaneously divided into 5 networks –East network, Central network (which the capital city Tashkent is belonging to), South West network, North West network and South network (which is actually is considered as a part of South West network since the it is small). The local dispatch centers are established in all networks, and they are under the control of National Dispatch Center (NDC).

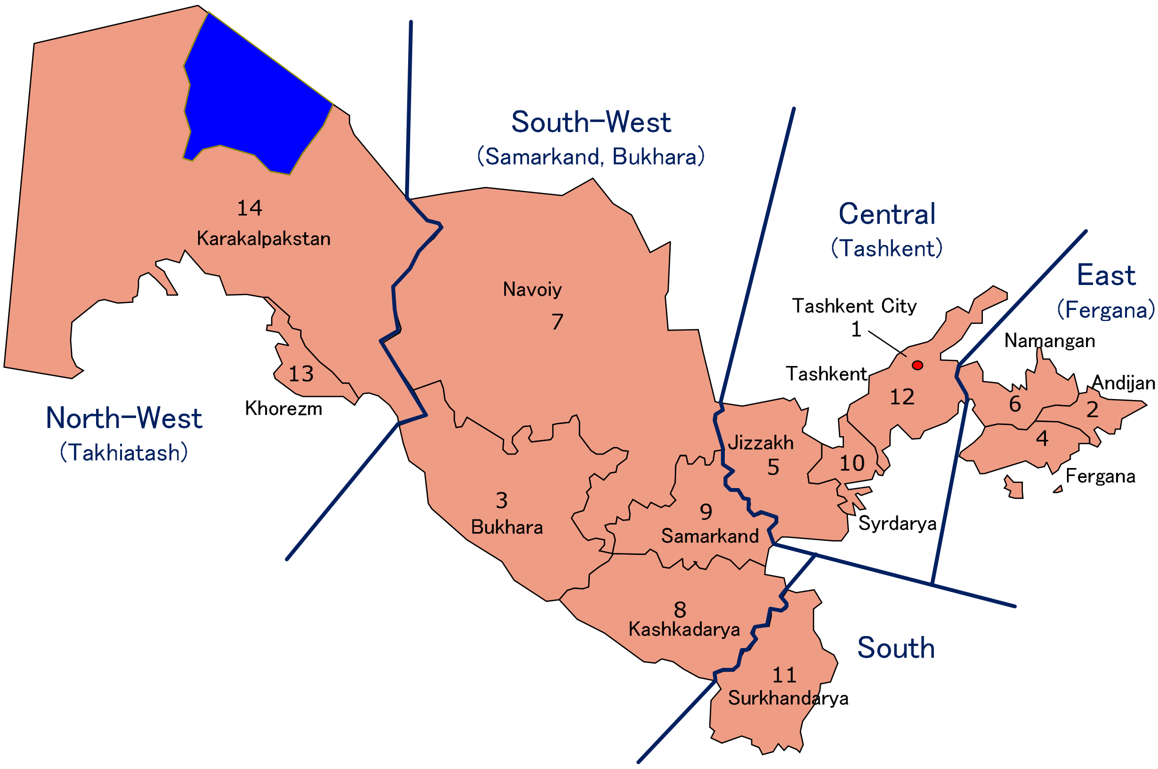
Trunk lines connect the networks mutually; specially, the Central and the East are connected by 2 circuits of 500 kV and 2 circuits of 220 kV lines, and the Central and the South West also by 2 circuits of 500 kV and 2 circuits of 220 kV lines, and the South West and the North West by 1 circuit of 220 kV line.



Source : Uzbekenergo JSC

Border between networks

Figure 3.1.5.2-1 Bulk power network in Uzbekistan and surrounding countries



Source: JICA Study Team

Figure 3.1.5.2-2 Administrative districts and area-wise networks

(3) Geographical distribution of load and generation

JICA Study Team has investigated the demand and supply balance, based on the network analysis data of the year 2015 which were built by "Energo Set Project" Institute when it developed the master plan in 2011.

Distribution chart of load and generation of power of the aforementioned 5 areas is shown in Figure 3.1.5.2-3, and area-wise proportional comparison of load and generation is shown in Figure 3.1.5.2-4.

Percentage of the distribution of the total load of 9,307 MW including exported and imported power is as follows:

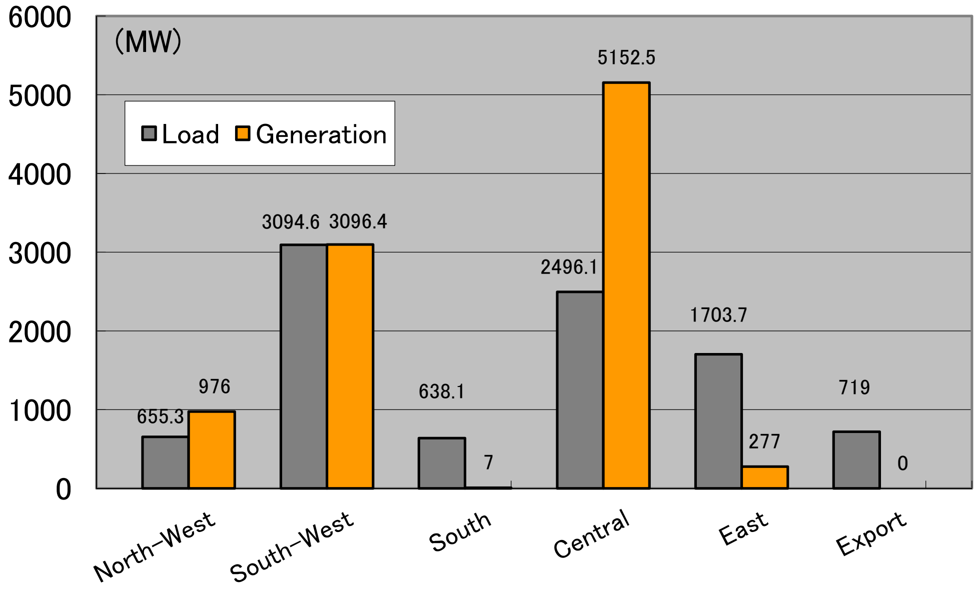
North-West network: 7 %, South-West network: 33 %, South network: 7 %, Central network: 27 %, East network: 18 % and export: 8 %.

Meanwhile, the percentage of the total generation is as follows:

North-West network: 10 %, South-West network: 33 %, South network: 0 %, Central network: 54 % and East network: 3 %.

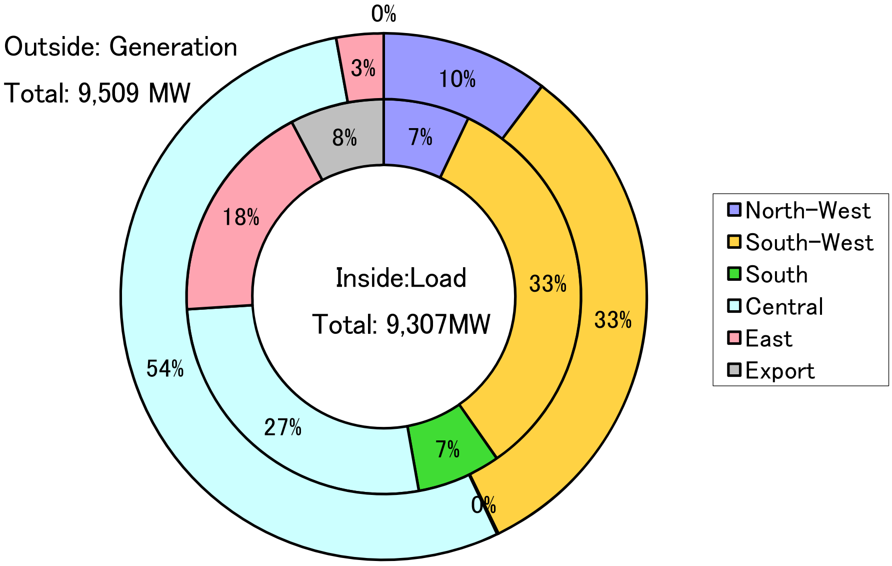
The South-West network keeps balance between load and generation. Although the Central network makes large share for the load (27 %), it also generates more than half of the total generation (54 %), and as a result, it transmits the power to the East network which is deficient in power. In order to improve this situation, Turakurgan thermal power station (four 450 MW units, expected to be commissioned sequentially in 2017–2022) is now under construction in the East area. The station is expected to improve significantly the load and supply balance after completion.

Taking into consideration the total load of 9,307 MW and the total generation of 9,509 MW, the transmission loss in the 500 kV and 220 kV network can be calculated to be 2.1 %; this value is acceptable for bulk power networks.



Source: JICA Study Team based on the data provided by Energo Set Project Institute

Figure 3.1.5.2-3 Distribution chart of load and generation



Source: JICA Study Team based on the data provided by Energo Set Project Institute

Figure 3.1.5.2-4 Proportional comparison of load and generation

(4) Network development plan

The network development plan is now being formulated and is not finalized. A 500 kV and 220 kV network development plans from 2015 to 2030 are shown in Table 3.1.5.2-1 as reference. Uzbekenergo JSC selects 5 projects which have high priority from projects shown in the Table 3.1.5.2-1. They are written in red ink and the numbers in a parenthesis show the priority.

Table 3.1.5.2-1 Network development plan (220 kV, 500 kV facility)

No.	Project	Scale	Construction cost (million US$)
Year 2015–2020			
1	220 kV Karakul Substation (SS)–Kandim SS (supply line to Kandimgas processing plant)	2×45 km	58.8
2	220 kV line in Sarimai (Elikala) area Tahiatash thermal power station (PS) –HorezmSS–220 kV branching point	338 km	191.0
3	220 kV Tahiatash thermal PS–BeruniSS–220 kV switching station	327 km	109.1
4	500 kV Tarakurgan thermal PS–Lochin SS	150 km	144.2
5	220 kVCharvak hydro PS–Tashkent SS	2×52+3+8 km	22.4
Subtotal: 500 kV + 220 kV, (150 + 870) km			525.5
Year 2021–2025			
6	(2) 220 kV SarimaiPP–Zaravshan SS	226 km	85.0
7	(1) 220 kV branching point－Tarakurgan thermal PS –Yulduz SS	2×100 km	75.0
8	220 kV Opornaya SS, branch line from Novo-Angrenthermal PS–Angren thermal PS	2×200 MVA, 2×0.5 km	36.3
9	220 kV Nukus SS, branch line from Tahiatash thermal PS–BeruniSS	2×63 MVA, 4×1 km	53.1
10	220 kVAmir-Temur SS－Guzar SS	2×125 MVA, 2×150 km	119.8
11	(3) 500 kV Novo-Angrenthermal PS –Tarakurganthermal PS	163 km	166.4
12	(5) 500 kV Talimarjan thermal PS –SurhanSS	270 km	190.0
13	(4) 500 kV Navoiy SS, 500 kV Talimarjan thermal PS –Navoi SS	2×501 MVA, 276 km	192.6
14	Installing 500 kV transformer in Tashkent thermal PS	501 MVA	50.0
15	500 kV Samirai (Ellikala) SS, 500 kV Karakul SS– Ellikala SS	2×501MVA, 255 km	171.2
Subtotal: 500 kV + 220 kV, (2,505 + 776)MVA, (964 + 731) km			1,139.4
Year 2026–2030			
16	220 kV Gulistan SS, branch line from 220 kV Sirdarya thermal PS–Guzal SS	2×125 MVA, 2×63 km	49.6
17	220 kV Yangiyul SS, 220 kVKuilyukSS –Adolat SS	2×125 MVA 2×30 km	48.5
18	220 kV Novo-Vostochnaya SS, branch line from Kuilyuk SS –Tashkent SS	2×125 MVA, 2× 5.5 km	34.0
19	220 kV Koshkupir SS, branch line from Tahiatash thermal PS –Horezm SS	2×125 MVA, 2×5 km	36.0
20	220 kV Kuvasaiskaya SS, 220 kVSokin SS－Kuvasaiskaya SS	2×125 MVA, 2×33 km	38.7
21	220 kV Mullalakskaya hydro PS –Tashkent SS	2×65 km	40.3
22	220 kVPskemskayahydro PS –Mullakskayahydro PS	2×20 km	17.5
23	500 kVMullalakskayahydro PS –Tashkent SS	65 km	37.0
24	500 kV Muruntau SS, 500 kV Navoiy SS –Muruntau SS	2×501 MVA, 168 km	143.6
25	500 kVSarimai(Elliakala) SS –Muruntau SS	226km	90.4
26	500 kV Kolcevaya SS, 500 kV branch line from Sirdarya thermal PS –Tashkent SS	2×501 MVA, 2×26 km	127.1
27	500 kV Sirdarya thermal PS –Kolcevaya SS	150 km	68.0
28	500 kV NavoiSS –Sogdiana SS	256 km	102.4
29	500 kV Djizak SS, 500kV branch line from Sirdarya thermal PS –Sogdiana SS	2×501 MVA, 4×2 km	126.0
30	500 kV Talimarjan thermal PS –Guzar SS	83 km	55.3
Subtotal: 500 kV+220 kV, (3,006 + 1,250) MVA, (1,008 + 443) km			1,014.4
Grand total: 500 kV + 220 kV, (5,511+ 2,026) MVA, (2,122 + 2,044) km			**2,679.3**

Source: Uzbekenergo JSC

3.1.6 Electricity Tariff System and the Dynamics of the Tariffs

Electricity rates in Uzbekistan are reviewed 2 times a year, in April and October. Regulation of tariffs is carried out by the Government. At the request of Uzbekenergo JSC, the Ministry of Finance sets tariffs on the basis of relevant Decree on establishment of regulated prices (tariffs). Along with this, the Antimonopoly Service of the Republic of Uzbekistan verifies that the tariffs are set in the right way.

Table 3.1.6-1 shows the dynamics of power tariffs. The tariffs are set for each group of consumers. For all consumer groups, the tariffs have been increased by 15–20 % per year (except for tariffs for advertising and illumination).

Table 3.1.6-1 Electricity tariffs in Uzbekistan

Consumer groups	01.04.2010	01.10.2010	01.04.2011	01.10.2011	01.04.2012	01.10.2012	01.04.2013	01.10.2013	01.04.2014	01.10.2014
Industrial consumers with attached power of 750 kVA and above										
for 1 kW peak load per year	116,400	126,630	137,800	150,150	160,400	171,800	184,740	197,700	216,500	237,780
for 1 kWh of energy consumed	55.50	60.45	65.80	71.70	76.50	81.90	87.84	94.02	102.72	112.80
Industrial consumers with attached power of 750 kVA and above	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
Agricultural production consumers	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
Electrified railway and urban transport (electric traction)	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
Non-industrial consumers, budget organizations, urban street lighting	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
Organizations of trade, cafes, restaurants and services	72.00	78.40	85.40	93.00	99.50	106.50	114.50	122.50	134.1	147.30
Population, settlements	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
The population of residential houses, fitted with electric stoves	32.25	38.40	41.80	45.55	48.75	52.20	56.10	60.00	65.7	72.15
Electrical energy used for the needs of heating, hot water and cooling (conditioning)	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30
Advertising and illumination	110.00	110.00	110.00	110.00	110.00	110.00	118.30	126.60	138.6	152.25
Business needs of energy system	70.50	76.80	83.60	91.10	97.50	104.40	112.20	120.00	131.4	144.30

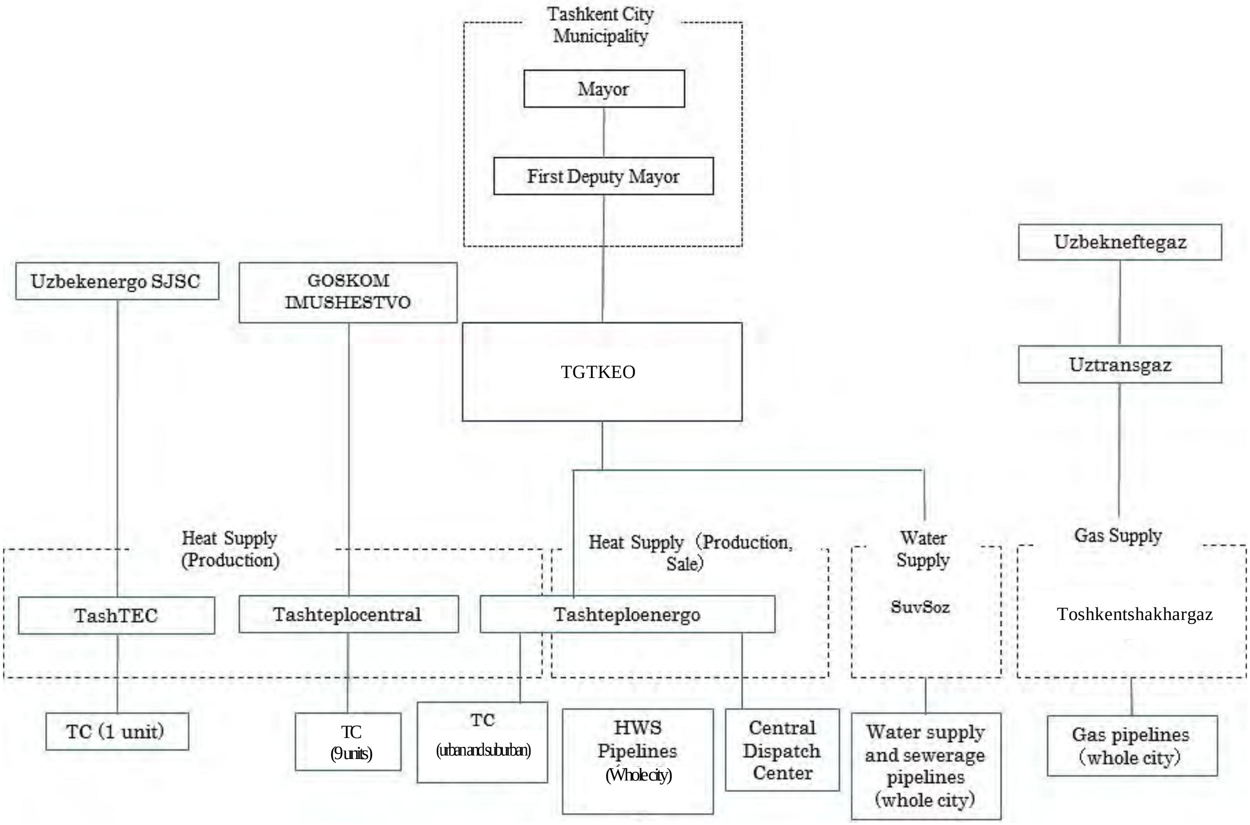
Source: Ministry of Finance of the Republic of Uzbekistan

3.2 Heat Supply Situation in Tashkent

3.2.1 Heat Supply Structure

(1) Heat supply implementation structure

The central heat supply system in Tashkent City was formed in 1960–1970. At the present time the heat (hot water) for heating and hot water supply (HWS) in Tashkent are executed by Tashteplocentral JSC, Tashkent CHP JSC (hereinafter referred to as TashTETs) and Tashteploenergo. 75 % of the necessary hot water is provided by Tashteplocentral JSC, 15 % by TashTETs, and the remaining 10 % by heating plants of Tashteploenergo. Sale of thermal energy to end-users, collection of payments, supply management are carried out by Tashteploenergo. The original water needed for heat is delivered by the water supply organization, Suvsoz. Fuel is supplied by Toshkentshahargaz which is a subsidiary of Uztransgaz JSC, a gas transport company. Figure 3.2.1-1 represents the structure of heat supply structure in Tashkent. Tashteploenergo and Suvsoz are subordinate organizations of Tashkent City Territorial Municipal Maintenance Association (TGTKEO, for its Russian acronym, *Tashkentskoe Gorodskoe Territorialʹnoe Kommunalʹno-Ekspluatatsionnoe Obʹyedinenie*) under Tashkent City Municipality. Tashteplocentral is under the State Committee of the Republic of Uzbekistan for State Property Management (Goskomimushestvo).



Source: Compiled by JICA Study Team

Figure 3.2.1-1 Heat supply structure in Tashkent

1) Review of organizations supplying heat

Tashteplocentral is a manufacturer of thermal energy; 99 % of its shares are owned by Goskomimushestvo, and the remaining 1 % by the employees' association. The organization was founded in 1967. Currently, Tashteplocentral JSC carries out the activities in accordance with Decree No. 93of the Cabinet of Ministers of the Republic of Uzbekistan dated February 24, 2001, Decree No. 1-179 k-po of Tashkent City Department of Goskomimushestvo dated July 07, 2001 and Decree No. 1094by the Mayor of Mirzo-Ulugbek District in Tashkent dated July 06, 2001. Nine heating plants (TC) of Tashkent City, TC-1–TC-10 (except for TC-2) are heat supply divisions of Tashteplocentral JSC. These heating plants are managed at the expense of own funds and do not get government subsidies.

TGTKEO is the focal point for issues relating to infrastructure in Tashkent. Tashteploenergo and Suvsoz are under TGTKEO. According to the Paragraph 6 of the Decree No.493 of the Cabinet of Ministers dated December 21, 2000, First Deputy Mayor of Tashkent City is appointed as Director of TGTKEO. The organizational staff is 60 people. According to the Paragraph 6 of the Decree No.493 of the Cabinet of Ministers dated December 21, 2000, the budget of TGTKEO is formed at the expense of monthly payments from the subordinate enterprises.

Tashteploenergo was formed in 1984. Currently, the company carries out its activities in accordance with Decree No. 288 of the Cabinet of Ministers of the Republic of Uzbekistan dated August 16, 1996 and Decree No. 259 of Tashkent City Mayor dated September 03, 1996. Tashteploenergo carries out production and wholesale of thermal energy, and it also supplies heat (hot water and steam for heating and hot water supply) to consumers in Tashkent City. Tashteploenergo procures hot water and steam from 9 heating plants of Tashteplocentral JSC and TashTETs and sells them to consumers together with hot water produced by its own heating plant (TC-2 and suburban grids). Regulation of the supply of hot water is carried out by the Central Dispatch Service under Tashteploenergo. Tashteploenergo is managed at the expense of own funds; however, it has losses; therefore the government covers part of the losses.

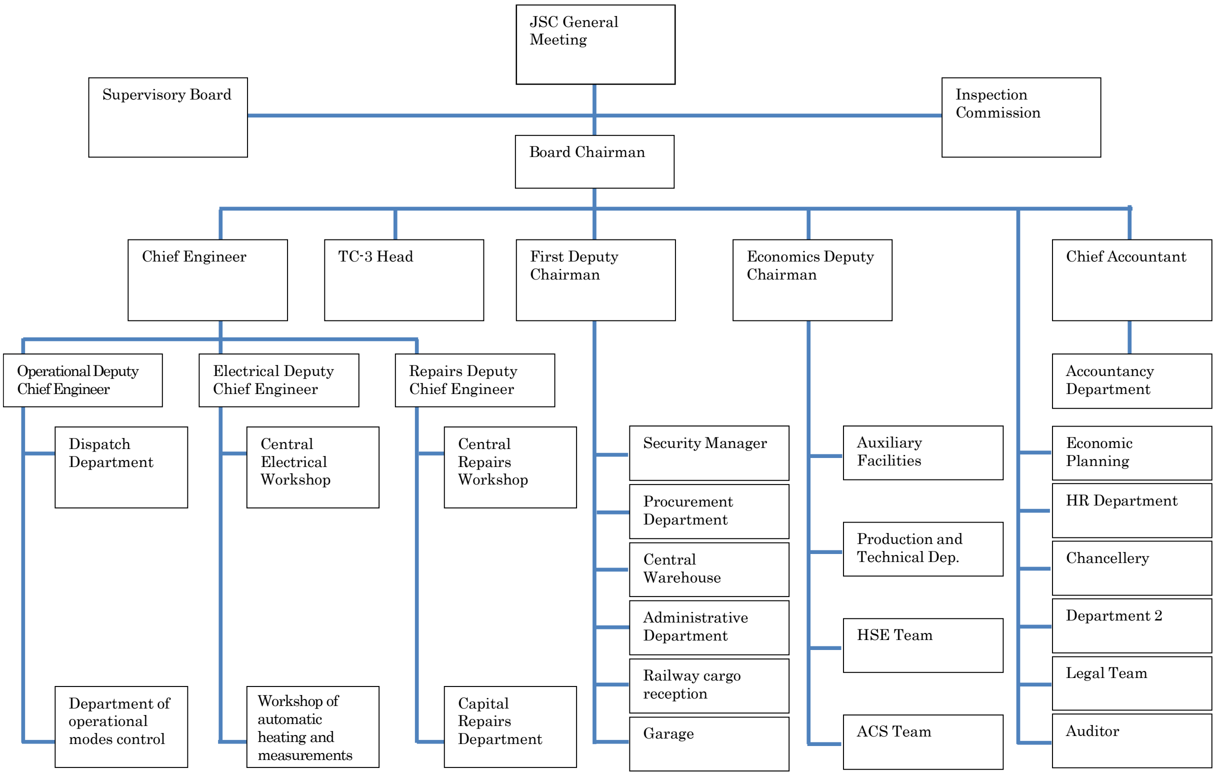
TashTETs is a heat and power plant in Tashkent City. It is planned that TashTETs will carry out operation and maintenance of equipment for the project. Initially, TashTETs was a division of Uzbekenergo JSC, but in accordance with the policy of the government in 2001 it was transformed into the Open Joint-Stock Company, where 51 % of shares belong to Uzbekenergo JSC, 47 % to the government fund, and the remaining 2 % to the employees association of TashTETs. Control of TashTETs is implemented by Uzbekenergo JSC and the government. TashTETs is managed at the expense of own funds and does not get government subsidies.

Gas used to produce heat is supplied by Toshkentshakhargaz enterprise which is a division of Uztransgaz State Joint-Stock Company. Toshkentshakhargaz was founded in 1957 and currently employs 2,200 people. Wholesale gas prices for legal entities and retail prices for individual consumers are established by the Ministry of Finance. Toshkentshakhargaz is managed at the expense of own funds and does not get government subsidies. Raw water is supplied by Suvsoz under TGTKEO. Heat supply of Tashkent City is fully carried out by the organizations and enterprises under the government control. The following is an overview of the respective heat supplying companies.

2) Activity and financial indicators of Tashteplocentral JSC

i) Organizational structure

Figure 3.2.1-2 presents the organizational structure of Tashteplocentral JSC.



Source: Tashteplocentral JSC

Figure 3.2.1-2 Organizational structure of Tashteplocentral JSC.

ii) Income and expenses of Tashteplocentral JSC

The only source of income of Tashteplocentral JSC is thermal energy production which is fully supplied by Tashteploenergo. Heat is supplied in the form of hot water; therefore, in the winter period, when the air temperature is low, the consumption grows, and in the summer, when there is no need in heating, the demand falls. The consumption in the summer falls up to the level of 30 % of the winter consumption. Pricing for hot water supplied by Tashteploenergo is established by the Ministry of Finance.

The share of expenses for raw materials and materials for the last 5 years is about 90 % of the proceeds from the sale of thermal energy (Table 3.2.1-1); the cost of natural gas, which is fully procured from Toshkentshakhargaz, has a share of approximately 70 %.

Table 3.2.1-1 Share of expenses for raw materials and materials in the proceeds from sale of thermal energy by Tashteplocentral JSC

	2010	2011	2012	2013	2014
Expenses for raw materials and materials Income from sales of thermal energy	89 %	91 %	91 %	95 %	92 %

Source: Compiled by JICA Study Team

Table 3.2.1-2 and Table 3.2.1-3 present production volumes of thermal energy, and - profit and losses statement of Tashteplocentral JSC, respectively.

Table 3.2.1-2 Production volumes of thermal energy at Tashteplocentral JSC

Name	2010	2011	2012	2013	2014
Heat supply (thousand GCal)	7, 919	8, 169	8, 607	8, 153	8, 850
Average price without VAT (sum/GCal)	13, 168	15, 813	19, 266	23, 554	28, 804

Source: Tashteplocentral JSC

Table 3.2.1-3 Profit and losses statement of Tashteplocentral JSC

(million sums)

Name	2010	2011	2012	2013	2014
Income					
Revenues from sales of heat	104, 274	129, 182	165, 818	192, 026	254, 926
General expenses	101, 656	127, 973	164, 102	198, 083	254, 443
Cost of production	92, 774	117, 070	150, 775	182, 709	234, 775
Raw materials, including	83, 035	105, 202	138, 380	167, 707	215, 855
Fuel-gas, fuel oil	57, 427	74, 733	101, 589	123, 625	163, 631
Electricity	16, 804	19, 645	23, 646	27, 203	32, 801
Water	6, 995	8, 274	9, 896	12, 252	14, 532
Chemical reagents	1, 508	2, 112	2, 462	3, 317	3, 678
Other materials	301	438	787	1, 310	1, 213
Wages (including taxes and deductions)	5, 320	6, 564	7, 814	9, 486	11, 492
Debt repayment	2, 401	2, 122	1, 524	1, 406	1, 354
Capital and current repairs	1, 664	2, 747	2, 442	3, 479	5, 457
Miscellaneous	354	435	615	631	617
Operating costs	934	1, 219	1, 502	1, 763	2, 216
Other operating costs	7, 948	9, 684	11, 825	13, 611	17, 452
Total, including taxes	6, 120	7, 482	9, 305	10, 897	13, 890
Other expenses, interest on credits	241	278	768	1, 179	857
Other operating income	356	391	381	462	525
Profit before tax	2, 733	1, 322	1, 329	-6, 774	151
Profit tax	544	331	282	0	128
Net profit	2, 189	991	1, 047	-6, 774	23

The reason for the decline in the production of hot water in 2013 is reduction of the volume of consumption as a result of warmer winter compared to the previous year. Due to the fact that it is difficult to immediately adjust the level of capacity utilization, a loss of 6.7 billion sums was registered in 2013 (approximately 300 million yens).

If we add other costs to raw materials and materials costs, the expenses and revenues of the previous year will be nearly balanced, the return on sales and rate of return coefficient is low (−4 % to +3 %). The heat price for calculations between Tashteplocentral JSC and Tashteploenergo is set by the Ministry of Finance. The government controls profits and losses, so that the alleged profit and loss would not exceed the acceptable level for the government enterprise.

Table 3.2.1-4 contains articles of receivables and liabilities of Tashteplocentral OJSC. The main part of receivables is the debt of Tashteploenergo to which is heat supplied. Tashteploenergo in the priority order executes payments for Tashteplocentral JSC that is why the amount of overdue receivables in 2014 was greatly reduced.

The main part of payables is the debt to the gas supplier, Toshkentshakhargaz. After 2011 payable accounts to Toshkentshakhargaz were not observed.

Table 3.2.1-4 Receivables and payables of Tashteplocentral OJSC.

(million sums)

Item	2010	2011	2012	2013	2014
Accounts receivable	78, 801	87, 706	109, 021	155, 176	151, 997
Including debt of Tashteploenergo	78, 289	86, 635	107, 536	152, 899	149, 465
Including overdue	22, 984	12, 065	17, 655	51, 243	7, 623
Overdue proportion of receivables	29 %	14 %	16 %	34 %	5 %
Accounts payable	66 427	70 647	90 801	142 197	151 244
including for Toshkentshakhargaz	61, 494	63, 202	82, 432	130, 270	142, 134
Including overdue	409	7	0	0	0

Source: Compiled by JICA Study Team

iii) Balance sheet of Tashteplocentral

Table 3.2.1-5 presents a balance sheet, and Table 3.2.1-6 presents debt and capital ratio of Tashteplocentral. The total amount of assets has almost doubled since 2010 (i.e., in five years); however, the net worth amount has not increased. Therefore, the net worth share of the general assets has reduced, and in 2014 it was 16 %. The liquidity ratio, which reflects the ability to repay short-term obligations, has shown a downward trend in recent years, but it remains higher than 1.0. This indicates that the problems with the management of the funds do not exist.

The main part of current obligations is payables to Tashkentshakhargaz for the supplied gas. The proportion of current obligations in total liabilities amount is about 100 %; however, there is no delinquency in payments, and there are no problems with managing funds.

Table 3.2.1-5 Balance sheet of Tashteplocentral

(million sums)

Name	2010	2011	2012	2013	2014
Asset					
Current assets					
Cash in hand	49	6	206	507	5
Inventory	4, 299	3, 664	3, 555	10,114	11, 435
Receivables debt	78,485	86, 808	108, 378	153, 803	150, 461
Advances	315	898	643	1 374	1 536
Miscellaneous		15	26	43	43
Total current assets	83, 149	91, 391	112, 808	165, 841	163, 480
Capital assets:					
Tangible assets	13, 381	12, 860	13, 758	13, 947	15, 293
Intangible assets	5	3			
Long-term investments, Miscellaneous	1, 033	1, 170	893	1, 990	2, 124
Total fixed assets	14, 419	14, 033	14, 651	15, 938	17, 417
Total asset	97, 568	105, 424	127, 460	181, 778	180, 897
Liabilities					
Current liabilities					
Accounts payable debt	63, 169	67, 705	87, 045	138, 710	146, 205
Unpaid wages	486	496	675	707	852
Unpaid corporate tax	2, 772	2, 447	3, 081	2, 779	4, 188
Short-term loans	835	2, 505	2, 448	5, 572	187
Total of current obligations	67, 262	73, 152	93, 249	147, 769	151, 432
Long-term liabilities					
Long-term loans				6, 000	
Miscellaneous					57
Total long-term obligations				6, 000	57
Total liability	67, 262	73, 152	93, 249	153, 769	151, 488
Capital					
Net worth	7, 803	7, 803	7, 803	7, 803	7, 803
Capital surplus	26, 428	27, 532	28, 819	29, 819	31, 196
Retained earnings	-3, 925	-3, 063	-2, 411	-9, 614	-9, 591
Grand total:	30, 306	32, 272	34, 211	28, 009	29, 408
Total payables and receivables	97, 568	105, 424	127, 460	181, 778	180, 897

Source: Compiled by JICA Study Team on the basis of information provided by Tashteplocentral JSC.

Table 3.2.1-6 Ratio of debt and capitalization of Tashteplocentral JSC

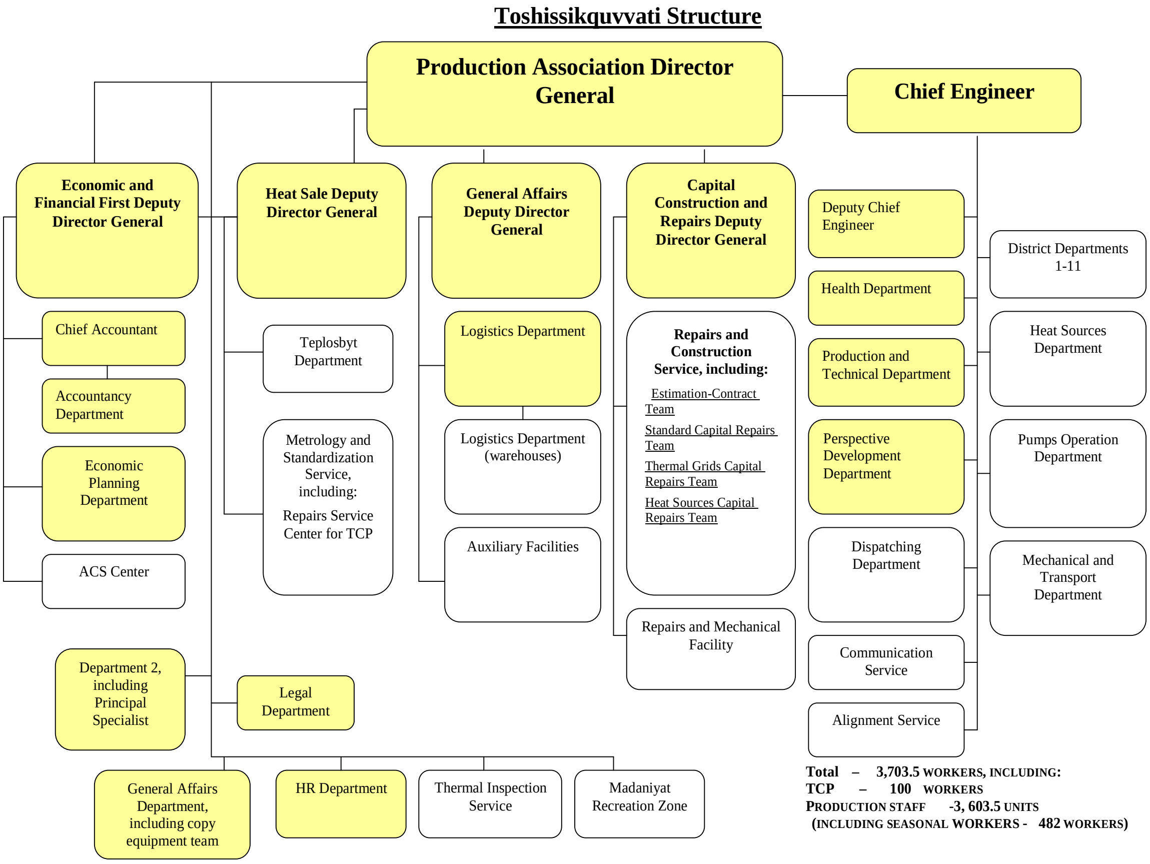
	2010	2011	2012	2013	2014
Liquidity ratio (current assets/current liabilities)	1.24	1.25	1.21	1.12	1.08
Current liabilities/total liabilities	1.00	1.00	1.00	0.96	1.00
Capitalization ratio (equity/total assets)	31 %	31 %	27 %	15 %	16 %

Source: Compiled by JICA Study Team on the basis of information provided by Tashteplocentral JSC.

3) Activity and financial indicators of Tashteplocentral JSC

i) Organizational structure

Figure 3.2.1-3 represents the organizational structure of Tashteploenergo.



Source: Tashteploenergo

Figure 3.2.1-3 Organizational structure of Tashteploenergo

ii) Income of Tashteploenergo

Source of income for Tashteploenergo is the revenue from the sale of thermal energy, of which 86 % is supplied to individual consumers, and 14 % to legal entities. 75 % of heat required for supply is produced by Tashteplocentral JSC, 15 % by TashTETs, and the remaining 10 % by its own heat plant in Tashkent City (TC-2). Heat supply in Tashkent City is carried out in accordance with the contracts concluded directly between Tashteploenergo and individual consumers or legal entities. In accordance with the contract, payments for the used volume of hot water are produced monthly; payments for thermal heating in winter take place once a year. The payment is made at Tashteploenergo branches, payment outlets in banks, post offices, or Household Owners Offices with which Tashteploenergo has concluded a relevant contract. Thermal energy tariffs for end users are set by the Ministry of Finance of the Republic of Uzbekistan. Tashteploenergo in its activity uses the tariffs set by the policy of the government.

iii) Expenses of Tashteploenergo

The main expenditure item is thermal energy procured from Tashteplocentral and TashTETs which makes up 70 % of the production cost.

iv) Production volume and thermal energy supplies by Tashteploenergo

Table 3.2.1-7 shows dynamics in volumes of production and supply of thermal energy. Over the past 5 years the amount of thermal energy supply to final consumers has increased by about 12.5 %. The volume of own production virtually has not changed; however, the amount of thermal energy purchased from Tashteplocentral JSC and TashTETs has increased by 11.2 %. The proportion of heat loss for heat supply volume declined from 11.5 % in 2010 up to 9.8 % in 2014.

Table 3.2.1-7 Production volume dynamics and thermal energy supplies by Tashteploenergo

Item (thousand GCal)	2010	2011	2012	2013	2014
The amount of heat energy production	1, 063	1, 075	1, 139	1, 037	1, 083
The amount of heat energy produced for own needs	20	20	22	19	21
Purchased thermal energy	9, 537	9, 783	10, 348	9, 822	10, 611
Heat supply volume	10, 579	10, 837	11, 466	10, 840	11, 673
Thermal energy used for own needs	13	13	13	11	12
The loss of thermal energy	1, 226	1, 168	1, 158	1, 113	1, 151
The heat delivered to end-users	9, 341	9, 657	10, 295	9, 716	10, 510

Source: Tashteploenergo

(v) Amount of heat supply by consumer groups

Table 3.2.1-8 presents the dynamics of volume of heat supply by consumer groups. Heat consumption of the resident increased by 16.3 % in the period 2010–2014, that is greater than the growth of total consumption of heat. However, the amount of heat consumption by government agencies in the same period, 2010-2014, decreased by 11.4 %.

Table 3.2.1-8 Dynamics of heat consumption by consumer groups

1, 000 GCal.

Consumer groups	2010	2011	2012	2013	2014
Resident	7,820.9	8,062.4	8,724.4	8,426.9	9,096.3
Public institutions	1,124.6	1,147.1	1,105.8	917.5	995.9
Enterprises	365.9	421.1	440.7	350.1	397.0
Organizations exempt from VAT	8.7	8.5	8.9	6.1	6.0
Religious organizations having the status of legal person	2.3	2,6	2,6	2.8	4.5
For cleaning	18.3	15.1	12.3	13.1	9.8
Grand total	9,340.7	9,656.8	10,294.7	9,716.4	10,509.7

Source: Tashteploenergo

vi) Profit and losses statement of Tashteploenergo

Table 3.2.1-9 presents the profit and losses statement of Tashteploenergo. Wholesale price for end-users, as well as price for thermal energy procured from Tashteplocentral JSC is set by the Ministry of Finance of the Republic of Uzbekistan. However, the cost of production, which is generated from the purchase of heat from Tashteplocentral JSC and expenses for raw materials and materials (fuel, water and etc.) constantly exceeds the level of income from heat supply (Table 3.2.1-9). Thus, the more products are sold, the more the losses.

The main reason for the annual loss is that fixed tariffs for thermal energy sold to end users, as well as the tariffs for the used volume of thermal energy, do not cover sufficiently the costs of thermal energy supply. In addition, households that do not have thermal energy meters pay at a fixed rate, but according to the information of Tashteploenergo, consumers paying for heat at a fixed rate are not bothered about saving heat energy. Therefore, the costs for supply of actually consumed volume of heat are not covered sufficiently.

Table 3.2.1-9 Profit and losses statement of Tashteploenergo

(million sums)

Item (million sums)	2010	2011	2012	2013	2014
Total income	128,688	156,869	199,420	218,545	347,652
Revenue from the supply of heat	122,596	149,800	190,983	210,928	284,839
Income not associated with the major production activity	5,827	6,840	8,236	7,447	62,557
Other incomes	264	229	200	169	256
Production cost (total)	173,333	210,909	275,959	318,269	396,232
Among them:					
Materials	2,895	4,378	6,842	7,985	7,027
Purchased heat	119,142	147,106	191,187	225,221	296,811
Water	836	1,010	1,239	1,421	1,506
Fuel	7,895	10,037	13,788	15,917	20,212
Electricity	3,123	3,795	4,217	4,782	5,647
Wages of technical staff	13,114	15,859	18,658	22,481	28,448
Contributions and deductions for social insurance	3,278	3,965	4,664	5,620	7,112
Expenses for depreciation of fixed assets	2,938	3,373	3,899	4,740	5,496
Other operating expenses	20,113	21,387	31,465	30,103	23,974
Other costs, total:	3,704	4,669	6,575	6,952	8,750
Among them:					
Circulation cost	978	1,170	1,333	1,636	1,965
Operating costs, total	1,102	1,366	1,711	2,004	2,545
Other operating costs, total:	1,625	2,133	3,531	3,313	4,240
Expenses related to financial activities	656	485	276	993	170
Subtotal	177,692	216,063	282,810	326,215	405,152
Profit before tax	-49,005	-59,194	-83,390	-107,670	-57,500
Profit tax					
Net profit (loss)	-49,005	-59,194	-83,390	-107,670	-57,500

Source: Tashteploenergo

Decree No. 300 of the Cabinet of Ministers of Uzbekistan dated November 6, 2011[14] is a special decree aiming at improving the financial condition of the government-owned enterprises that provide utility energy services. In order to combat annual losses and excess of liabilities over assets, the Government covers part of the losses of Tashteploenergo. In the above profit and losses statement, the item “Income not associated with the major production activity” includes government subsidies for maintenance of heat supply grids and heat sources. Thanks to these subsidies, Tashteploenergo provides payment of payables to Tashteplocentral JSC and TashTETs. Table 3.2.1-10 presents the dynamics of changes in the amount of government subsidies.

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[14] Decree No. 300 of the Cabinet of Ministers of the Republic of Uzbekistan dated November 06, 2013 On Measures on Financial Recovery of Heat Supply and Water Supply Organizations of the Republic, and Decree No. 197 of the Cabinet of Ministers of the Republic of Uzbekistan dated July 17, 2014 On measures on Implementation of the Programs — Road Maps for Financial Recovery of Unprofitable Heat Organizations.

Table 3.2.1-10 Dynamics of changes in the amount of government subsidies

(million sums)

	2010	2011	2012	2013	2014
Subsidies for grids maintenance of heat supply and heat sources	4, 951	5, 412	5, 571	6, 048	6, 664

vii) Balance sheet of Tashteploenergo

Table 3.2.1-11 presents the balance sheet of Tashteploenergo. There is an excess of liabilities over assets, which reached approximately 60 billion sums (approximately 2.9 billion yens) in 2014. However, in 2014 the main part of liabilities was payables debt to Tashteplocentral and TashTETs, and the loans were short-term and amounted to only 2 million sums. Tashteploenergo will continue further to play an indispensable role in ensuring heat supply to Tashkent City; therefore, it is assumed, that in the future the government will provide financial support through subsidies.

Table 3.2.1-11 Balance sheet of Tashteploenergo

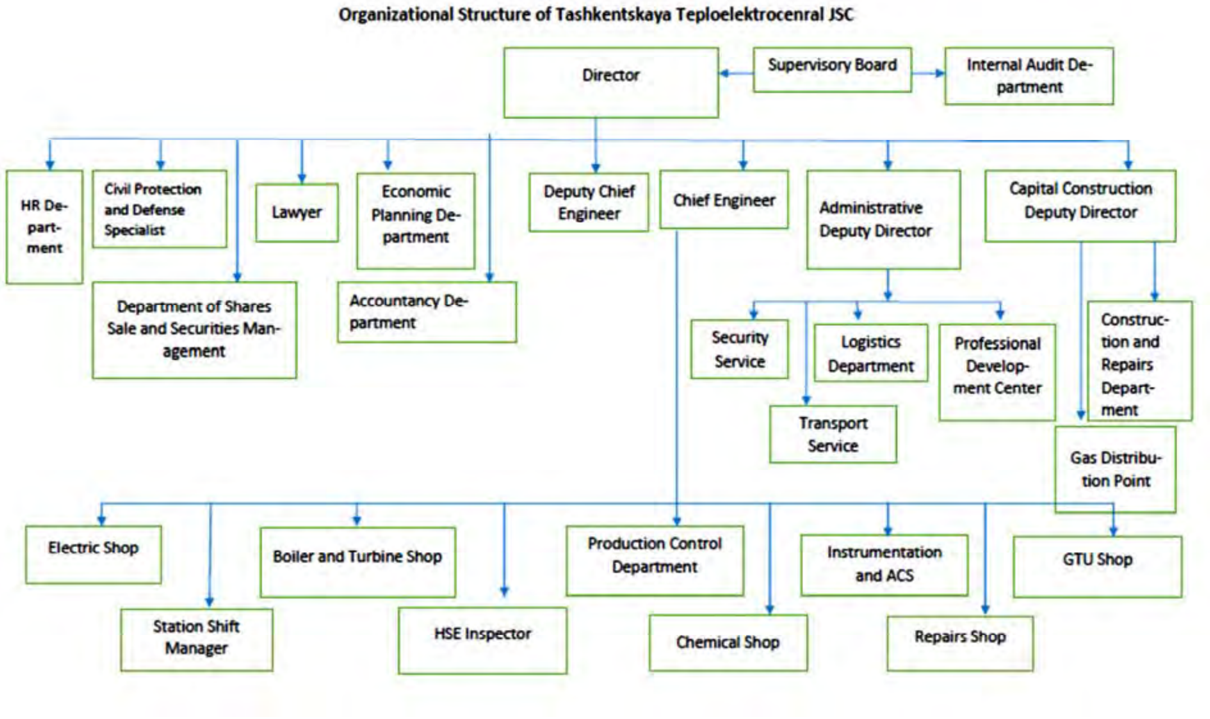
(million sums)

Name	2010	2011	2012	2013	2014
Asset					
Capital assets					
Land, buildings and structures	22, 563	26, 348	29, 624	36, 225	35, 135
Other long-term assets	1, 227	1, 007	452	217	917
Total fixed assets	23, 789	27, 355	30, 075	36, 442	36, 052
Current assets					
Inventory	3, 302	4, 017	5, 964	7, 177	4, 970
Accounts receivable	53, 180	56, 222	65, 062	88, 855	125, 323
Other current assets	127	932	1, 354	1, 039	1, 232
Total current assets	56, 609	61, 170	72, 380	97, 070	131, 524
Total asset	80, 399	88, 525	102, 455	133, 512	167, 576
Equity and liabilities					
Net worth	-36, 287	-42, 573	-65, 737	-96, 632	-60, 711
Liabilities					
Long-term liabilities	2, 346	1, 240	10, 367	3	
Accounts payable	113, 559	127, 746	157, 823	225, 640	228, 286
Short-term bank loans	750	2, 081	-	4, 500	
Short-term loans	30	32	2	2	2
Total liability	116, 686	131, 098	168, 191	230, 144	228, 288
Total capital and liability	80, 399	88, 525	102, 455	133, 512	167, 576

4) Activity and financial indicators of TashTETs

i) Organizational structure

TashTETs is one of subordinate power plants of Uzbekenergo JSC which simultaneously produces electricity and heat. TashkentTETS is an integral part of the heat supply system in Tashkent. TashTETs introduced new gas turbine cogeneration equipment to increase the efficiency of the heat supply system and meet the growing demand in thermal energy in Tashkent City. After completion of this project the new equipment at TashTETs will be introduced; it is operating the equipment under the guidance of Uzbekenerfo SJSC. Figure 3.2.1-4 represents the organizational structure of TashTETs.



Source: TashTETs

Figure 3.2.1-4 Organizational structure of TashTETs

The price of electricity for payments between TashTETs and Uzbekenergo JSC in accordance with the Decree No. 239 of the Cabinet of Ministers of the Republic of Uzbekistan[15] shall be established by the Ministry of Finance on request by Uzbekenergo JSC. Uzbekenergo JSC takes significant part in management of the TashTETs. In accordance with Paragraph 6 of the Decree No. 290 of the Cabinet of Ministers of the Republic of Uzbekistan dated June 21, 2014, TashTETs is a structural division of Uzbekenergo JSC, and following arrangements are between Uzbekenergo JSC and the TashTETs

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[15] Decree No. 239 of the Cabinet of Ministers of the Republic of Uzbekistan dated October 28, 2010.

- TashTETs accountability before Uzbekenergo JSC and submitted reports.
  - Conduct accounting and submission of financial, technical and other reports of Uzbekenergo JSC.
  - Bear responsibility for maintaining confidence in the financial condition of the company, for the maintenance of accounting records and the timely provision of monthly, quarterly and annual accounting and other financial reports to Uzbekenergo JSC.
  - Provide information relating to reducing production costs and saving energy.
- Uzbekenergo JSC's SJSC obligations related to TashTETs.
  - Approve main forecast feasibility indicators.
  - Approve the balance of production and consumption of thermal and electric energy.
  - Approve performance of electricity production, the supply of heat energy, specific fuel consumption.
  - Approve the program for introduction of energy equipment; complete the financing of this program.
  - Set schedules of capital repairs and maintenance of energy equipment.

ii) Income and expenses of TashTETs

TashTETs income is generated from production and sale of electric energy and heat, that is the thermal energy (hot water and steam) supplied to Tashteploenergo, and the electric energy supplied to Uzbekenergo JSC (the counterparty is Energosotish a branch of Uzbekenergo JSC). Buyers are only those two organizations, and volumes of heat and electricity production are determined by contracts with these two organizations. Heat sale is a main income source for TashTETs, and over the past 5 years, sales of heat made 67–82 % of the total revenue. The delivered heat is sold by Tashteploenergo to the residents and enterprises.

About 90 % of the cost is the cost of production, of which 80 % is the cost of natural gas purchased from Toshkentshahargaz. Table 3.2.1-12 below shows the dynamics of changes for sold heat volumes and TashTETs electric energy, and Table 3.2.1-13 shows TashTETs profit and losses statement.

Table 3.2.1-12 Dynamics of changes of heat and electricity volumes sold by TashTETs

Item	2010	2011	2012	2013	2014
Heat supply (thousand GCal)	1,628.40	1,621.97	1,746.58	1,677.71	1,759.48
Electricity (thousand kWh)	73,350.97	114,259.37	115,312.16	134,975.07	291,141.81
Average cost, excluding VAT					
For 1 GCal of heat (sums)	9,657.92	11,795.58	18,583.33	21,370.83	25,805.42
For 1 kW/h of electricity (sums)	59.50	67.50	62.75	59.46	78.10
Revenue from the sale of heat (million sums)	15,727	19,132	32,457	35,854	45,404
Revenues from sales of electricity (million sums)	4,364	7,713	7,236	8,025	22,738
Total revenue (million sums)	20,091	26,845	39,693	43,879	68,142
The proportion of heat in revenue	78 %	71 %	82 %	82 %	67 %
Share of electricity in revenue	22 %	29 %	18 %	18 %	33 %

Source: Compiled by JICA Study Team on the basis of information provided by TashTETs.

Table 3.2.1-13 Profit and Loss Statement of TashTETs

(Unit of measure: million sums)

Item	2010	2011	2012	2013	2014
Income					
Revenues from sales of heat	19,131	25,178	33,232	41,578	62,025
Total income	19,131	25,178	33,232	41,578	62,025
Consumption					
Production expenses					
Raw materials, etc.:	15,416	19,107	26,525	35,434	46,532
Fuel, gas, fuel oil	13,161	16,881	23,683	29,830	42,263
Electric power, thermal energy for own needs	41	53	57	74	129
Purchased electricity	457				
Water	1,563	1,780	2,299	2,773	3,124
Materials	194	393	486	2,757	1,016
Total production costs	18,479	23,042	30,783	42,376	54,843
Wages (including taxes)	1,869	2,433	3,214	4,194	4,888
Debt repayment	54	61	77	82	1,630
Capital and current repairs	1,096	1,375	844	2,535	1,689
Others	44	66	123	131	104
Circulation cost	15	20	21	69	93
Operating costs	253	321	402	644	693
Other operating costs	1,705	2,655	2,828	6,081	7,098
Total expenditure	20,452	26,038	34,034	49,170	62,727
Overhead costs associated with ancillary equipment	894	1,075	1,472	3,987	4,713
Other expenses, the interest rate on the loan	154	164	121		1,070
Other incomes	69	1,134	218	240	1,821
Profit before tax	-1,406	110	-705	-7,352	49
Profit tax		46			19
Net profit	-1,406	64	-705	-7,352	30

Source: TashTETs

Over the past 5 years production costs have exceeded production revenues, and production of heat and electricity has recorded not profit. In 2014 the profit was only 30 million sums (about 1.5 million yens); however, it was formed at the expense of outdated equipment and materials sale, as well as other incomes. In 2013 the deficit balances amounted to 7 billion 350 million sums (approximately 300 million yens); this was the result of reduction of heat use in the mild winter, plus depreciation expenses and increase of the burden of operating costs in connection with the introduction of new equipment. Although TashTETs is not receiving government subsidies, by the aforementioned pricing method the gains and losses of TashTETs are regulated by the government, so that the claimed profit and loss would not exceed the acceptable government enterprise level.

Table 3.2.1-14 contains receivables and payables of TashTETs. Accounts receivable consists are mainly related to Tashteploenergo, the sole buyer of heat from TashTETs. TashTETs considers Tashteploenergo as a government enterprise and is not worried about the return of receivables. Payables refer to Toshkentshkhargaz and its dependent enterprises.

Table 3.2.1-14 Receivables and payables of TashTETs

(million sums)

Item	2010.	2011.	2012.	2013.	2014
Accounts receivable	8,776	11,995	18,894	26,598	30,559
Including overdue payments				17	14
In relation to Tashteploenergo	8,593	9,803	15,786	26,108	28,429
Including overdue payments					
Accounts payable	8,922	19,017	40,099	64,130	73,130
Including overdue payments	234	360	178	42	0.9
In relation to Toshkentshakhargaz	7,056	13,446	31,420	56,112	56,749

Source: TashTETs

iii) Balance Sheet of TashTETs

Table 3.2.1-15 shows the balance sheet of TashTETs and Table 3.2.1-16 shows the debt ratio. Capitalization ratio in 2014 was 54 %, that is a healthy trend for energy companies and is not a problem. The liquidity ratio, indicating short-term solvency is 0.5 or less, and the ratio of current liabilities to total liabilities in 2014 was 0.93, which is high. However, since the sales volume of thermal and electric energy is stable and payments for each month are received, there are currently no problems in the management of funds. According to the information of the Chief Accountant at TashTETs, liquidity ratio should improve in the future by reducing investment costs for equipment.

Table 3.2.1-15 Balance sheet report of TashTETs

(million sums)

Item	2010	2011	2012	2013	2014
Assets					
Capital assets					
Land, buildings and structures	1,161	1,498	1,566	1,655	133,350
Long-term investment assets	310	310	323	332	332
Machines	118	56,054	70,179	72	
Equipment	2765	6,028	18,921	120,308	716
Total fixed assets	4,353	63,890	90,989	122,366	134,399
Current assets					
Inventory	1,308	1,330	4,432	2,777	3,400
Advances	8	10	35	43	1,255
Accounts receivable	8,776	11,994	18,895	26,598	30,559
Cash in hand	13	772	203	107	971
Short-term securities	186	189	186	195	188
Other short-term assets		52			
Total current assets	10,291	14,348	23,752	29,720	36,372
Total assets	14,644	78,238	114,741	152,086	170,770
Capital					
Capital	2,090	2,090	2,090	2,090	2,090
Retained earnings	3,259	53,786	64,746	67,252	8,221
Evaluation tools and tools from exchange rate difference				10,522	82,012
Total capital	5,349	55,876	66,836	79,864	92,324
Obligations					
Long-term liabilities		1,833	7,795	8,063	5,308
Long-term borrowings		1,833	7,795	8,063	5,308
Total long-term liabilities		1,833	7,795	8,063	5,308
Current liabilities					
Accounts payable, including:	8,922	19,017	40,099	64,130	73,130
Owed to a supplier or business partner	7,351	16,465	32,007	57,181	57,090
Intercompany indebtedness	921	1,717	7,197	3,596	12,327
Other current liabilities	374	1,511	10	30	9
Total for current obligations	9,295	20,528	40,109	64,160	73,139
Total obligations	9,295	22,362	47,904	72,222	78,447
Total assets and liabilities	14,644	78,238	114,741	152,086	170,770

Source: TashTETs

Table 3.2.1-16 Assets and liabilities of TashTETs, as well as the debt ratio

	2010.	2011.	2012.	2013.	2014
Fixed assets ratio (fixed assets/total assets)	0.30	0.82	0.79	0.80	0.79
Liquidity ratio (current assets/current liabilities)	1.11	0.70	0.59	0.46	0.50
Current liabilities/Commitments	1.00	0.92	0.84	0.89	0.93
Capitalization ratio (capital/total assets)	37 %	71 %	58 %	53 %	54 %

Source: Compiled by JICA Study Team on the basis of information provided by TashTETs.

5) Contract between Tashteplocentral JSC and Tashteploenergo

Trade relations between Tashteplocentral and Tashteploenergo are executed based on the contract. The contract duration is 5 years; the last contract became effective from January 2015 and will continue until December 2019. Tashteploenergo annually declares the requested volume of supply taking into account the forecast for need in heat based on ambient temperature and supply capacity of Tashteplocentral JSC, and the volume of supply is specified in an additional contract which is attached to the above mentioned contract. Also, tariffs established by the Ministry of Finance are stated in the contract, if the tariff changes after the conclusion of the contract, payment for the received hot water is carried out according to the new tariff from the date of its introduction. According to the 2015 contract, the cost of 1 GCal of thermal energy is 38,737 sums (inc. VAT), and the volume of heat supply is 6,403,887 GCal.

According to Tashteploenergo, prepayments accounting for at least 30 % of the total planned volume of consumption are made at the beginning of each billing month, and the remaining payments are made at the end of the billing month.

6) Contract between Tashkent TC and Uzbekenergo JSC/Tashteploenergo

Table 3.2.1-17 shows the dynamics of prices and tariffs for payments between Tashkent TC and Tashteploenergo and Uzbekenergo JSC. Tariffs for thermal energy supplied by Tashteplonergo are set by the Ministry of Finance regardless of factors influencing the production cost, such as expenses for raw materials. The contract amount is revised twice a year, and currently the cost of one GCal makes 32,441 sums (incl. VAT). Mutual payments are made on the basis of a contract for one year, and changes are made every year. Heat rates consistently increase and are set at the rate of about 70 % of tariffs for the population and enterprises controlled by the government. Although thermal energy is supplied in accordance with the required volume of delivery by Tashteploenergo, the volume of heat supply executed by Tashkent TC is always at the level of 15 % of the total volume of heat supply in Tashkent.

Tashteploenergo monthly pays for delivered heat, 50 % of which is paid as advance payment at the beginning of the billing month. Uzbekenergo JSC monthly pays for delivered electricity, 15 % of which is paid as advance payment at the beginning of the billing month.

Table 3.2.1-17 Cost of heat and electricity sold by Tashkent TV JSC

	Period	Price		Period	Price
The cost of heat energy sold by Tashteploenergo (sums, 1 GCal, inc. VAT)	10/2008–12/2010	10,920	Cost of electricity sold by Uzbekenergo JSC (sums, 1kWh, incl. VAT)	10/2008–03/2009	59.95
	12/2010–08/2011	12,150		03/2009–07/2009	38.00
	08/2011–10/2011	13,974		07/2009–05/2010	42.00
	10/2011–10/2012	15,375		05/2010–11/2010	69.00
	10/2012–06/2013	22,300		11/2010–09/2011	71.40
	06/2013–04/2014	25,645		10/2011–09/2012	81.00
	04/2014–10/2014	29,491		10/2012–06/2013	75.30
	10/2014–present time	32,441		06/2013–10/2013	68.30
				10/2013–04/2014	74.40
				04/2014–09/2014	51.10
				10/2014–present time	155.90

Source: TashTETs

7) Establishing prices (tariffs) for heat and electricity of TashTETs

The price at which TashTETs supplies electricity to Uzbekenergo JSC is set by the Ministry of Finance in accordance with Decree No. 239 of the Cabinet of Ministers dated October 28, 2010. In order to set prices, TashTETs is required to submit a detailed financial report, as well as a profit and losses statement to the Ministry of Finance, including a price calculation for electric energy.

In contrast to the consistent increase of tariffs for thermal energy in the case of electricity tariffs for Uzbekenergo JSC the consistent trend is not observed; electricity tariffs for Uzbekenergo JSC greatly differ from the tariffs for end-users established by the Ministry of Finance which are increased with a certain coefficient. This is due to the fact that tariffs for heat are established first, afterwards electricity tariffs are established as adjustment mechanism of the TashTETs revenue management.

Tariffs for electricity, which will be supplied the planned new heat and power plant of Uzbekenergo JSC, will be set by the Ministry of Finance based on the expenses analysis for fuel, raw materials and materials, workforce and other production costs, as well as study of profitability indicators according to TashTETs financial reports.

(2) Heat supply grid

Heating is carried out by networks of Tashkent City, built during the Soviet period; heating networks are currently operated by Tashteploenergo. The total length of networks of heat supply is about 2,200 km (supply and return pipeline). Heating and hot water in winter, and hot water in summer are delivered to consumers, such as one-apartment and multi-apartment residential houses, businesses, factories, and hospitals. The division of responsibility of heat grids is shown below, and construction of new pipelines and their maintenance is carried out by relevant organizations bearing operational responsibility.

Table 3.2.1-18 Division of responsibility of heat networks in Tashkent

Responsible organization	Division of responsibility
Heat manufacturer	From heat supply equipment to border of operational responsibility of heat supply equipment[*1]
Tashteploenergo	From border of operational responsibility of heat supply equipment to border of operational responsibility of consumer[*2]
Consumer	From border of operational responsibility of consumer[*2]

*1 Border of operational responsibility of heat supply equipment is the territorial border of heat supply equipment and a hot water commercial meter, etc.

*2 Border of operational responsibility of consumer is the territorial border of consumer (fence or building walls, etc.) and an entrance gate of apartment houses, etc.

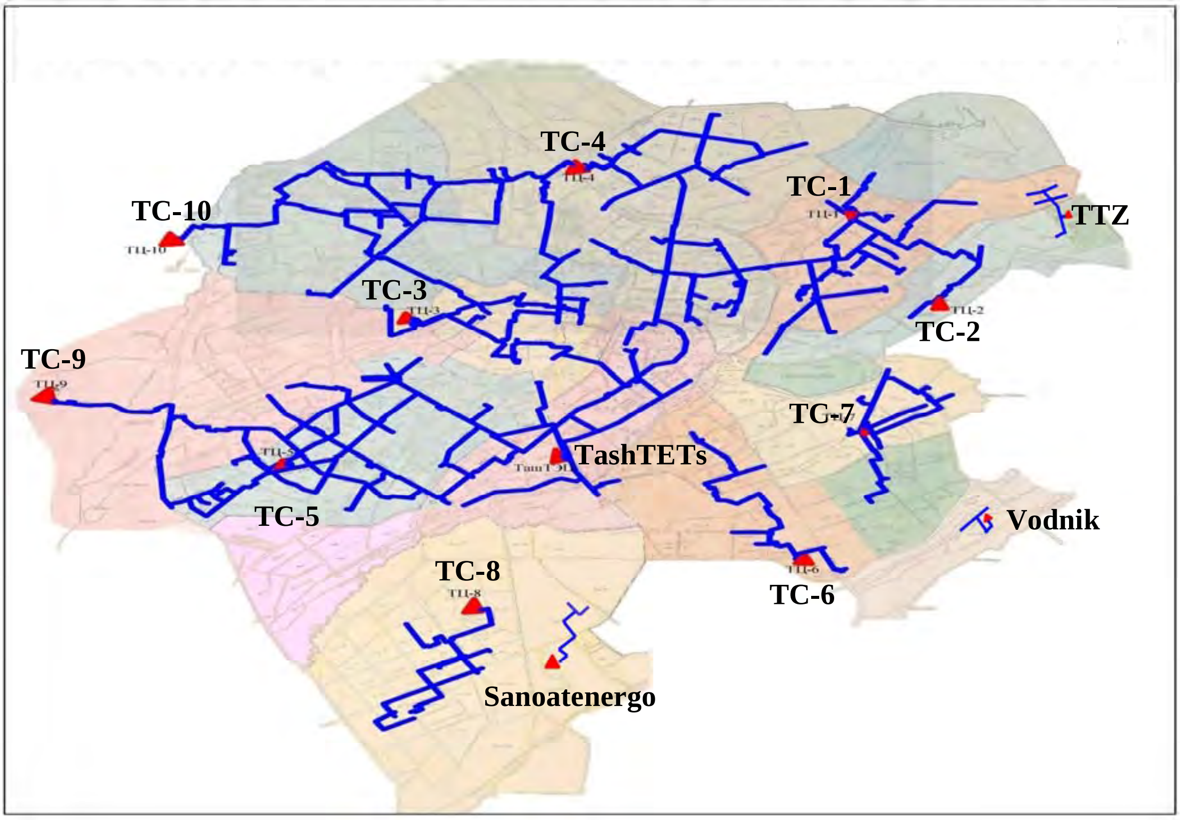
Source: compiled by JICA Study Team according to the information provided by Tashteploenergo.

Basically, the system of heat supply of Uzbekistan, including Tashkent, was built in 1950–1970, and the equipment is of old type (e.g. hot water used for heating returns back to heat generating equipment, but hot water for hot water supply not returns). Therefore, due to the obsolete equipment the energy efficiency falls. In order to improve this falling efficiency of the system, three locations in Uzbekistan (Andijan, Chirchik and Tashkent) were selected for pilot projects promoting the improvement of the efficiency of heat supply systems with the support of the World Bank. Sergeli District of Tashkent has been selected as a project target (TC-8 coverage); it is planned to return the whole volume of hot water to the heat generation equipment and introduce a circulation system with water re-heating by installing heat exchangers on the consumer side, as well as installation of cogeneration equipment. According to the World Bank, the use of cogeneration system as the main source of heat, and hot water boilers as a backup source during peak hours is the most profitable for heat supply of Sergeli District.

For the above mentioned project in Sergeli District, the design cost for grids reconstruction is 46.5 million US dollars (15.2 million US heat pipeline dollars, 4.2 million US dollars for GDS, and 27.1 million US dollars for heat supply part of cogeneration equipment). Total estimated cost of the project, including the energy generation part of the cogeneration equipment is 98.8 million US dollars. In the future, the government of Uzbekistan will proceed to financing of the project.

Among Tashkent heat pipelines TC-6, TC-7, TC-8, TTZ, TC-2, Sanoatenergo and Vodnik are with independent thermal network, and the remaining boilers are combined into a single grid and can supply heat to the nearby areas in emergency cases. However, due to heat losses in the pipe, transmitting heat over a long distance is not possible (for example, from the suburb to the city centre). Among heat pipes laid on the surface, some places with worn-out insulation and exposed to corrosion were found; a casing was used for underground piping, which is relatively in a better condition. According to According to the Tashteploenergo’s information, approximately 50 % of urban heat pipes exceeded their service life. Therefore, in accordance with Decree No. 197 of the Cabinet of Ministers of the Republic of Uzbekistan (On measures to implement programs - road maps for financial recovery of unprofitable heat organizations) it is planned to conduct repair works (of 1,485 km of hot water supply pipeline and replacement of heat insulation) until 2024, and the improvement of heat supply grids is expected in the future.

Figure 3.2.1-5 Pipeline of hot water supply
(on the right: aboveground part; on the left: underground part)



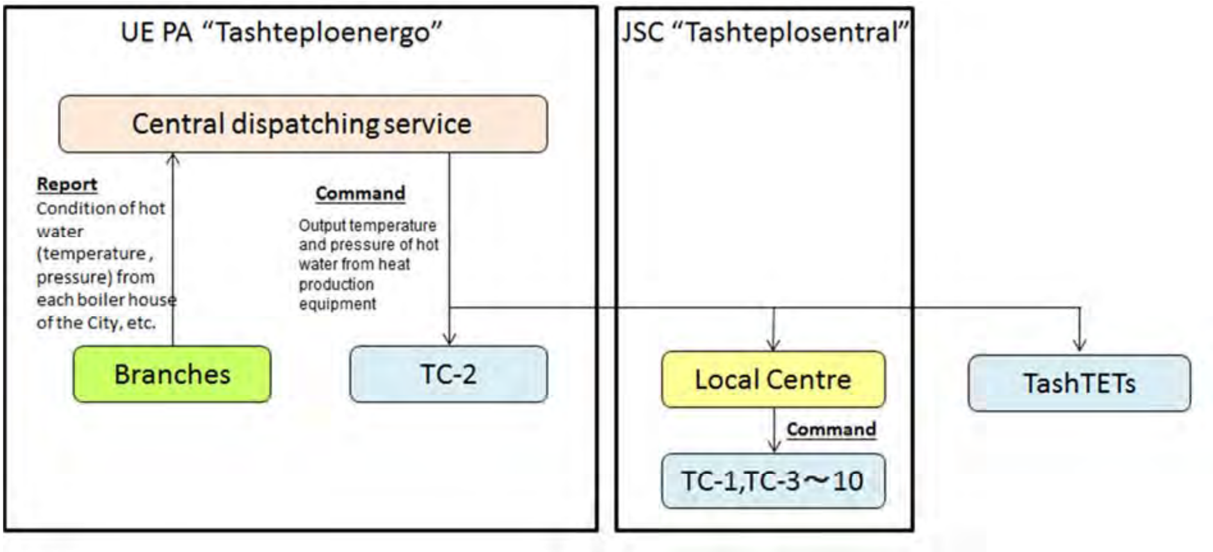
Source: Compiled based on materials of TashTETs

Figure 3.2.1-6 Main pipelines of heat supply grids in Tashkent

With regard to areas remote from the aforementioned networks of heat supply, as territorial heating systems use is not effective, local boilers are installed targeting several houses.

(3) Regulation of supply and demand

Regulation of heat supply and demand is fully carried out by the Central Dispatch Service of heat supply under Tashteploenergo. This dispatch service instructs boiler houses regarding temperatures and pressures of supply water based on temperature and hot water pressure data obtained from its own divisions in each area of the city. On the basis of these instructions, output capacity and quantity of involved boilers are regulated. With regard to Tashteplocentral JSC, which has on the balance a number of boiler houses, all instructions of the Central Dispatch Service for heat supply go to the local center located in TC-1, and from there instructions are given to boiler houses.



Source: Compiled by JICA Study Team based on interviews with Tashteploenergo and TashTETs

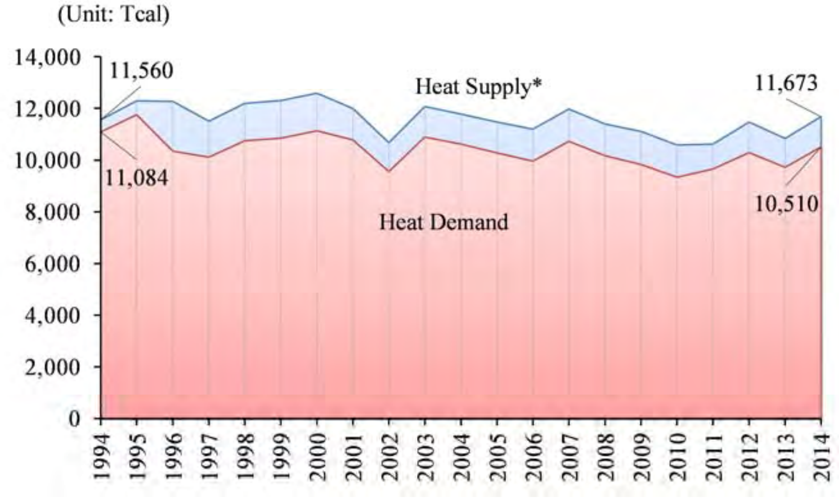
Figure 3.2.1-7 Method of regulating demand and supply of thermal energy in the city of Tashkent

3.2.2 Heat Demand

(1) Heat Demand of Tashkent City

According to the data provided by Tashteplocentral, the heat demand of Tashkent City has decreased from 11,084 Tcal in 1994 to 10,510 Tcal in 2014, declining at an average annual rate 0.3 %. In the same period, heat supply volume of the city was fluctuating, but the supply of heat was almost at the same level. The loss caused by the transport of heat supply of Tashkent City on average 10.9 % per annual.

Tashkent City has no plan to construct a specific pipeline system for steam supply. However, Tashteplocentral has provided the steam to a few specific consumers. The total amount of steam supplied by Tashteplocentral has decreased gradually since 2010, and 5,634.3 GCal steams was provided to the only customer, Tosh Tukimachi (textile manufactory), in 2014. But the amount of steam demand in the same year accounted for only 0.05 % of the total heat demand.



Note: * Included heat purchase.
Source: Tashteplocentral

Figure 3.2.2-1 Heat Consumption of Tashkent City (1994– 2014)

Table 3.2.2-1 Steam Consumers and Actual Supply by Tashteplocentral

Name of Company	Type of Industry	Actual Steam Supply (GCal/year)					
		2009	2010	2011	2012	2013	2014
Agrohimplast	Vinyl factory (for vinyl house)		26.8				
Gabus-Temir BetonBuyumlari	Concrete manufacturer (for rail way)	264.0					
Zavod Jelezobetonnih Izdeliy	Concrete manufacturer (for rail way)	512.9					
Gafarov	Liquid glass manufacturer	49.6	153.7	270.1			
Tashkaya Teksyil	Textile factory						
Tosh Tukimachi	Textile factory	8,965.6	8,298.9	8,621.7	8,329.7	10,299.0	5,634.3
Uzjeldorpass	Cleaning factory	9,009.4	9,608.2	8,068.5	6,573.2	3,479.7	
Total		18,801.5	18,087.6	16,960.3	14,902.9	13,778.7	5,634.3

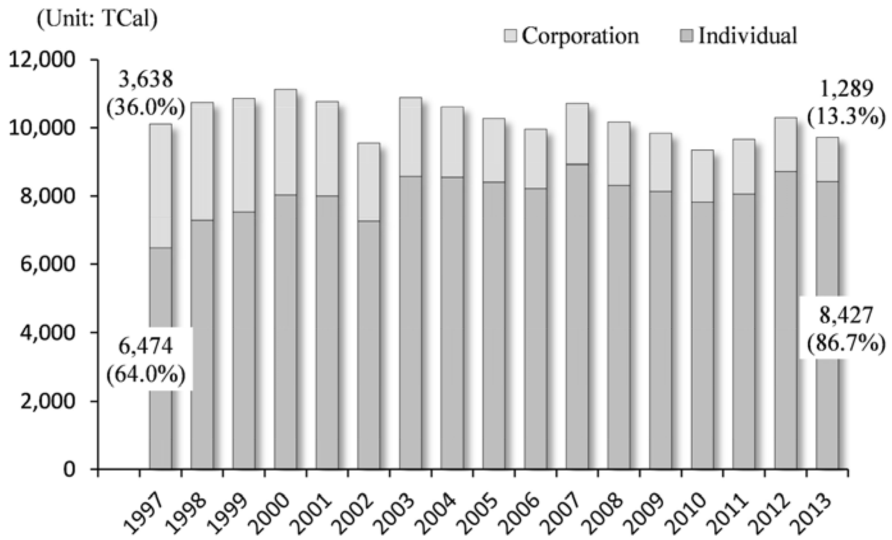
Source: Tashteplocentral

(2) Type of Contract and Pricing System

Currently, there are two types of Tashkent City heat supply contracts: individual (residential) contract, and corporation (commercial) contract. These contracts are intended to be concluded between the consumers and Tashteplocentral. In terms of contract type, the heat consumption by individuals increased at an average annual growth rate of 1.7 % from 1997 to 2013. The increase of heat demand of residential sector in Tashkent City is mainly the result of the increase of housing due to the increase of population. This can be confirmed by the heat supply floor area which increased from 13.25 million square meters in 1994 at an average annual rate of 0.76 % to 15.3 million square meters in 2013. As of the 2013 heat demand data, residential sector consumed 86.7 % of the total heat supply to Tashkent City. The share has increased by 22.7 points compared to 64.0 % in 1997. The use of distributed heating equipment instead of centralized heat supply system in new detached single-family houses is increasing, but in the case of multi-family apartment buildings the centralized heat supply system is used basically.

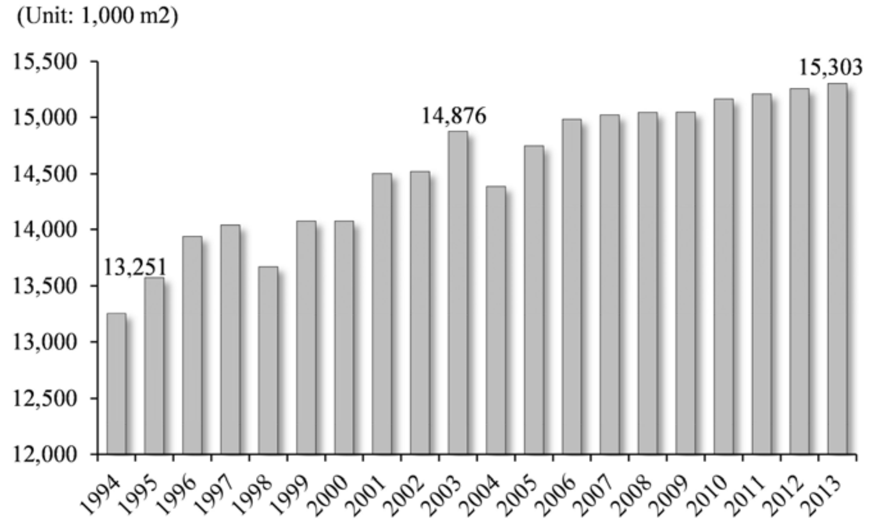
On the other hand, heat demand of corporation contracts decreased at an average annual rate of 6.3 % over the same period. Parts of the demand of commercial sector were substituted by private heat supply system installed by the commercial sector itself. As a macro level, there are also many industries trying to shift their business from Tashkent City to Tashkent Province because of the difference of cost performance between the two region. However, about 87 % of the heat supply volume is consumed by individuals, from the fact that corporate customers share is only about 13 %, it can be said that the decrease of the corporate contracts will not affect much on the general heat demand.

The heat supply infrastructure in Uzbekistan was established in the Soviet Union era. Most of the heat supply infrastructures in the city are of outdated facilities and equipment. Generally the heat supply will start in October and end in March of the following year. The heat supply cannot be stopped or adjusted for the temperature during the supply period. Because of this reason, some new houses and commercial consumers shift to the distributed heat supply system for more flexibility. The shift is especially high in service industries such as hotels and restaurants, where high adjustment of heat supply is one of the conditions for providing a comfortable environment to the customers. But still a majority of residential area in city and regional area relies on the central heat supply system. Central heat supply system will keep serving as the main system for Tashkent City. The system could improve by replacing the plumbing, installing meter on demand side, and putting the heating contactors in each of the room.



Source: Tashteplocentral

Figure 3.2.2-2 Heat Consumption by Sector (1997– 2013)



Source: Tashteplocentral

Figure 3.2.2-3 Heat Supply Floor Space of Tashkent City (1994– 2013)

The heat supply in Tashkent City is only executed on the basis of individual contracts and corporation contracts. The number of individual contracts has increased from 423thousands in 2010 compere to 426 thousands in 2014, increasing by only 3,061 and at an average annual growth rate of 0.18 %. The average number of persons per household in Tashkent City has been estimated at 3.8 persons, and assuming that the total population in the city in 2014 was 2.35 million persons, the number of households becomes 619 thousands. Around 426.5 thousands or 68.9 % of the households in Tashkent have become customers of individual contracts using the centralized heat supply system. On the other hand, the number of customers of the corporation contracts in the same period increased by 1,927, declining at an average annual rate of 5.2 %.

Table3.2.2-2 Type of Contracts and Number of Customers (2010–2014)

Year	Individual (Number of Contracts)	Corporation (Number of Contracts)
2010	423,408	8,569
2011	424,786	9,477
2012	426,232	9,841
2013	425,362	10,164
2014	426,469	10,496

Source: Tashteploenergo

Pricing structure is as shown below.

1) Corporation Contract

Hot water and heat consumed are measured by meter, and the customers are charged according to the consumption measured in 1 GCal.

2) Individual Contract

<Heat>

The contract is based on the floor area of the building. For example, if the floor area of the house is 100 square meter, based on the charge level of 845 sums per square meter per month, the payment will be 84,500 sums per month. Since the heating supply service is provided on during the five months of the winter, from November to end of March, the customer of the above example will have to pay 422.5 thousand sums in one season. However, generally the total amount is divided by 12 months to reduce the burden on the consumer.

<Hot Water>

The consumption of hot water is measured by meter, and charged according to the amount used by unit used. In the region where old houses without meters exist, some fixed fee calculated based on the number of residents per household is used.

Heat and hot water price (such as electricity, gas and water bills) is adjusted twice a year, in October and April.

Table 3.2.2-3 shows the trends of heat and hot water price rates of Tashkent City. The rate of charges for heat and hot water has increased by 17 %–26 % annually in the last five years.

According to the interviews with Tashkent residents, the adjustment of the fee for public service is based on the increase rate of social welfare spending (pensions, medical care, education, etc.) in the same year, in August or September.

Table 3.2.2-3 Heat and Hot Water Price of Tashkent City

Price Adjustment Schedule	Individual Contracts			Corporation Contracts
	Heat (Sums)	Hot Water (Sums)		
		Basic Charge	User Charge	
	Floor Space 1 m^2/Month	1 person /Month	1 m^3/Month	1 GCal
Oct-10	397	4,969	1,272	22,321
Apr-11	437	5,460	1,398	24,527
Oct-11	464	5,806	1,486	26,082
Apr-12	535	n.a	1,717	n.a
Oct-12	584	7,311	1,871	32,842
Apr-13	663	n.a	2,124	n.a
Oct-13	705	n.a	2,260	n.a
Apr-14	788	9,861	2,524	44,298
Oct-14	845	10,571	2,706	47,487

Source: Ministry of Finance, Uzbekistan. (data for Apr-2012, Apr-2013, Oct-2013 and pricing data for 1m^3 of hot water gathered by Study Team by interview survey of citizens of the city)

3) Table 3.2.2-4 shows the charges levied against the heat supply of Tashkent City. Total amount of fare collection in 2014 reached 275.74 billion sums, which is a double of that of 2010, 131.33 billion sums, the average annual growth rate is 20.4 %. However, the collection rate was lower in 2014 (93 %) than in 2010 (100 %). The reason for fare collection rate changes was due to shifts in the timing of the payment. Individual contracts accounted for 74.3 % of the total of the 2014 amount, and corporation contracts for the remaining 25.7 %.

Table3.2.2-4 The Fare collection rate on Heat Supply for ”Toshissiqquvvati” (2010–2014)

Period	Total (1,000 Sums)			Individual Contracts (1,000 Sums)			Corporation Contracts (1,000 Sums)		
	Billing Amount	Payment	Collection Rate (%)	Billing Amount	Payment	Collection Rate (%)	Billing Amount	Payment	Collection Rate (%)
2010	128,724,505	131,329,156	102	91,775,326	94,784,552	103	36,949,179	36,544,605	99
2011	157,386,654	160,867,187	102	111,624,901	117,095,668	105	45,761,752	43,771,519	96
2012	199,895,943	191,734,457	96	145,847,874	136,859,693	94	54,048,070	54,874,764	102
2013	220,186,571	224,527,563	102	164,012,372	167,950,716	102	56,174,199	56,576,846	101
2014	297,378,673	275,740,672	93	221,334,849	204,847,468	93	76,043,824	70,893,204	93

Source: Manager, Management Department of “Teplosbyt”.

(3) Challenges of Heat Supply

Tashkent City did not prepare a heat demand projection for long-term or short-term. According to Tashteplocentral, it follows the instructions from Tashkent City government to estimate the heat demand for the following year and report to the city government. Tashteplocentral increases the heat demand by 0.5 % compared to previous year in the report it submits to Tashkent City government. Tashteplocentral has assumed that the trend of heat demand will not change until the year of 2020, and it expects the demand to grow at an average annual rate of 0.5 % until 2020. On the other hand, based on the Cabinet Decree No.197, Tashkent City is requested to replace the city pipeline by 2020. Currently more than 50 % of the pipelines in the city are over service age. The replacement of new equipment and pipeline can reduce the heat supply. However, the promotion of energy saving by efficient heat supply through the replacement of the existing facilities is an important element and challenge which is essential to meet the future heat demand increase.

3.2.3 Overview of Existing Heat Supply Equipment and Operational Status

(1) Overview of existing heat supply equipment

Hot water for heat supply system of Tashkent city is produced by 69 natural gas-fired hot water boilers installed in 9 boiler houses of JSC “Tashteplosentral”, (TC-1, TC-3 to TC-10), 4 boiler houses of UE PA “Tashteploenergo” (TTZ, TC-2, Sanoatenergo, Vodnik), and in one cogeneration power plant of Uzbekenergo JSC (TashTETs), with a total installed capacity of 5,870 GCal/h. Most of the boilers were constructed during the Soviet Union and in service for 20–50 years, and they are becoming outdated. In connection, the total available amount of heat supply has decreased to 80 % (4,745 GCal/h) of installed capacity. In this regard the sequential renewal of the equipment is required, especially that of TC-4 of JSC “Tashteplosentral”, which has the highest operational rate and is most outdated in comparison with others. In case of steam supply, individual steam supply is provided by TashTETs to a nearby textile mill, and some of the leading companies, such as SJSC “Tashkent Aviation Production Association named after V. P. Chkalov”, have installed small scale boilers for self-consumption, which are different from hot water utilization, and do not have supply network.

Table 3.2.3-1 List of boiler equipment in Tashkent

Item	Name	Installed capacity (available capacity) [GCal/h]	Average operational rate (%)	Number of boiler equipment Type Installed year Accumulated operation time (as of end of 2014) (hour)									
Tashteplosentral	TC-1	500 (399)	49	#1 PTVM-50 1968 161,272	#2 PTVM-50 1969 176,389	#3 PTVM-100 1970 169,115	#4 PTVM-100 1975 200,964	#5 PTVM-100 1978 220,583	#6 PTVM-100 1999 48,364				
	TC-3	400 (315)	45	#1 PTVM-50 1971 180,331	#2 PTVM-50 1971 185,038	#3 PTVM-100 1972 202,485	#4 PTVM-100 1978 175,233	#5 PTVM-100 1978 190,391					
	TC-4	900 (815)	62	#1 PTVM-50 1970 219,778	#2 PTVM-50 1970 231,359	#3 PTVM-100 1970 253,509	#4 PTVM-100 1975 234,059	#5 PTVM-100 1976 214,784	#6 KVGM-100 1987 130,739	#7 KVGM-100 1986 123,587	#8 KVGM-100 1991 78,117	#9 KVGM-100 1996 72,576	#10 KVGM-100 1998 47,805
	TC-5	700 (566)	44	#1 PTVM-50 1969 174,914	#2 PTVM-50 1970 162,489	#3 PTVM-100 1971 186,544	#4 PTVM-100 1975 183,668	#5 PTVM-100 1978 171,336	#6 PTVM-100 1979 56,432	#7 PTVM-100 19XX 135,006	#8 PTVM-100 2000 52,054		
	TC-6	300 (231)	29	#1 PTVM-50 1973 179,883	#2 PTVM-50 1973 144,354	#3 PTVM-100 1981 112,567	#4 PTVM-100 2000 57,588						
	TC-7	400 (347)	41	#1 PTVM-50 1976 186,608	#2 PTVM-50 1978 163,322	#3 PTVM-100 1980 165,970	#4 KVGM-100 1988 98,620	#5 KVGM-100 1997 53,836					
	TC-8	300 (278)	32	#1 PTVM-50 1980 192,795	#2 PTVM-50 1981 159,321	#4 KVGM-100 1990 87,341	#5 KVGM-100 1983 78,415						
	TC-9	540 (518)	19	#1 KVGM-180 1986 90,861	#2 KVGM-180 1987 113,157	#3 KVGM-180 1988 71,739							
	TC-10	540 (518)	19	#1 KVGM-180 1986 67,114	#2 KVGM-180 1987 107,278	#3 KVGM-180 1988 100,828							
Tashteploenergo	TTZ	220 (220)	6	#1 PTVM-50 1969 7,682	#2 PTVM-50 1969 35,050	#3 PTVM-30 1983 2,972	#4 PTVM-30 1976 8,512	#5 PTVM-30 1977 22,006	#6 PTVM-30 1976 49,120				
	TC-2	300 (286)	4	#1 PTVM-100 1980 26,767	#2 PTVM-100 1980 21,727	#3 PTVM-100 1981 27,753							
	Sanoatenergo	60 (60)	3	#1 PTVM-30 1988 40,651	#2 PTVM-30 1988 3,440								
	Vodnik	60 (60)	4	#1 KVGM-20 1993 3,854	#2 KVGM-20 2000 12,788	#3 KVGM-20 2000 15,469							
Uzbekenergo JSC	TashTETs	650 (650)	32	#6 PTVM-50 1963 120,179	#7 PTVM-50 1964 133,434	#8 PTVM-100 1964 140,753	#9 PTVM-100 1966 133,524	#10 PTVM-100 1967 138,995	#11 PTVM-100 1968 143,199	#12 PTVM-100 1969 129,679			

Source: Prepared on the basis of materials submitted by JSC “Tashteplosentral”, UE PA “Tashteploenergo”, JSC “Tashkent Cogeneration Power Plant”

(2) Present state of existing heat supply equipment

a) Operating conditions of each boiler house

Hot water supply in Tashkent is carried out according to “Summer” operating mode from April to around September, and “Winter” operating mode from October to around March. Switching between operating modes is carried out at average temperature of 15°C. Accordingly, the amount of hot water supplied by each boiler house fluctuates greatly (See Table 3.2.3-1 and Table 3.2.3-2). By using this, scheduled inspection of each boiler house is sequentially carried out from April to September in order to prepare for the next winter season.

Among boiler houses, the largest amount of hot water supplied by TC-4, followed TashTETs and then TC-5 (See Figure 3.2.3-3). This is connected not only to the large installed capacity of the plant, but also to the hot water interchanges with the neighboring areas in addition to the hot water supply of surrounding area (e.g. TC-4⇒TC-10, TC-5⇒TC-9, etc.).

Source: Prepared on the basis of materials submitted by JSC "Tashteplosentral", UE PA "Tashteploenergo", JSC "Tashkent Cogeneration Power Plant"

Figure 3.2.3-1 Actual records of monthly hot water supply of boiler houses in Tashkent (2013, integrated value)

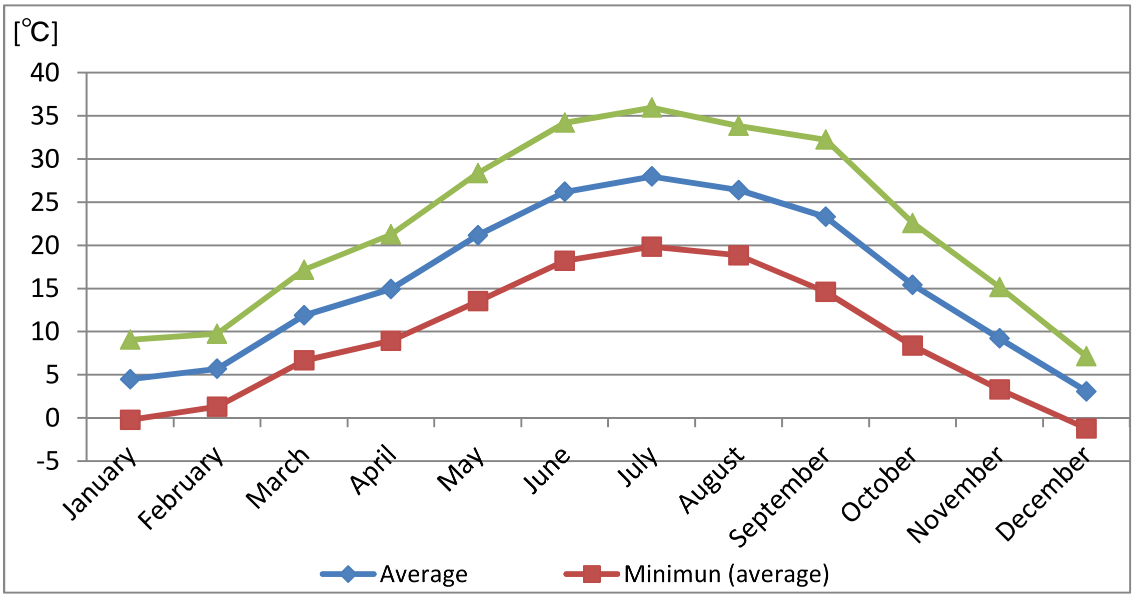
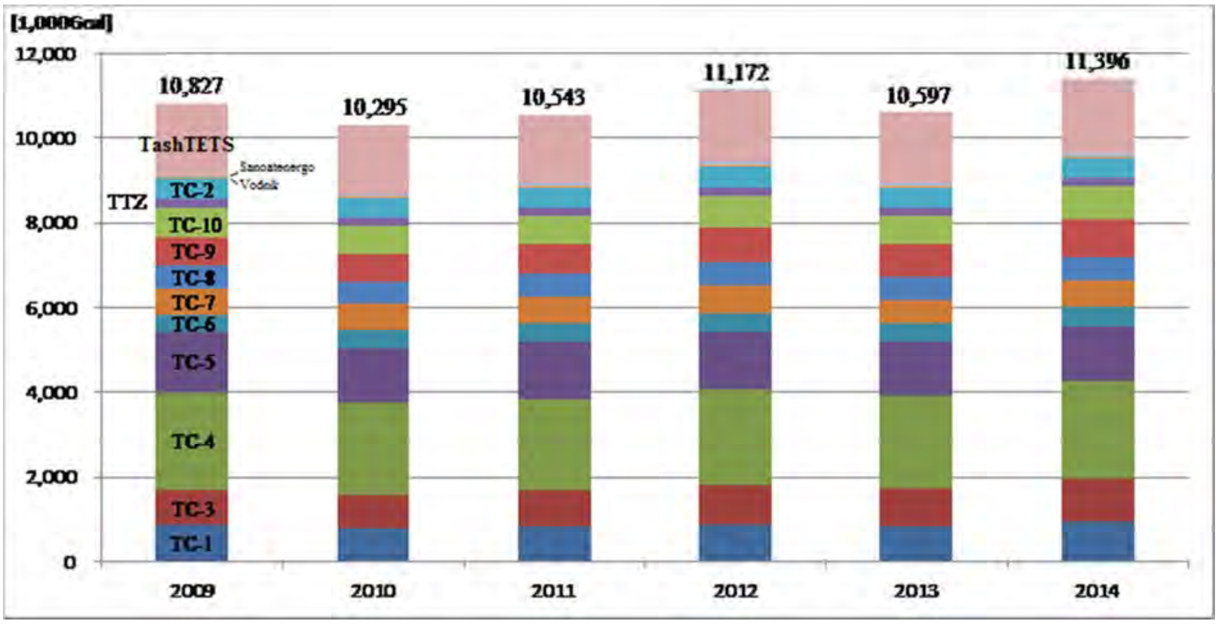


Figure 3.2.3-2 Records of monthly average temperature in Tashkent (2013)



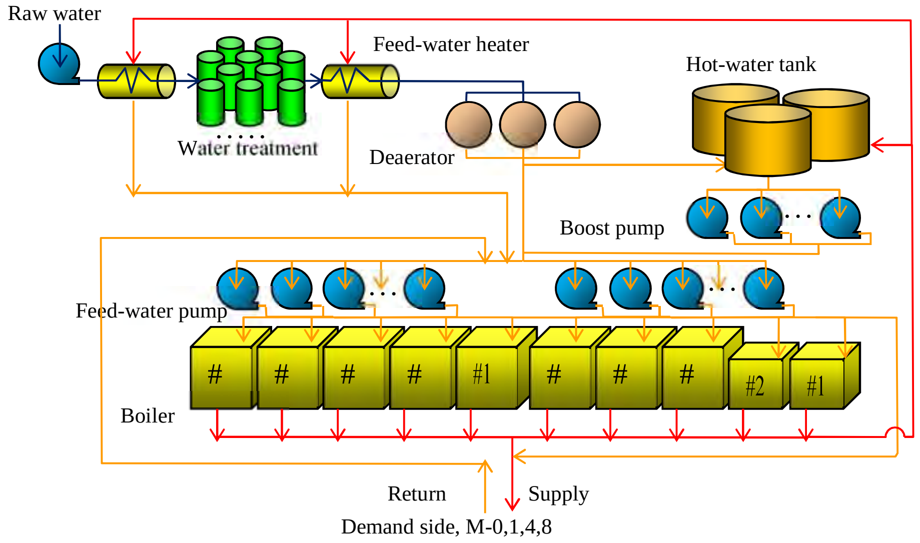
Source: Prepared on the basis of materials submitted by JSC "Tashteplosentral", UE PA "Tashteploenergo", JSC "Tashkent Cogeneration Power Plant"

Figure 3.2.3-3 Annual hot water supply performance of boiler houses

b) TC-4

Here operating conditions of TC-4, the largest boiler house of Tashkent which is adjacent to the Project site, are described.

TC-4 consists of 10 gas-fired hot water boilers, raw water (tap-water from SuvSoz) treatment facility to feed the boilers, and various auxiliary equipment, such as pumps.



Source: Prepared on the basis of materials submitted by JSC "Tashteplosentral"

Figure 3.2.3-4 Schematic diagram of TC-4

Table 3.2.3-2 Specification of hot water boiler of TC-4

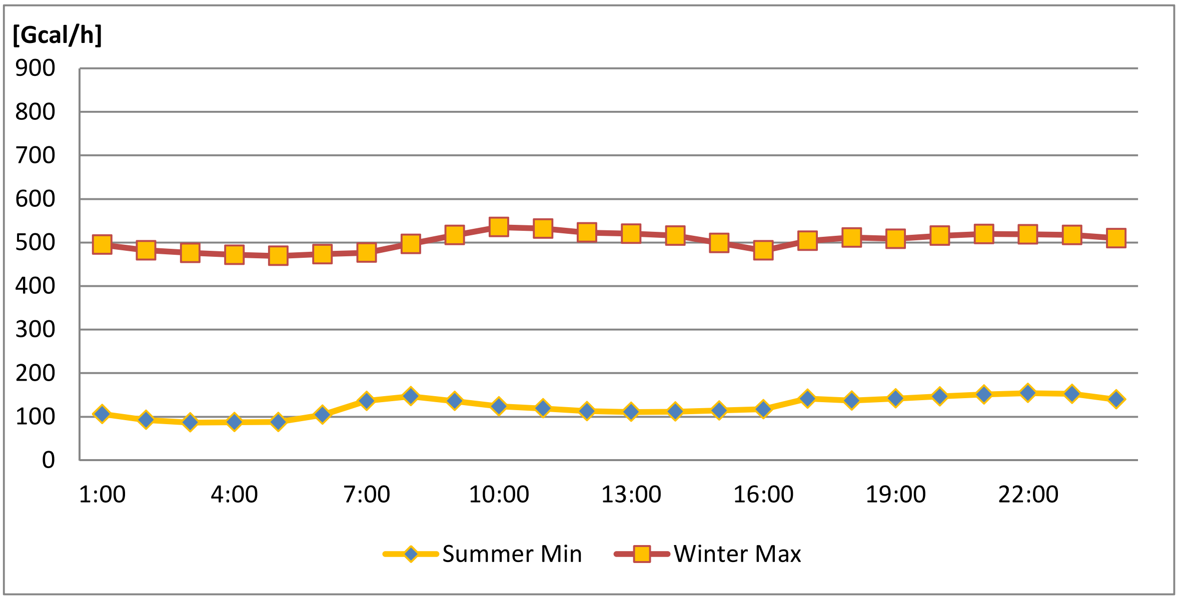
	Installed capacity (GCal/h)	Temperature of the feed water		Pressure of feed water		Rated flow (t/h)
		Inlet	Outlet	Inlet	Outlet	
#1 PTVM-50	50	70	150	25.0	10.0	625
#2 PTVM-50						
#3 PTVM-100	100					1,235
#4 PTVM-100						
#5 PTVM-100						
#6 KVGM-100						
#7 KVGM-100						
#8 KVGM-100						
#9 KVGM-100						
#10 KVGM-100						

Source: Prepared on the basis of materials submitted by JSC “Tashteplosentral”

Table 3.2.3-3 Utilization ratio of hot water boilers of TC-4

	2013 year [%]												
	January	February	March	April	May	June	July	August	September	Octoberь	Novemberь	Decemberь	Annual
#1 PTVM-50	78.7	73.4	53.1	-	-	-	-	-	-	1.6	54.7	54.9	26.1
#2 PTVM-50	57.6	52.7	48.0	14.8	41.4	11.9	-	-	-	-	-	0.54	18.8
#3 PTVM-100	60.1	52.1	47.3	29.2	-	-	-	-	2.0	45.8	56.3	55.9	28.9
#4 PTVM-100	49.6	53.2	48.2	41.1	43.2	45.8	46.8	39.4	28.0	15.5	55.6	46.6	42.7
#5 PTVM-100	50.9	48.7	47.9	35.8	34.9	27.3	3.3	0.7	5.3	-	0.98	43.8	24.9
#6 KVGM-100	48.4	41.7	21.3	-	0.8	7.2	31.2	38.1	2.2	29.9	28.3	20.4	22.4
#7 KVGM-100	60.2	56.5	45.3	46.3	18.0	-	-	-	21.6	0.3	20.5	70.0	28.1
#8 KVGM-100	69.0	65.1	51.5	-	-	-	-	-	7.6	10.2	0.4	-	16.8
#9 KVGM-100	66.8	72.4	70.3	6.0	39.9	67.8	20.4	-	36.4	63.0	79.6	61.1	48.5
#10 KVGM-100	9.0	2.6	-	-	-	-	49.1	59.5	14.4	-	58.8	79.2	22.9
Monthly	53.57	50.59	42.48	18.42	17.50	17.12	16.76	15.30	13.06	18.39	36.43	44.97	28.62

Source: Prepared on the basis of materials submitted by JSC “Tashteplosentral”



Source: Prepared on the basis of materials submitted by JSC "Tashteplosentral"

Figure 3.2.3-5 Seasonal (summer minimum, winter maximum) daily load curve of heat supply of TC-4 (2013)

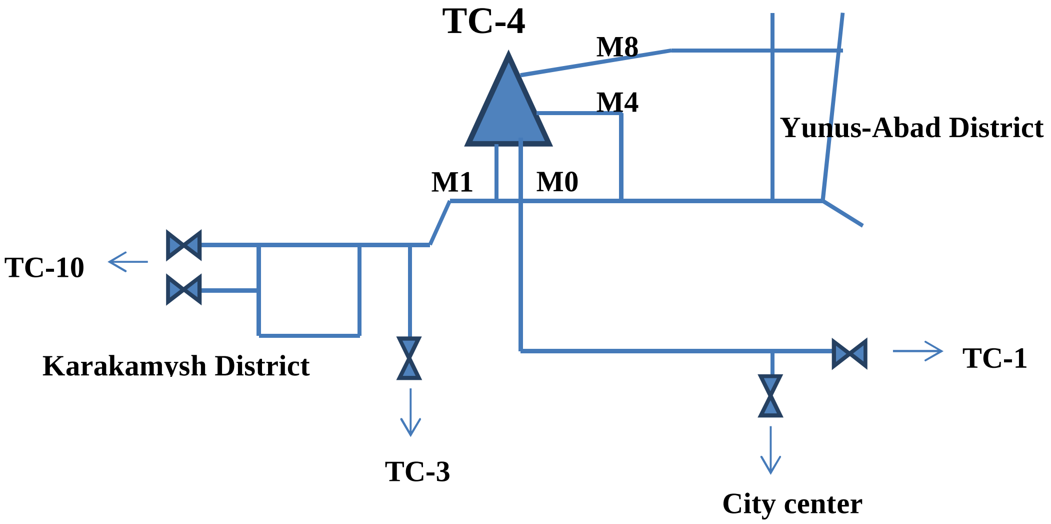
According to JSC "Tashteplosentral", the load of hot water boilers at a range of 40-45 % is economic, and the boilers are being operated at this range. Even if owned rated capacity is 900 GCal/h, in winter, when the demand is the highest, with the use of all boilers the amount of heat supplied is only about 500 GCal/h. In summer, the period of low demand for heat as there is no need for heating, the amount of heat supplied is 90–140 GCal/h.

Also, design inlet temperature of boiler feed water is 70°C, and design outlet temperature of hot water is 150°C. However, according to operation records, the inlet temperature of feed water is around 45°C, and the outlet temperature of hot water is 75-120°C.

Outlet temperature of hot water is regulated by the number of burners; outlet flow volume and pressure are regulated by the number of running feed-water pumps. Hot water produced by boilers is not necessarily supplied in full amount at the same time; a part of hot water is accumulated in hot-water tanks of TC-4 and supplied during the high demand.

The temperature of hot water supplied to a demand side is regulated by admixing of low temperature feed water to a high temperature water at the outlet of a boiler.

Water treatment facility consists of 52 Na-cation exchangers. Real water treatment capacity is 4300 t/h; there was a case during a winter season when water was treated at a rate of almost 4300 t/h. According to JSC "Tashteplosentral" there will be reserve water treatment capacity after the refurbishment of above-mentioned supply pipeline of the network side.



⋈ : Valve between areas (usually close, except emergency situation and repair works in summer period)

Source: Prepared on the basis of materials submitted by UE PA "Tashteploenergo"

Figure 3.2.3-6 Heat supply area of TC-4

Table 3.2.3-4 Actual data of hot water interchange from TC-4 to other networks

Interchange area	Interchanged volume (GCal/h)※	Interchange period (hour)
Area of TC-1	15.9	216
Area of TC-3	6.2	120
Area of TC-10	40.8	4,584
Northern part of city center	20.0	1,776

Source: Prepared on the basis of materials submitted by UE PA "Tashteploenergo" ※Interchange volume is a maximum value in 2009–2014.

Hot water produced byTC-4 is supplied to the main pipeline of UE PA "Tashteploenergo" (M0, M1, M4, M8) in full amount. In winter, when demand for a hot water is high, TC-4 supplies hot water mainly to nearby Karakamysh district and Yunus-Abad district. In summer and in emergency situations, hot water is interchanged to northern part of Tashkent (TC-1, TC-3, TC-10) and to a northern part of city center.

b) TashTETs

Here we present information about TashTETs, which carries out combined heat and power generation, as well as the present project.

TashTETs carries out electricity and heat (hot water and steam) production and supply using 5 steam boilers for combined heat and power generation (total capacity: 415t/h, total heat output: 280GCal/h), 1 steam turbine generator (rated capacity: 22.5 MW), 7 hot-water boiler for hot-water supply (total heat output 650 GCal/h), gas turbine unit (MHPS H-25 (28), rated capacity: 27 MW) and HRSG which were introduced within the New Energy and Industrial Technology Development Organization (NEDO)'s energy-saving model project and put into operation in 2013.

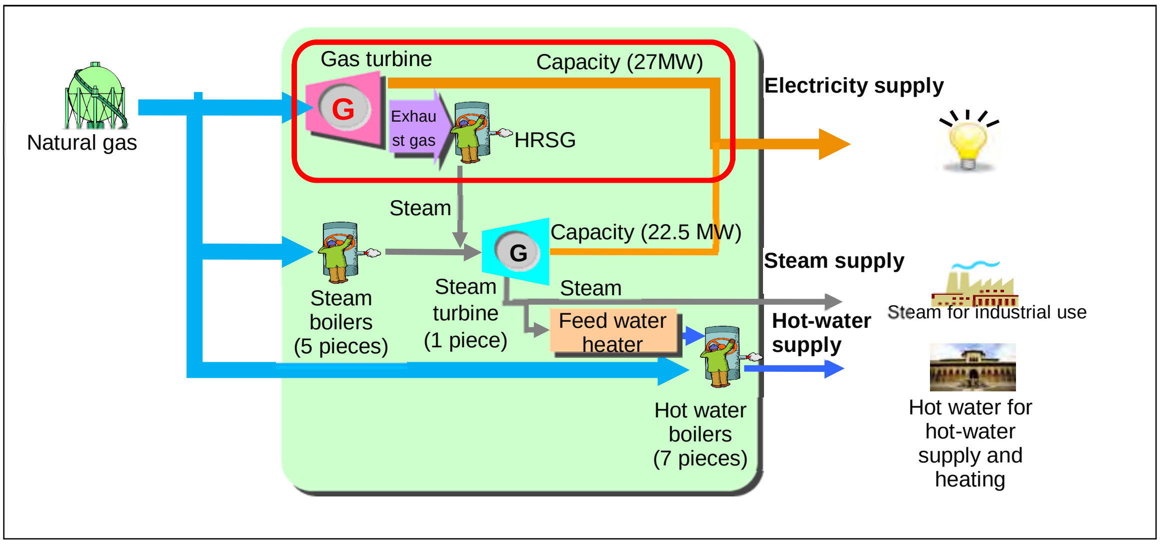


Figure 3.2.3-7 Schematic diagram of TashTETs equipment

Table 3.2.3-5 Specification of TashTETs steam boilers

Item	Unit	Unit number				
		No.1	No.2	No.3	No.4	No.5
Type	―	Drum-type, natural circulation				
Rated capacity	t/h	60	60	70	75	150
Actual capacity	t/h	60	60	70	75	150
Main steam pressure	kg/cm^{2}G	30	30	30	30	30
Main steam temperature	°C	410	410	410	410	410
Inlet pressure of feed water	kg/cm^{2}G	48	48	48	48	48
Inlet temperature of feed water	°C	105	105	105	105	105
Fuel		Natural gas				
Year of commencement of operation	year	1938	1938	1948	1953	1955
(Duration of operation)	year	76	76	66	61	59

Source: Prepared on the basis of materials submitted by TashTETs.

Table 3.2.3-6 Specification of TashTETs hot-water boilers

Item	Unit	Specification						
Unit number	―	No.6	No.7	No.8	No.9	No.10	No.11	No.12
Rated capacity	GCal/h	50	100	100	100	100	100	100
Actual capacity	GCal/h	50	100	100	100	100	100	100
Outlet pressure of hot water	kg/cm^{2}G	12.5	12.5	12.4	12.5	13	12.2	12.5
Outlet temperature of hot water	°C	88	86	86	65	70	70	65
Inlet pressure of feed water	kg/cm^{2}G	17	16.8	17	17	17	17.3	17.5
Inlet temperature of feed water	°C	71	70	56	56	57	56	56
Fuel	―	Natural gas						
Year of commencement of operation	year	1963	1964	1964	1966	1967	1968	1969
(Duration of operation)	year	51	50	50	52	47	46	45

Source: Prepared on the basis of materials submitted by TashTETs.

Table 3.2.3-7 Specification of TashTETs steam turbine

Item		Unit	Specification
Unit number		—	AP-25 (M) No.4 Steam turbine
Type	Type	—	Condensing extraction turbine
	Rotor	—	Multistage disk-type
Rated output		MW	25
Actual output		MW	22.5
Number of revolutions		rpm	3000
Steam inlet pressure		kg/cm^2	29
Steam inlet temperature		°C	400
Degree of vacuum of condenser		kg/cm^2	0.05
Amount of steam	Turbine inlet (at maximum steam extraction)	t/h	350
	Turbine inlet (without steam extraction)	t/h	130
Number of stages		stage	15
Length of last-stage blade		mm	447
Year of commencement of operation		year	1954
Duration of operation		year	60

※Actual output (22.5MW) is lower than rated output due to change of cooling medium (hydrogen→ air) used for generator cooling.

Source: Prepared on the basis of materials submitted by TashTETs.

Table 3.2.3-8 Specification of TashTETs gas turbine

Item	Unit	Specification
Manufacturer	—	Hitachi, Ltd.
Type	—	Simple open cycle single-shaft type
Model	—	H-25
Quantity	unit	1
Output	kW	28,630 (design value) ※ 29,000 (max.)
Design atmospheric conditions	—	Air temperature: 15°C Atmospheric pressure: 101.3 kPa Relative humidity: 60 %
Year of commencement of operation	year	2013
Duration of operation	year	2

※ 27MW output is an output based on standard atmospheric pressure.

Source: Prepared on the basis of materials submitted by TashTETs.

Table 3.2.3-9 Specification of TashTETs HRSG

Item	Unit	Specification
Manufacturer	—	Daekyung Machinery & Engineering Co., Ltd.
Type	—	Single drum, horizontal, natural circulation type
Quantity	unit	1
Capacity	t/h	49.8 t/h
Main steam temperature	°C	416 (design value)
Main steam pressure	kg/cm^2	3.46 kg/cm^2 (a)
Feed water temperature	°C	105°C
Feed water pressure	kg/cm^2	4.31 kg/cm^2 (a)

Source: Prepared on the basis of materials submitted by TashTETs.

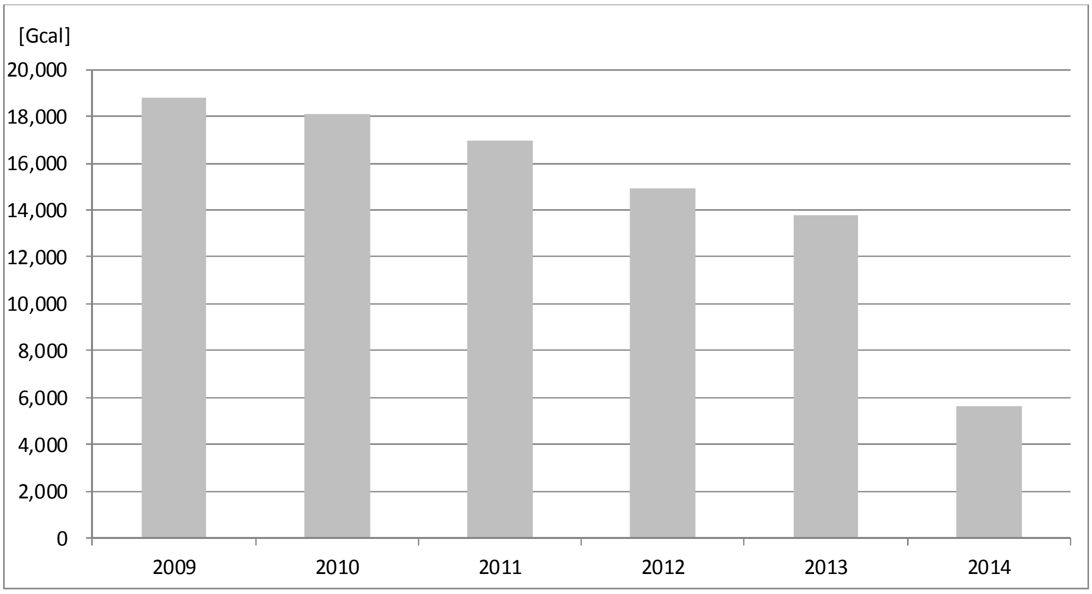
Steam generated by steam boilers is piped to steam turbine and used for power generation. Along with this, the steam is depressurized and used as heating steam in feed-water heater. On the other hand, the process steam is supplied to textile mill and other neighboring enterprises. The exhaust heat of gas turbine unit provides steam generation in HRSG. Thus, the gas turbine unit, as well as the steam generated by steam boilers, is used both for power and heat generation.

Gas turbine is operated in base load mode with maximum output throughout the year, excluding the periods of routine inspections and shutdown due to accidents in power system. The power adjustment under NDC instructions is conducted through hot-water boilers and steam turbine generator.

Table 3.2.3-10 Consumers of TashTETs process steam

Company	Type of business	Supply temperature (°C)	Supply pressure (kg/cm^2)
PE LLC "Agrokhimplast"	Production of plastic for greenhouses	250（±5 %）	8（±5 %）
LLC "Gabus-Temir beton buyumlari"	Production of concrete products for railroads		
Reinforced concrete product plant	Production of concrete products for railroads		
LLC "Gafarov Nadir"	Liquid glass production		
JV LLC "TashKaya Tekstil"	Textile mill		
OJSC "Toshtukimachi"	Textile mill		
OJSC "Uzjeldorpass"	Cleaning shop		

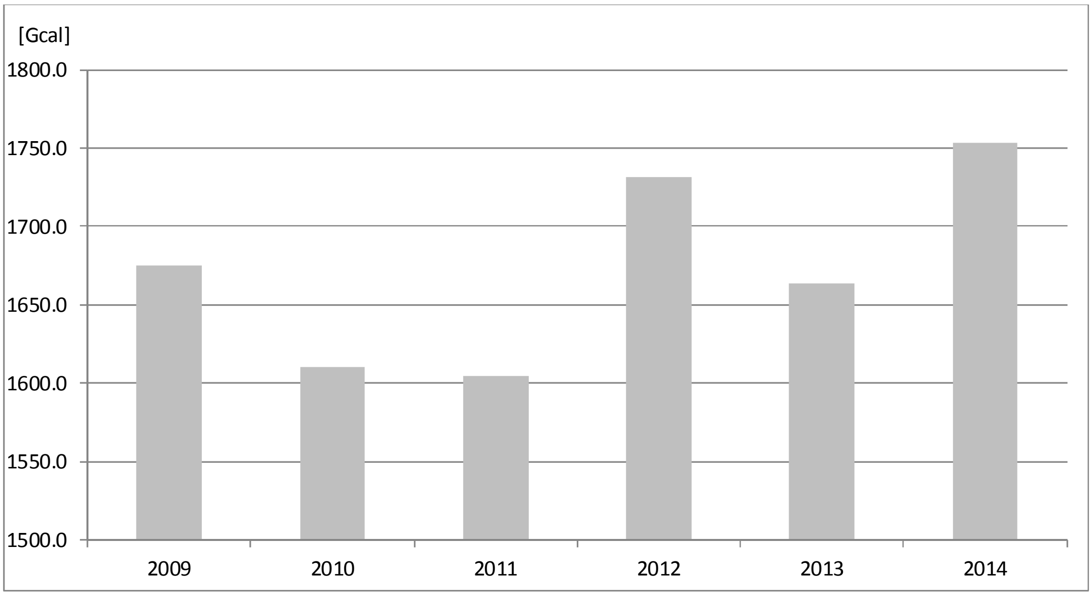
Source: Prepared on the basis of materials submitted by TashTETs.



Source: Prepared on the basis of materials submitted by TashTETs.

Figure 3.2.3-8 Actual data on steam supply by TashTETs in 2009-2014

Hot water produced by hot-water boilers is being sold by wholesale to UE PA "Tashteploenergo" and supplied to the neighboring area for hot-water supply and heating. The hot water can be produced regardless of electrical output of equipment. Therefore, adjustment of hot-water production and supply is conducted in accordance with instructions of Heat Supply Control Center without considering the changes in electrical output.



Source: Prepared on the basis of materials submitted by TashTETs.

Figure 3.2.3-9 Actual data on hot-water supply by TashTETs in 2009–2014

3.2.4 Heat Supply Facilities Development Plan

According to Decree No.197 of the Cabinet of Ministers of the Republic of Uzbekistan dated July 17, 2014 ("On measures for implementation of roadmaps for improvement of financial state of unprofitable heat supply enterprises"), it is planned to improve and modernize the equipment of every heat supply enterprise in Uzbekistan.

Main development plans for Tashkent City are presented in Table 3.2.4-1. According to Uzbekenergo JSC, item No.1, "Introduction of gas turbine cogeneration system", was initially planned to be implemented within TC-4 by JSC "Tashteplosentral". However, at the present time this project is part of the present survey.

Table 3.2.4-1 Tashkent heat supply facilities development plan

	No.	Plan 1)	Item	Implementation term
Production equipment	1	Introduction of gas turbine cogeneration system	TC-4：4 units	2015-2024 （FS: 2015）
	2	Replacement of existing pumps by high-efficiency pumps	TC-1：11 .pcs	2015-2024
	3	Replacement of existing burners by high-efficiency burners	TC-1：6 pcs, TC-3：5 pcs, TC-4：5 pcs, TC-5：8 pcs, TC-6：4 pcs, TC-7：3 pcs, TC-8：2 pcs	2015-2024
	4	Installation of inverters on burner fans	TC-1：6 pcs, TC-3：5 pcs, TC-4：10 pcs, TC-5：8 pcs, TC-6：4 pcs, TC-7：5 pcs, TC-8：4 pcs, TC-9：3 pcs, TC-10：3 pcs	2015-2024
	5	Replacement of meters (by ultrasonic type)	17 pcs	2015-2024
	6	Construction of local boiler houses	124 sets (suburb)	2015-2024
Heat transportation facility	7	Introduction of closed heat supply system	Within city limits	2015-2024
	8	Reconstruction of hot water supply pipelines	Replacement of hot water supply pipelines (1485km), Replacement of thermal insulation	2015-2024
	9	Replacement of pumps	38 pcs	2015-2024

1) JSC "Tashteplosentral" is in charge of No. 1-5, and UE PA "Tashteploenergo" is in charge of No. 6-8.

3.2.5 Policy Regarding Heat Supply

It is stated in the Decree No.194 of the Cabinet of Ministers of the Republic of Uzbekistan dated July 15, 2014 "On approval of public services provision rules", that the government and local authorities are responsible for equal provision of heat supply for all citizens.

Paragraph 19 of the Decree No.194 of the Cabinet of Ministers of the Republic of Uzbekistan dated July 15, 2014 "On approval of public services provision rules":

The Council of Ministers of the Republic of Karakalpakstan, regional governments and Tashkent City government are obliged to provide local heat supply (modular or local boiler-houses and heat supply systems) to customers.

The local heat supply system is constructed at the expense of local government and transferred to heat supplier which provides heat supply to customers.

According to above-mentioned rules, JSC "Tashteplosentral" performs heat production (operation of boiler-houses), and UE PA "Tashteploenergo" performs control of supply-demand balance and transfer of heat from heat production enterprise to customers in Tashkent City.

The presidential decrees and decrees of Cabinet of Ministers of the Cabinet of Ministers concerning heat supply service are presented in Table 3.2.5-1.

Table 3.2.5-1 Policy regarding the heat energy development strategy (in chronological order)

Item	Presidential decree or Decree of the Cabinet of Ministers	Date of enforcement	Remarks
Method of establishment of rules on public service use	Decree No. 271 of the Cabinet of Ministers	30.07.1996	Regarding calculation of heat consumption amount
On further improvement of public service management system	Presidential decree No. 2791	19.12.2000	—
On acceleration of economic reforms in public service sector	Presidential decree No. 2832	17.04.2001	Development of program for transfer of local heat supply service to self-supporting accounting system
On disclosing of reasons for increase of electricity and heat prices and liability of customers for payments (term of payment)	Presidential decree No. 5	11.02.2005	Regarding liability for payments (term of payment)
On price (rate) fixing procedure and price (rate) approval (executed under government control)	Decree No. 239 of the Cabinet of Ministers	28.10.2010	Price (rate) fixing method
On measures for improvement of financial state of heat supply and water supply enterprises	Decree No. 300 of the Cabinet of Ministers	06.11.2013	Measures for increasing efficiency of enterprises
On approval of public services provision rules	Decree No. 194 of the Cabinet of Ministers	15.07.2014	Rules for provision of public service to multiple dwelling houses

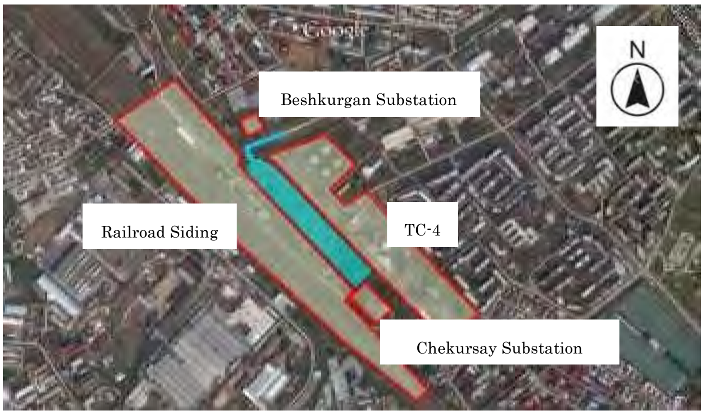
Until recently, there was no comprehensive legislation on heat supply in Uzbekistan. The heat supply has been regulated by separate laws and managed by appropriate ministries and agencies. However, a bill "On heat supply" has been drawn up in October 2012. At the present time the bill is under deliberation aiming at enactment of law "On heat supply". The present bill regulates issues concerning improvement of energy efficiency of heat supply system, rational use of heat, security and protection of customers, heat quality, application of cogeneration system, balance of economic interests of heat supply enterprises and customers.

Chapter 4 Present Condition of Project Site

Chapter 4 Present Condition of Project Site

4.1 Location and General Condition around Project Site

The project site for TashTETs-2 is located in Yunus Abad district, north of Tashkent city, Republic of Uzbekistan. The site is surrounded by some facilities, such as Beshkurgan Substation, Chekursay Substation, Railroad siding, and TC-4 as shown in Figure 4.1-1.



Source: JICA Study Team

Figure 4.1-1 General Condition around Project Site

The site is about 3 km from Tashkent urban ring road, and there are several access roads, such as Amir Temur Street, Quloqtepa Street, Moyqo'rg'on Street, and Ahmad Donish Street, as shown in Figure 4.1-2. Therefore, the transport access is relatively good.

Source: JICA Study Team

Figure 4.1-2 Transport Access to Project Site

4.2 Present Condition of Project Site

4.2.1 Site Condition (Area and Shape of Site, Utilities and Facilities, Obstacles)

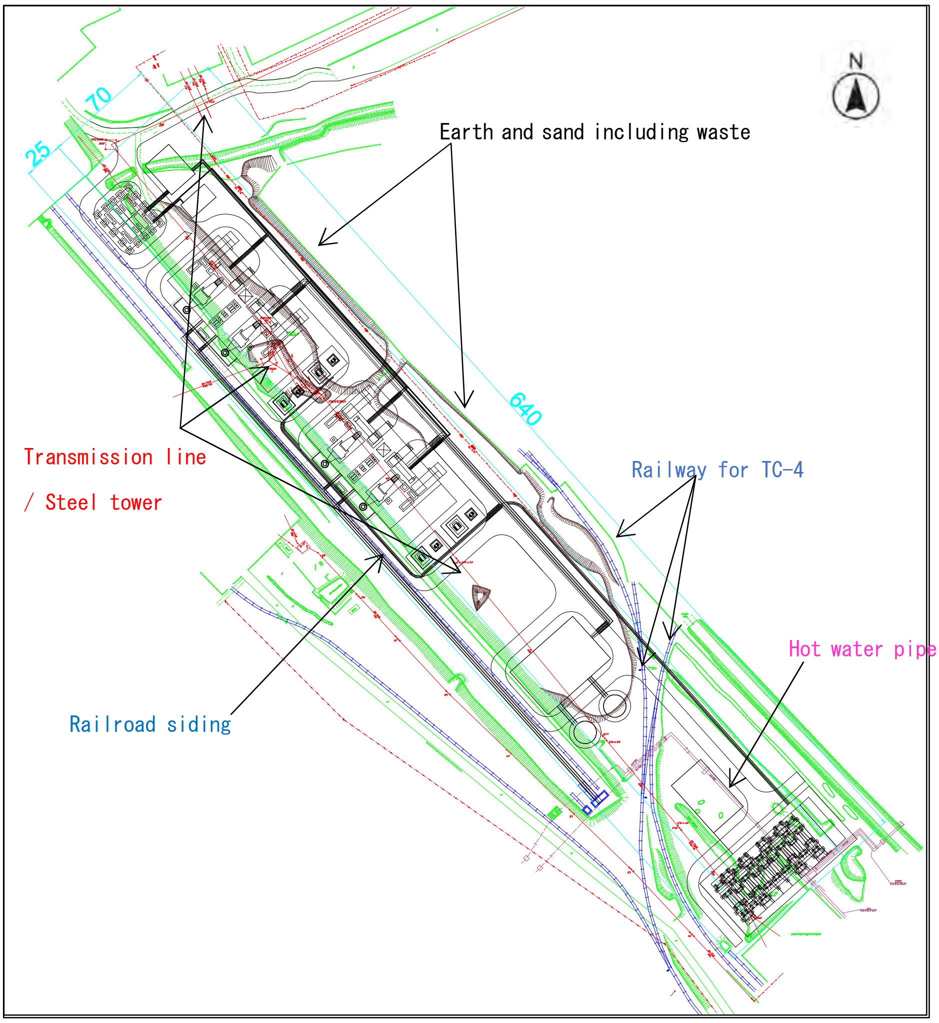
(1) Area and Shape of Site

Area of site is approximately five hectares, and it has a rectangular shape (640 meters×70 meters). Elevation of the ground level is between 445 and 449 meters.

(2) Utilities and Facilities on the Ground（Refer to Figure 4.2.1-1 and Figure 4.2.1-2）

Ground surface of the site is covered with earth and sand including construction waste and household garbage. Railway transporting in preliminary fuel to TC-4 crosses the site. Existing utilities and facilities on the ground of the site area found by site survey are as follows:

- Earth and sand including waste : approx. 96,000 m^3
- Railroad siding : approx. 500 m
- Railway for TC-4 : approx. 200 m
- Overhead power transmission line : approx. 640 m
- Steel tower for transmission line : 7 towers
- Hot water pipe φ1000×2 : approx.170 m
- Sewage manhole : large number



Source: JICA Study Team

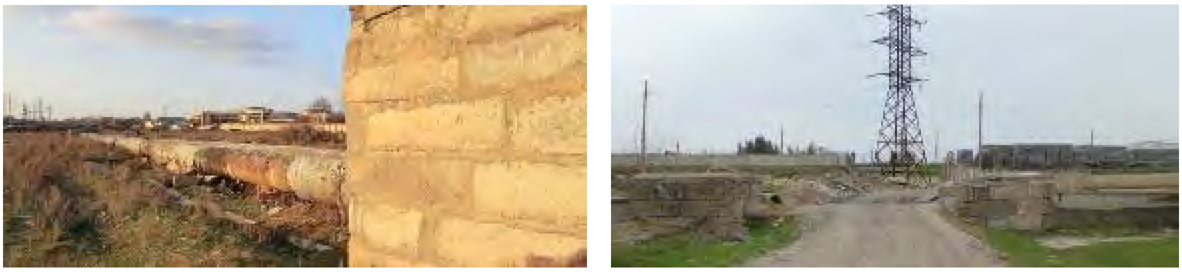
Figure 4.2.1-1 Existing Utilities and Facilities on the Ground

Earth and sand including waste

Railroad siding & Sewage manhole

Railway for TC-4

Transmission line & Steel tower



Hot water pipe

Culvert for transmission line

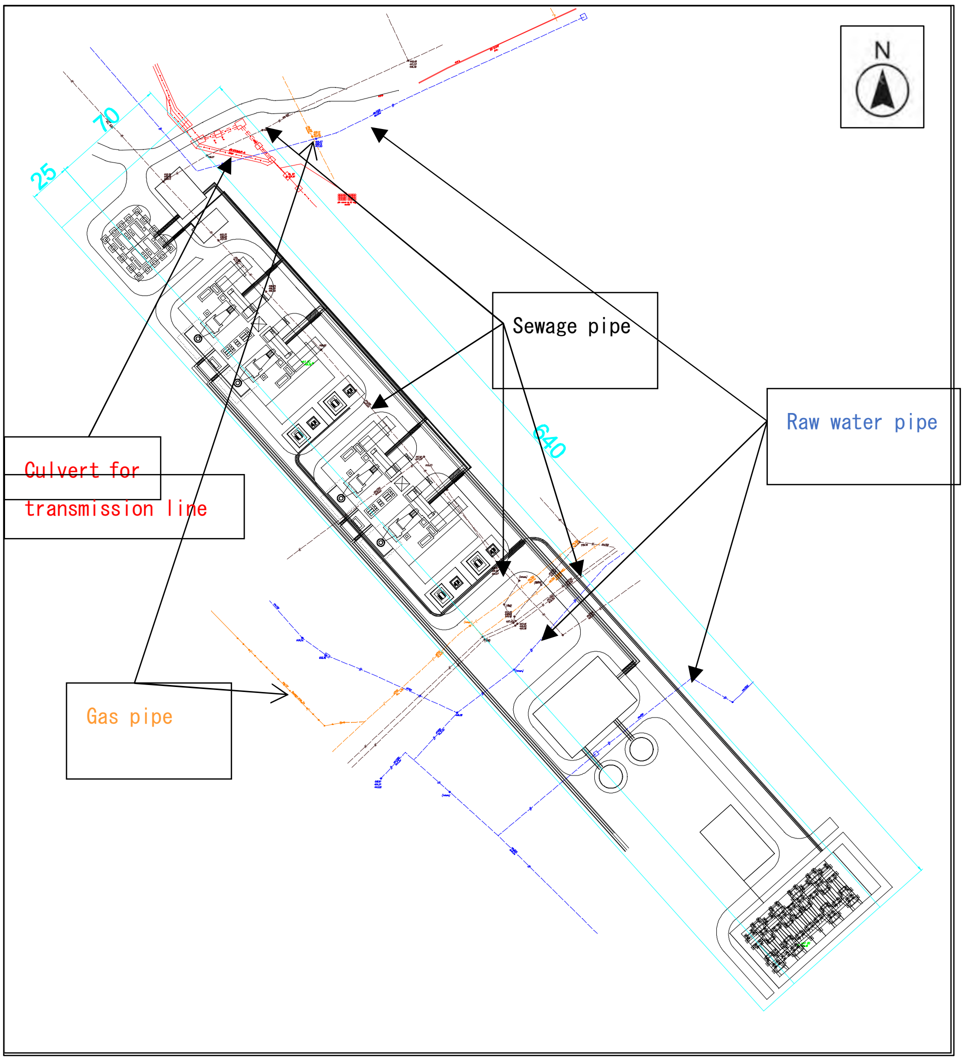
Source: JICA Study Team

Figure 4.2.1-2 Photo of Existing Utilities and Facilities on the Ground

(3) Utilities and Facilities under the Ground（Refer to Figure 4.2.1-3）

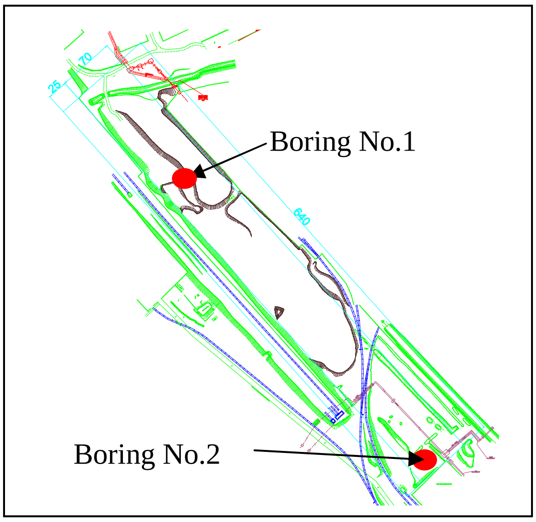
Existing underground utilities and facilities in the site area found by site survey are as follows:

・Raw water pipe φ1200	: approx. 200 m
・Gas pipe φ1000	: approx. 200 m
・Sewage pipe φ1200,400	: approx. 550 m
・Culvert for transmission line	: approx. 150 m



Source: JICA Study Team

Figure 4.2.1-3 Existing Underground Utilities and Facilities



Source: JICA Study Team

Figure 4.2.2-1 Boring Location

4.2.2 Geological Features

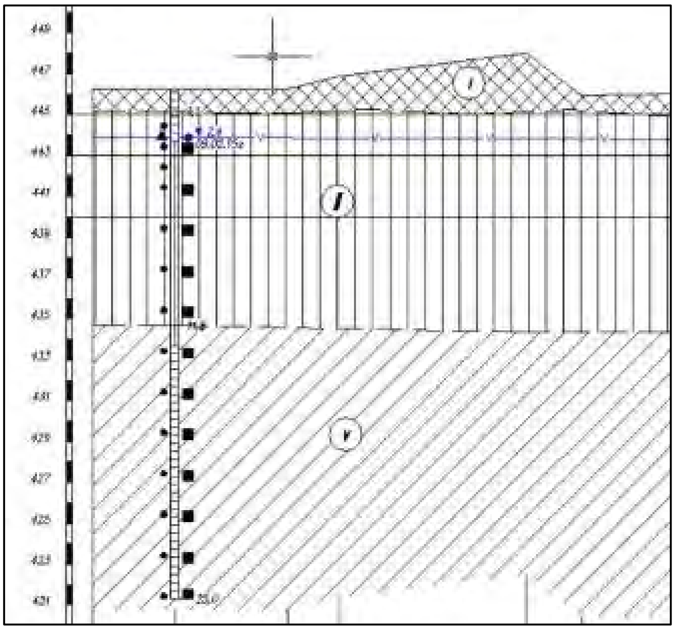
Two geological surveys by boring are conducted in the site, and following five layers are found:

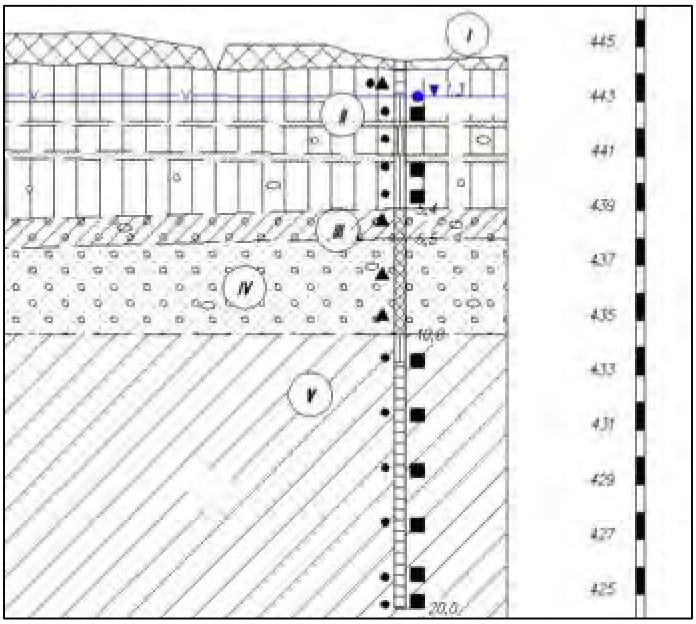
- First layer : Earth and sand including waste
- Second layer : Loam
- Third layer : Gravelly clay
- Fourth layer : Gravelly sand
- Fifth layer : Loam

Geological layer are constituted as shown in Figure 4.2.2-2 and 4.2.2-3. First layer, Second layer, and Fifth layer are distributed in the site. The thickness of each layer is as follows:

- First layer : 1–3 m (Elevation 449–445 m)

・Second layer : 4–10m (Elevation 445–435m)
・Fifth layer : 5m– (Elevation 435m–)





Source: JICA Study Team (Topographical and Geological Survey Report)

Figure 4.2.2-2 Boring No. 1

Figure 4.2.2-3 Boring No. 2

The results of soil tests are as shown in Table 4.2.2-1. Standard Penetration Test is not conducted to obtain N-value in Uzbekistan. Therefore geological conditions are confirmed by Internal Friction Angle (φ) and Cohesion (C) which are estimated from the soil test. The samples for the soil test are collected from two borings.

First layer includes waste such as construction waste, household garbage. Therefore, it cannot be used as the bearing layer for foundation.

Second layer (Loam) is evaluated as consolidated cohesive soil (moderate to soft) from the result of soil test. The layer has a Wet Density (ρ) of 2.01 tf/m^3, Internal Friction Angle (φ) of 24.5 deg., and Cohesion (C) of 22.4 kN/m^2. Therefore, it can be the bearing layer for foundation after further detail examination in the detail design stage such as the settlement of bearing layer. The following two measures are recommended to be conducted as the detail examination in detail design stage for preventing of the settlement of bearing layer:

・Sand compaction pile method:
  This method can be applied to various type of soil.
・Compaction method by vibration roller:
  This method had been used for the existing Tashkent thermal power cogeneration plant.

Third layer (Gravelly clay) and fourth layer (Gravelly sand) are found from only boring No. 2, and they are not distributed in the entire site.

Fifth layer (Loam) is evaluated as consolidated cohesive soil (moderate), and the result of the soil tests shows that it is consolidated more than the second layer. The layer has Wet Density (ρ) of 2.06 tf/m3, Internal Friction Angle (φ) of 24.4 deg., and Cohesion (C) of 25.7 kN/m^2. Therefore, it also can be the bearing layer for foundation like the second layer. But the cost of foundation cannot be economical due to the depth from the ground level.

From the result of soil tests, the second layer is recommended as the bearing layer, and spread foundation as the foundation type. The reasons are summarized as follows:

- Second layer and Fifth layer are consolidated cohesive soil, but they are composed of roam which has more than 20 degree of Internal Friction Angle.
- Spread foundation is common type of foundation in Tashkent city area.
- The top level of Fifth layer lies at a depth of more than 10 meters from ground level. Therefore the cost of foundation will not be economical if Fifth layer is used as the bearing layer.

Groundwater level is relatively high. It existed at a depth of between 1.3 and 2.4 meters from ground level during geological survey on February 2015. The water quality test was conducted in the geological survey. The results are as follows:

- Chloride Ion Concentration : 71–204 milligrams per liter
- Sulfide Ion Concentration : 179–704 milligrams per liter
- Potential of Hydrogen (pH) : 6.4–6.6

Table 4.2.2-1 Result of Soil Test

	Test Name	Symbol	Unit	Second layer Loam	Fifth layer Loam
1	Wet Density	ρ	tf/m^3	2.01	2.06
2	Dry Density	ρ_d	tf/m^3	1.65	1.72
3	Soil Particle Density	ρ_s	tf/m^3	2.69	2.70
4	Natural Water Content	W_0	%	0.218	0.197
5	Liquid Limit	W_l	%	0.276	0.357
6	Plastic Limit	W_p	%	0.201	0.229
7	Plasticity Index	I_p	-	0.075	0.128
8	Degree of Saturation	S_r	%	0.931	0.933
9	Liquidity Index	I_L	-	0.23	<0.0
10	Void Ratio	e	-	0.63	0.57
11	Internal Friction Angle	φ	deg.	24.5	24.4
12	Cohesion	C	kN/m^2	22.4	25.7
13	Deformation Modulus	E_0	MN/m^2	5.0	7.9

Source: JICA Study Team (Topographical and Geological Survey Report)

4.2.3 Meteorological Condition

Tashkent is located on the border of the subtropical and temperate continental climate zone, and the climate is hot and dry summer and cold winter. The annual and daily fluctuation in air temperature is quite extreme. Temperature sometimes drops to minus 20 ℃ and below in winter, and often reach plus 35 ～ 40 ℃ in summer. The minimum temperature is minus 29.5 ℃ (20/December/1930), and the maximum temperature is plus 44.6 ℃ (18/June/1997).

- Average annual temperature : plus 14.8 ℃
- Average wind speed : 1.4 meters per second
- Average annual humidity : 56 %

The values and records above mentioned are referred to “Topographical and Geological Survey Report” prepared by JICA Study Team.

Chapter 5 Basic Design for Tashkent Thermal Power Cogeneration Plant Construction

Chapter 5 Basic Design for Tashkent Thermal Power Cogeneration Plant Construction

5.1 Electric Power and Heat Demand Forecasting

5.1.1 Electric Power Demand Forecasting

(1) Model Configuration

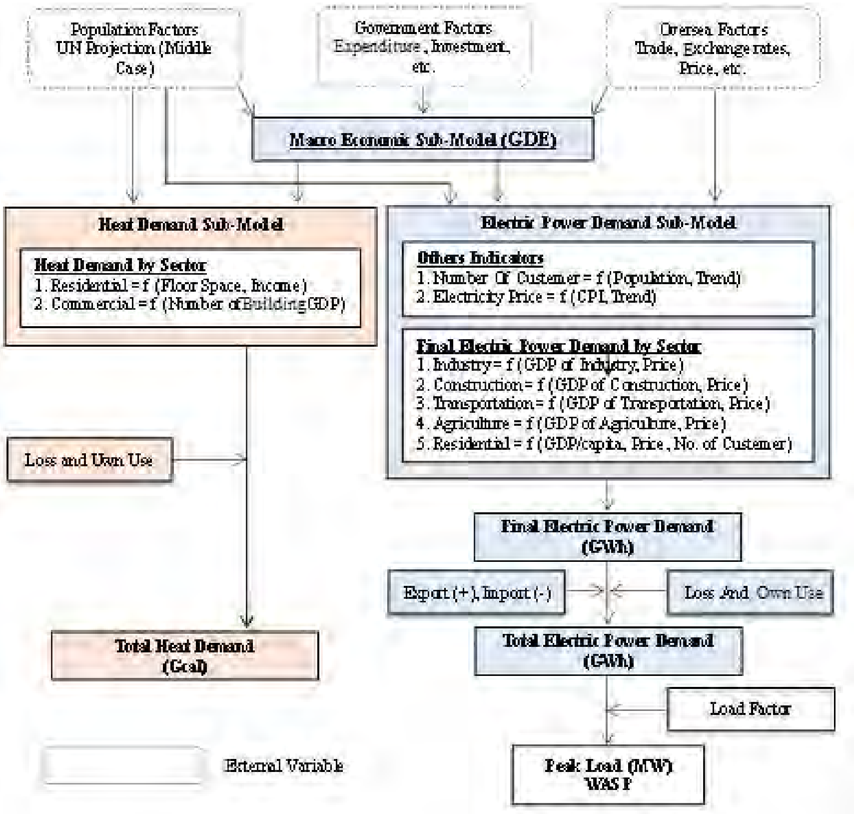
1) Concept and Structure

Uzbekistan government has been implementing the dissemination of market economy consistently since its independence in December 1991. But it was hit by runaway inflation and economic turmoil of the 1990s. In the first half of the 2000s the economy has stabilized, and it has begun to grow since the second half at a high growth rate. We recommended the introduction of the analysis method of econometric model for electric power demand forecast analysis in this project because we expect that the Uzbekistan government will continue to promote the market economy in the future. The reasons are as follows:

① Economic activity has been relatively stable since 2000, and inflation has remained stable at about 6–10 %.

② Number of samples in statistical data enables analysis by econometric tools.

③ As the transition of Uzbekistan's economy towards market economy progresses, the macro-economic activity and power demand become even more correlated.



Source: JICA Study Team

Figure 5.1.1-1 Structure of Model

The structure of the modeling is composed "Macro Economic Sub-Models", "Electric Power Demand Sub-Models" and "Heat Demand Sub-Models". General configuration diagram of the sub-models is shown in Figure 5.1.1-1. The simulation analysis to estimate the electric power demand and heat demand of Uzbekistan by 2030will be based on these three sub-models. This integrated quantitative analysis model can easily verify the correlation between macro-economic indicators and power demand. Furthermore, there is another advantage which is easily explaining how the electric power demand may be changed in the future by the economic activity.

Macro-Economy Sub-Model

"Institute of Forecasting and Macroeconomic Research" (IFMR) is one of the main institutions who forecasts the short-term (2016–2018) and long-term (until 2030) trends of economy and energy demand in Uzbekistan. In case of long-term forecast (until 2030), IFMR is not entirely reliant on the model, but uses also scenario analysis as a part of the long-term projection process. As a result, the country's economic growth rate is projected to grow at annual rate of 8.3–9.0 % until 2030. Gross Domestic Product (GDP) in 2030 is projected to expand by 3.7 times, compared to the current level. The total population is estimated to reach 37 million by 2030, at an average annual growth rate of 1.28 %. IFMR also points out that Uzbekistan may face big challenges in ensuring the labor force, investment and resources (fuel and water) to maintain high economic growth by 2030[1].

Considering the above IFMR forecasting method of electric power demand projection model study, the JICA Study Team suggests to introduce an econometric analysis method for modeling construction. The national economy of Uzbekistan will analyzed by Macroeconomic Sub-Model based on gross domestic expenditures (GDE). Although it is difficult to analyze the current industrial structure without the input-output (IO) tables[2], the GDP by sector is simulated by share function based on the historical trends of the industrial sector and changes in the structure.

Macroeconomic sub-model uses private consumption, government expenditure (investment), import and export, etc. as explanatory variables to simulate the gross domestic expenditure (GDE). The main characteristic of the model is trade factors (trade partner's economy change, foreign exchange), government factors (government investment, interest rates, etc.) and population factors given as external variables to simulate the economic growth rate and production by each sector.

Electric Power Demand Sub-model

The core part of the entire model is the "Electric Power Demand Sub-model". It uses explanatory variable indicators obtained from the "Macro-economic Sub-model", such as the GDP by sector, electricity tariff, population, income and number of customers, to determine the electric power demand by sector in final sector. The sum of final sector power demand, transmission loss, own use[3] and net

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[1] January 27, 2015, by interviews to "Institute of Forecasting and Macroeconomic Research" (IFMR). (Refer to interview minutes)

[2] According to IFMR, the current input-output (IO) tables of Uzbekistan are divided into 36 sectors, and the structure of the tables has become relatively simpler. Although the development of IO tables has supported by international organizations, reflecting fully the real economy to the table is expected to take time.

[3] It means the demand of Generators, Substations and Uzbekenergo JSC offices usage.

import-export will become the total electric power demand of Uzbekistan. Peak load (MW) can be calculated by multiplying the load factor by the total electric power demand. Power capacity development plan is created base on this peak load. Power capacity composition is calculated by optimization software, “WASP”, explained in another chapter.

Electric power demand in each province/region is calculated according to the ratio of total electric power demand of Uzbekistan.

Heat Demand Sub-Model

Heat demand models structure of Tashkent city is relatively concise because there only two types of heat demand contracts in the city. The two contract types are residential contract and commercial (included public service) contract. Numerical indices were calculated from the macro-economic models, and residential floor space and number of building contracts were used as explanatory variables to determine the heat demand of Tashkent city. (See section 5.1.2 for more information.)

2) Projection Period and Model Scale

The model estimation period is over 17 years, from 2014 to 2030. The model has a total of 232 equations consisting of 97 function equations and 135 definitional equations. All equations in the model are calculated by simultaneous equations. Historical macro-economic data from 1995 to 2013, and electricity and heat data from 2000 to 2013 are used.

3) Data

The sources of the historical macroeconomic data are the International Monetary Fund (IMF) and the United Nations statistic Division (UNSTAT), and the electric power and heat data are provided by Uzbekenergo JSC and Tashteprocentral.

(2) Assumptions

1) Population Factor

Uzbekistan’s population at the end of 2013 was 30.24 million. In December 1991, the annual growth rate of Uzbekistan was 2.0 % compared to the previous year. But after independent, the growth rate started to drop reaching 1.2 % in 2006. However, the expansion of economic growth observed since 2007 has increased the growth of population. For example, the annual growth rate of population turned up was 2.9 % in 2010. In 2013, the annual growth rate of population dropped to 1.6 % and this trend is expected to continue in the future. The growth rate of population projection for 2014-2030 estimated by United Nations Statistic Division has been used in the electric power demand model as an external variable. According to the same UN estimation results, after the year 2013 the increase rate of the population of Uzbekistan will decelerate gradually from 1.35 % to 0.61 % in 2030.

However, many of the population of Uzbekistan are migrant working in neighboring Kazakhstan and Russia, and population factors as explanatory variables might contain elements of uncertainty.

Table 5.1.1-1 Population Projection of Uzbekistan (2014–2030)

Year	Population (Million)	Annual Growth Rate (%)
2014	30.61	1.35
2015	31.01	1.31
2016	31.40	1.27
2017	31.79	1.22
2018	32.16	1.17
2019	32.52	1.13
2020	32.87	1.08
2021	33.21	1.03
2022	33.54	0.98
2023	33.85	0.93
2024	34.15	0.88
2025	34.43	0.83
2026	34.70	0.78
2027	34.96	0.73
2028	35.20	0.69
2029	35.43	0.65
2030	35.64	0.61

Source: United Nations, Department of Economic and Social Affairs, Population Division (2013).
"World Population Prospects: The 2012 Revision"

2) Overseas Factor

Overseas factors are mainly economic trends of trading partners, currency exchange rate and international energy price. Especially, the economies trend of Russia and China has a high impact on Uzbekistan's economy. Trade balance of Uzbekistan has recorded surplus since2010 at national level, but it has recorded deficit with Russia and China. In 2012, the share of export to Russia account for 9.0 % and China accounted for 7 % of the total export. When we look at import, the share of Russia accounted for 21.0 % and China accounted for 16.0 % of the total import. The economic growth in both countries can be used as external variables to describe Uzbekistan import/export.

Exchange rate and international energy prices are important elements in order to evaluate the domestic energy costs. Especially, since Uzbekistan exports natural gas to Russia and China as energy resources net exporter, natural gas is one of important export goods to earn foreign currency.

3) Government Factor

The government factor is the most important key factor in this model analysis. As described above, Uzbekistan is in the process of formation of a market economy, and government's fiscal spending is an effective macro policy in order to promote economic growth. In this model, government expenditure and investment, as a driver of economic development, has incorporated as an external variable in the macro-economic sub-model. By analysis on changing this variable, the government budget required to maintain the growth of the 8 % level is estimated.

(3) Scenario Setting

1) Base Case

Uzbekistan government has implemented a continually expanding fiscal policy to maintain the growth rate at an average annual rate of 13.5 % until2030. By implementing structural reform of the industry corresponding to this financial expenditure, it is possible to boost the country's economic growth rate of 8 %. To maintain this fiscal expenditure plan, it is necessary to ensure the financial resources of 75.5 billion USD in 2030 (based on the 2013 exchange rate).

2) Energy Saving Case

Energy saving case is a case which implements the energy savings policy to reach 20 % of energy saving based on the base case. World Bank study reports have pointed out that energy intensity of Uzbekistan is high; therefore there is a high potential of energy saving in the long term. According to the same report, the energy-saving potential in the power sector is about 20 %[4]. Especially, since the energy-related equipment in Uzbekistan is aging, there is a high potential of saving energy by updating the equipment. About 20 % of energy saving may be realized by updating the main energy supply facilities, i.e., the power plant, cogeneration plants, heat supply plants, power transmission and distribution equipment.

3) Low Case

Low case corresponds to the so-called BAU case. In others words, it is assumed that the current structure of economy, social and energy consumption does not change, and the simulation result is based on the historical trend of the data.

(4) Simulation Results

1) Base Case

The table below shows the projection results of the macroeconomic sub-model. As described above, in base case, the Uzbekistan government will continues to expand the fiscal expansion policy continuously for maintaining the real economic growth rate at average annual rate of 8.1 % and the total reaches $75.5 billion USD by 2030. By the fiscal expansion policy and industrial restructuring, the growth rate of industry and construction sector will expand at an average annual growth rate of 10.9 % and 11.0 %. On the other hand, the share of service sector (service, transport and communication, etc.) will expand by 2 points compared to that of 2013, accounting for 49.4 % of the total in 2030. The decreasing trend of the share of agricultural sector is expected to continue in the future, and its share will decrease by 2.7 points, compared to that of 2013, becoming 16.9 % of the total GDP in 2030. Reform of Uzbekistan's industrial structure will continue, and the expansion of industrialization and service industry is sustainable.

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[4] World Bank, “Uzbekistan Energy Efficiency Strategy for Industrial Enterprises”, June 2013, page ix

Table 5.1.1-2 Macro Economy Sub-model Simulation Results (2013–2030)

(Base Case and Saving Case)

Descriptions	Unit	Actual			Estimation				CAGR (%)	
		2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Total Population	Million	26.2	28.6	30.2	31.0	32.9	34.4	35.6	1.2	1.0
GDP Growth (Previous)	%	7.0	8.5	7.0	6.7	7.9	8.8	9.7		
Real GDP (2005 Constant)	Billion Sum	15,923	23,918	29,996	33,723	48,315	72,496	113,290	7.0	8.1
Agriculture	Billion Sum	4,193	5,573	6,953	6,463	8,831	12,721	19,175	3.5	6.1
Industry	Billion Sum	3,371	4,342	5,366	8,875	12,907	19,604	30,950	13.4	10.9
Construction	Billion Sum	771	993	1,228	2,303	3,212	4,711	7,218	14.7	11.0
Service	Billion Sum	1,400	2,499	3,163	3,325	4,744	7,093	11,051	6.0	7.6
Transportation	Billion Sum	1,677	2,995	3,792	4,373	6,518	10,093	16,188	8.0	8.9
Others	Billion Sum	4,512	7,516	9,494	8,384	12,103	18,274	28,708	3.5	6.7
GDP by Sector (%)										
Agriculture	%	29.5	19.8	19.6	19.2	18.3	17.5	16.9		
Industry	%	23.7	26.3	26.1	26.3	26.7	27.0	27.3		
Construction	%	5.4	7.1	6.9	6.8	6.6	6.5	6.4		
Service	%	9.8	10.2	9.9	9.9	9.8	9.8	9.8		
Transportation	%	11.8	12.7	12.7	13.0	13.5	13.9	14.3		
Others	%	19.8	23.9	24.8	24.9	25.1	25.2	25.3		
Total	%	%	100.0	100.0	100.0	100.0	100.0	100.0		

Source: JICA Study Team

According to "Institute of Forecasting and Macroeconomic Research" (IFMR), Uzbekistan electric power demand will be twice of that of 2013, becoming 105,000 GWh in 2030. At present, Uzbekistan has no plans to introduce nuclear power plant in the future. The increase of energy demand in the future will be supplemented by renewable energy and coal. According to the projection result provided by IFMR, the ratio of renewable energy to total energy consumption in 2030 is estimated to reach 6 %. The energy supply and demand has been simulated by IFMR based on the software tool of "e-views" and "Excel" base optimization model. "e-view" is one of the famous software econometric analysis tools.

Electric power demand forecast of this study is estimated based on the data of Uzbekenergo JSC. Explanatory variables such as Macro-economic, population, number of households, floor space and electricity tariff are used to estimate the electric power demand by sector. The total of projection result by sector becomes the electric power demand of final sector. The total electric power demand of Uzbekistan is the total of final electricity demand, transmission losses and own use. For more information, refer to the flow chart below.

In the case of electricity demand, the total power demand is growing at an average annual growth rate of 3.7 % , and it will increase from 54,980 GWh in 2013 to 101,271 GWh in 2030. According to the power development plan of Uzbekenergo JSC, the company will continue promoting the power exports to neighboring countries, it target to export3,600 GWh in 2030. Export of power is mainly to Afghanistan, but some power works have been underway and there are plans to supply to the northern part of Pakistan in the future. Domestic electric power demand is projected to increase at an average annual growth rate of 3.6 % to become 97,671 GWh in 2030. Out of this, 75,989 GWh will be the demand of the final sector, and the remaining 21,683 GWh will be supplied to power plant own use including transmission loss. According to the Uzbekenergo JSC's documents, the average of transmission line loss from 2003 to 2012wasabout 15.7 %, and power plant own use was on average about5.1 %. Answering the interview question on the loss, Uzbekenergo JSC stated that that transmission and distribution loss accounts for about approximately 16 % of total electric supply. If this is proven, on the assumption that there will be technology improvement, the transmission and distribution loss of 2030 will become 18,279 GWh (15.7 %) and power plant own use will become 3,404 GWh (5.1 %).

In the final sector, residential sector becomes the maximum electric power demand sector in 2030, and its share will reach 43.1 % (32,780 GWh), at an average annual growth rate of 4.9 % (from 2013 to 2030), the second highest growth rate following the 7.5 % of the construction sector. In general, residential sector is still the sector that is driving the growth of electric power demand in the country. In industrial sector, the effects of the industry reform have appeared gradually from the independence year until 2007. In recent years, as an industrial policy, the government has supported the industrial park constructions and special economic zones in each region for small and medium-sized enterprises. If this policy is conducted continuously, electric power demand in the industrial sector seems to increase more and more in the future. The projection results of this model shows that the electric power demand in industrial sector will increase at an average annual rate of 3.6 % and reach 30, 883 GWh in 2030.

Transportation and agriculture sector show relatively slow growth in electric power demand. In case of agricultural sector, diversification of crop cultivation from cotton as a single crop of old Soviet Union regime era is gradually underway, and the demand for large-area irrigation water is shrinking. According to the data of Statistics Division of Food and Agriculture Organization (FAO[5]), the area of Uzbekistan's irrigated agriculture land has reduced by 66,000 hectares from 1992 to 2012. In the same period, rice and cotton cultivation area has reduced by 21,000 and 185,000 hectares, respectively. Electric power demand in the agricultural sector has increased by an average annual rate of 1.0 %until2030, but its share in the final sector decreased by 7.2 points, from 20.9 % in 2013 to 13.8 % in 2030. In the transportation sector, the railways have been already electrified at the national level, and the increase of electric power demand is not expected without any new construction plan. Moreover, the number of private vehicles and transport truck is rapidly increasing, and the road transport is becoming more important to the economic activity and the demand of liquid fuel is rapidly increasing.

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[5] Food and Agriculture Organization of the United Nations, Statistics Division, http://faostat3.fao.org/home/E, accessed28th April 2015.

Table 5.1.1-3 Electric Power Demand Simulation Result of Uzbekistan (Base Case) (2013–2030)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
(1) Final Sector Consumption	36,972	39,477	41,965	42,603	49,140	59,707	75,989	2.3	3.6
Industry	15,830	15,783	16,942	17,822	20,775	25,002	30,883	3.0	3.6
Construction	130	169	171	254	337	437	583	10.2	7.5
Transportation	1,353	1,193	1,214	1,233	1,255	1,262	1,263	0.5	0.2
Agriculture	9,920	8,592	8,792	8,407	8,956	9,643	10,479	0.3	1.0
Residential	9,466	13,449	14,568	14,887	17,816	23,363	32,780	2.9	4.9
(2) Loss and Own Use	10,515	11,294	11,721	11,774	13,755	16,888	21,683	2.3	3.7
(3) Domestic Demand (1) + (2)	47,487	50,771	53,687	54,377	62,895	76,595	97,671	2.3	3.6
(4) Export	149	843	1,293	1,459	1,971	2,664	3,600	6.2	6.2
(5) Total (3)+(4)	48,301	51,935	54,980	55,835	64,866	79,259	101,271	2.4	3.7
Final Sector by Share (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	43.1	40.3	40.6	41.8	42.3	41.9	40.6		
Construction	0.4	0.4	0.4	0.6	0.7	0.7	0.8		
Transportation	3.7	3.0	2.9	2.9	2.6	2.1	1.7		
Agriculture	27.0	21.9	21.1	19.7	18.2	16.2	13.8		
Residential	25.8	34.3	34.9	34.9	36.3	39.1	43.1		

Source: JICA Study Team

In 2013, Navoi Province (6,978 GWh) and Tashkent Province (6,447 GWh) are the highest electric power demand regions in Uzbekistan. The main Uzbekistan industries like mining, chemical industry, building materials production, spinning, food processing are concentrated in Navoi Province. Moreover, the special economic zone for industries promoted by the government as industrial policy to attract the foreign investment has succeeded in Navoi industrial zone. Tashkent Province has been the center of political, economic, cultural activities for Uzbekistan for a long time. Most of the industries including energy, chemical, textile and food have gathered in Tashkent Province. These two provinces are expected to remain the industrial center for Uzbekistan in the future leading the increase of electric power demand. In this simulation, the average annual growth rate of electric power demand of Navoi Province and Tashkent Province will increase by 4.1 % and 3.5 % respectively, to reach 13,929 GWh and 11,616 GWh respectively by 2030.

On the other hand, the highest growth rate of electric power demand has projected in the Republic of Karakalpakstan, Samarkand Province, Syrdarya Province, Fargana Province, and Khorezm Province. The electric power demand of these 5 provinces will increase at a growth rate of 4.0 % or more up to 2030. The electric power demand of these five provinces is mainly consumed by the residential sector (including the service sector), and except Fergana Province (57.9 %) the share of the residential sector in each of provinces accounts for 75 % in final electricity consumption. In other words, growth in the residential sector is the main driving force of the electric power demand.

Table 5.1.1-4 Electric Power Demand by Provinces / Regions (Base Case, 2013–2030)

Provinces /Regions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Uzbekistan Total	36,699	39,186	41,687	42,603	49,140	59,707	75,989	2.4	3.6
Karakalpakstan	753	778	877	899	1,070	1,366	1,854	2.9	4.5
Andijan	2,121	1,997	2,142	2,081	2,184	2,477	2,992	0.3	2.0
Bukhara	1,785	2,263	2,403	2,447	2,877	3,463	4,283	2.6	3.5
Jizzakh	1,241	1,239	1,289	1,314	1,479	1,742	2,147	2.0	3.0
Kashkadarya	4,368	4,294	4,691	4,722	5,415	6,380	7,710	2.1	3.0
Navoiy	5,842	6,788	6,978	7,417	8,963	11,070	13,929	3.6	4.1
Namangan	2,154	2,102	2,369	2,386	2,742	3,351	4,334	2.1	3.6
Samarkand	2,249	2,573	2,751	2,817	3,305	4,186	5,670	2.7	4.3
Surkhandarya	1,912	1,831	1,887	1,826	1,953	2,215	2,662	0.5	2.0
Syrdarya	903	909	996	1,018	1,183	1,472	1,965	2.5	4.1
Tashkent	5,946	6,262	6,447	6,668	7,673	9,259	11,616	2.5	3.5
Tashkent City	3,672	3,973	4,472	4,500	4,990	6,026	7,839	1.6	3.4
Fargana	2,861	3,284	3,378	3,481	4,099	5,159	6,877	2.8	4.3
Khorezm	892	892	1,008	1,026	1,207	1,541	2,112	2.6	4.4

Source: JICA Study Team

Tashkent City

The average annual growth rate of electric power demand of Tashkent City from 2013 to 2030 3.4 %, and this increases the demand from 4,472 GWh in 2013 to 7,839 GWh in 2030. Residential sector (including the service sector) is the main driver leading to the increase of electric power demand in the city. Compared to other sectors, the growth rate electric power demand in residential sector is projected to increase at an average annual rate of 4.7 % to be 6,620 GWh in 2030. In 2030, residential sector will account for about 84.4 % of the total electricity demand of the city. The growth rate of electric power demand in the construction industry has been expanding at an average annual rate of 7.6 % because of the high demand of the construction in the city. In transport sector, the development of motorization has begun in the city, and the transition to the automobile is rapidly progressing. There will be no significant increase in the power demand of the railway transportation in the short-term, and the electric power demand by rail would not stretch too much by 2030.

Electric power demand in the industrial sector has continued to decrease in the past trends. Many of the new investment projects are being carried out in the adjacent Tashkent Province, and in some other cases the industries moved from Tashkent City to Tashkent Province. Therefore, the electric power demand of industrial sector in Tashkent City is not expected to grow until 2030, on the contrary it is expected to continue to decrease from now on.

Table 5.1.1-5 Electric Power Demand Simulation Result of Tashkent City (Base Case)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Final Sector Consumption	3,672	3,973	4,472	4,500	4,990	6,026	7,839	1.6	3.4
Industry	1,643	885	1,197	1,132	1,003	894	775	-2.5	-2.5
Construction	28	56	65	100	135	174	228	11.0	7.6
Transportation	192	180	185	190	197	202	205	0.9	0.6
Agriculture	4	9	6	6	8	10	13	5.5	4.8
Residential	1,806	2,843	3,019	3,072	3,645	4,747	6,620	2.7	4.7
Share by Sector (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	44.7	22.3	26.8	25.2	20.1	14.8	9.9		
Construction	0.8	1.4	1.5	2.2	2.7	2.9	2.9		
Transportation	5.2	4.5	4.1	4.2	4.0	3.3	2.6		
Agriculture	0.1	0.2	0.1	0.1	0.2	0.2	0.2		
Residential	49.2	71.6	67.5	68.3	73.1	78.8	84.4		

Source: JICA Study Team

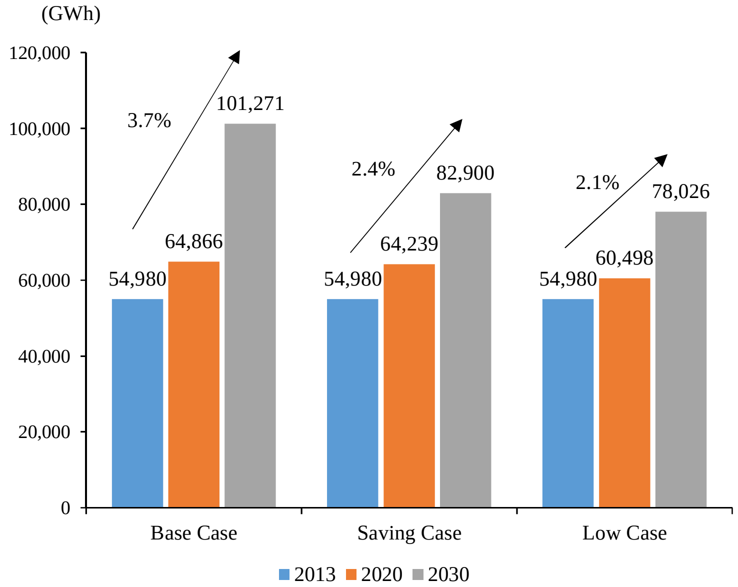
2) Conclusion of the Simulation Result

Figure 5.1.1-2 shows the comparison of the results of the three scenarios. The following features are observed from the results.

① In base case, the government fiscal expansion policy maintains high economic growth of 8.1 % until 2030, and simultaneously the electric power demand increases at an average annual rate of 3.7 % until 2030. Electric power demand of 2030 reaches 101,270 GWh, about two times of that of 2013. Although the GDP elasticity value of the electric power demand of 2013 was abnormally low, 0.35, (the power demand is not reflected because of power shortage issue), the value will rise up to 0.56 in 2030. It means that the relationship between the economic activity and electric power demand becomes stronger. The per capita electric power consumption which was 1,844 kWh in 2013 will increase to 2,841 kWh in 2030.

② In saving case, the growth rate of electric power demand during the forecast period will be loosely 2.4 %, if 20 % of the energy saving potential of power sector is reduced. Electric power demand in 2030 has projected to be 82,900 GWh, and compared to the base case, 18,371 GWh of electricity can be saved. The transmission and distribution loss of Uzbekistan is about 16 % of total electricity supply, which is very high compared to that of developed countries which is about 6 %. Therefore, there is a potential of decreasing the loss by 10 % in Uzbekistan by improving the transmission and distribution technology.

③ In low case, electric power demand of Uzbekistan is projected to increase at an average annual rate of 2.1 % from 2013 to 2030, to reach 78,026 GWh in 2030. This amount of demand is about 77 % of that of the base case in 2030. As a result, the contribution of residential sector to the electricity demand of Uzbekistan will be higher than that of industry sector, as electric power demand for residential sector is projected to increase at an average annual rate of 2.9 % until 2030, compared to 1.6 % of the industry sector.



Source: JICA Study Team

Figure 5.1.1-2 Simulation Result Comparison by Case (2013, 2020, 2030)

3) Other Simulation Results (Reference)

Energy Saving Case

Macroeconomic indicator projection results are the same as that of the base case (see Table 5.1.1-2).

Table 5.1.1-6 Final Electric Power Demand by Sector (Saving Case, 2013–2030)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
(1) Final Sector Consumption	36,972	39,477	41,965	43,524	48,650	54,652	61,696	2.1	2.3
Industry	15,830	15,783	16,942	17,580	19,283	21,150	23,198	1.9	1.9
Construction	130	169	171	185	225	273	332	4.0	4.0
Transportation	1,353	1,193	1,214	1,214	1,214	1,214	1,214	0.0	0.0
Agriculture	9,920	8,592	8,792	8,816	8,877	8,939	9,001	0.1	0.1
Residential	9,466	13,449	14,568	15,729	19,051	23,076	27,950	3.9	3.9
(2) Loss and Own Use	10,515	11,294	11,721	12,028	13,618	15,458	17,604	2.2	2.4
(3) Domestic Demand (1) + (2)	47,487	50,771	53,687	55,552	62,268	70,110	79,300	2.1	2.3
(4) Export	149	843	1,293	1,459	1,971	2,664	3,600	6.2	6.2
(5) Total (3)+(4)	48,301	51,935	54,980	57,011	64,239	72,774	82,900	2.2	2.4
Share by Sector (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	43.1	40.3	40.6	40.4	39.6	38.7	37.6		
Construction	0.4	0.4	0.4	0.4	0.5	0.5	0.5		
Transportation	3.7	3.0	2.9	2.8	2.5	2.2	2.0		
Agriculture	27.0	21.9	21.1	20.3	18.2	16.4	14.6		
Residential	25.8	34.3	34.9	36.1	39.2	42.2	45.3		

Source: JICA Study Team

Table 5.1.1-7 Electric Power Demand by Provinces / Regions (Saving Case, 2013–2030)

Provinces /Regions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Uzbekistan Total	36,699	39,186	41,687	43,524	48,650	54,652	61,696	2.2	2.3
Karakalpakstan	753	778	877	937	1,110	1,322	1,579	3.4	3.5
Andijan	2,121	1,997	2,142	2,151	2,207	2,304	2,435	0.4	0.8
Bukhara	1,785	2,263	2,403	2,537	2,873	3,221	3,597	2.6	2.4
Jizzakh	1,241	1,239	1,289	1,341	1,481	1,641	1,825	2.0	2.1
Kashkadarya	4,368	4,294	4,691	4,884	5,364	5,855	6,371	1.9	1.8
Navoiy	5,842	6,788	6,978	7,386	8,417	9,486	10,611	2.7	2.5
Namangan	2,154	2,102	2,369	2,473	2,777	3,152	3,611	2.3	2.5
Samarkand	2,249	2,573	2,751	2,911	3,390	3,997	4,753	3.0	3.3
Surkhandarya	1,912	1,831	1,887	1,904	1,977	2,093	2,253	0.7	1.0
Syrdarya	903	909	996	1,049	1,209	1,417	1,682	2.8	3.1
Tashkent	5,946	6,262	6,447	6,698	7,391	8,183	9,088	2.0	2.0
Tashkent City	3,672	3,973	4,472	4,629	5,119	5,757	6,563	1.9	2.3
Fargana	2,861	3,284	3,378	3,559	4,094	4,759	5,576	2.8	3.0
Khorezm	892	892	1,008	1,065	1,239	1,466	1,752	3.0	3.3

Source: JICA Study Team

Table 5.1.1-8 Electric Power Demand of Tashkent City (Saving Case, 2013–2030)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Final Sector Consumption	3,672	3,973	4,472	4,629	5,119	5,757	6,563	1.9	2.3
Industry	1,643	885	1,197	1,117	931	756	582	-3.5	-4.2
Construction	28	56	65	73	90	109	129	4.7	4.1
Transportation	192	180	185	187	191	194	197	0.4	0.4
Agriculture	4	9	6	6	8	10	11	5.3	3.9
Residential	1,806	2,843	3,019	3,246	3,898	4,688	5,644	3.7	3.8
Share by Sector (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	44.7	22.3	26.8	24.1	18.2	13.1	8.9		
Construction	0.8	1.4	1.5	1.6	1.8	1.9	2.0		
Transportation	5.2	4.5	4.1	4.0	3.7	3.4	3.0		
Agriculture	0.1	0.2	0.1	0.1	0.2	0.2	0.2		
Residential	49.2	71.6	67.5	70.1	76.2	81.4	86.0		

Source: JICA Study Team

Low Case

Table 5.1.1-9 Macro Economy Sub-model Simulation Result (Low Case, 2013–2030)

Descriptions	Unit	Actual			Estimation				CAGR (%)	
		2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Total Population	Million	26.2	28.6	30.2	31.0	32.9	34.4	35.6	1.2	1.0
GDP Growth (Previous)	%	7.0	8.5	7.0	5.4	5.4	5.6	5.8		
Real GDP (2005 Constant)	Billion Sum	15,923	23,918	29,996	32,993	42,758	55,811	73,687	5.2	5.4
Agriculture	Billion Sum	4,193	5,573	6,953	7,621	9,804	12,719	16,705	5.0	5.3
Industry	Billion Sum	3,371	4,342	5,366	5,802	7,241	9,152	11,747	4.4	4.7
Construction	Billion Sum	771	993	1,228	1,328	1,658	2,097	2,694	4.4	4.7
Service	Billion Sum	1,400	2,499	3,163	3,514	4,650	6,172	8,264	5.7	5.8
transportation	Billion Sum	1,677	2,995	3,792	4,199	5,518	7,286	9,712	5.5	5.7
Others	Billion Sum	4,512	7,516	9,494	10,530	13,887	18,385	24,564	5.6	5.8
GDP by Sector (%)										
Agriculture	%	26.3	23.3	23.2	23.1	22.9	22.8	22.7		
Industry	%	21.2	18.2	17.9	17.6	16.9	16.4	15.9		
Construction	%	4.8	4.2	4.1	4.0	3.9	3.8	3.7		
Service	%	8.8	10.4	10.5	10.7	10.9	11.1	11.2		
Transportation	%	10.5	12.5	12.6	12.7	12.9	13.1	13.2		
Others	%	28.3	31.4	31.7	31.9	32.5	32.9	33.3		
Total	%	%	100.0	100.0	100.0	100.0	100.0	100.0		

Source: JICA Study Team

Table 5.1.1-10 Final Electric Power Demand of Uzbekistan (Low Case, 2013–2030)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
(1) Final Sector Consumption	36,972	39,477	41,965	42,031	45,727	50,952	57,903	1.2	1.9
Industry	15,830	15,783	16,942	17,135	18,439	20,157	22,342	1.2	1.6
Construction	130	169	171	186	217	255	302	3.4	3.4
Transportation	1,353	1,193	1,214	1,233	1,255	1,262	1,263	0.5	0.2
Agriculture	9,920	8,592	8,792	8,693	9,148	9,643	10,191	0.6	0.9
Residential	9,466	13,449	14,568	14,785	16,668	19,636	23,806	1.9	2.9
(2) Loss and Own Use	10,515	11,294	11,721	11,616	12,800	14,412	16,522	1.3	2.0
(3) Domestic Demand (1) + (2)	47,487	50,771	53,687	53,647	58,527	65,364	74,426	1.2	1.9
(4) Export	149	843	1,293	1,459	1,971	2,664	3,600	6.2	6.2
(5) Total (3)+(4)	48,301	51,935	54,980	55,105	60,498	68,028	78,026	1.4	2.1
Share by Sector (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	43.1	40.3	40.6	40.8	40.3	39.6	38.6		
Construction	0.4	0.4	0.4	0.4	0.5	0.5	0.5		
Transportation	3.7	3.0	2.9	2.9	2.7	2.5	2.2		
Agriculture	27.0	21.9	21.1	20.7	20.0	18.9	17.6		
Residential	25.8	34.3	34.9	35.2	36.5	38.5	41.1		

Source: JICA Study Team

Table 5.1.1-11 Electric Power Demand by Provinces / Regions (Low Case, 2013–2030)

Provinces / Regions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Uzbekistan Total	36,699	39,186	41,687	42,031	45,727	50,952	57,903	1.3	1.9
Karakalpakstan	753	778	877	896	1,017	1,189	1,423	2.1	2.9
Andijan	2,121	1,997	2,142	2,061	2,030	2,082	2,201	-0.8	0.2
Bukhara	1,785	2,263	2,403	2,471	2,809	3,197	3,653	2.3	2.5
Jizzakh	1,241	1,239	1,289	1,306	1,411	1,551	1,734	1.3	1.8
Kashkadarya	4,368	4,294	4,691	4,753	5,243	5,820	6,498	1.6	1.9
Navoiy	5,842	6,788	6,978	7,194	8,081	9,119	10,347	2.1	2.3
Namangan	2,154	2,102	2,369	2,383	2,607	2,932	3,375	1.4	2.1
Samarkand	2,249	2,573	2,751	2,787	3,086	3,546	4,197	1.7	2.5
Surkhandarya	1,912	1,831	1,887	1,846	1,903	2,018	2,195	0.1	0.9
Syrdarya	903	909	996	1,015	1,126	1,289	1,518	1.8	2.5
Tashkent	5,946	6,262	6,447	6,478	6,937	7,609	8,510	1.1	1.6
Tashkent City	3,672	3,973	4,472	4,409	4,594	5,023	5,703	0.4	1.4
Fargana	2,861	3,284	3,378	3,417	3,763	4,284	5,013	1.6	2.3
Khorezm	892	892	1,008	1,016	1,122	1,292	1,537	1.5	2.5

Source: JICA Study Team

Table 5.1.1-12 Electric Power Demand of Tashkent City (Low Case, 2013–2030)

Descriptions	Actual (GWh)			Estimation (GWh)				CAGR (%)	
	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Final Sector Consumption	3,672	3,973	4,472	4,409	4,594	5,023	5,703	0.4	1.4
Industry	1,643	885	1,197	1,089	891	721	560	-4.1	-4.4
Construction	28	56	65	73	87	101	118	4.2	3.5
Transportation	192	180	185	190	197	202	205	0.9	0.6
Agriculture	4	9	6	6	8	10	12	5.8	4.6
Residential	1,806	2,843	3,019	3,051	3,411	3,989	4,807	1.8	2.8
Share by Sector (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Industry	44.7	22.3	26.8	24.7	19.4	14.3	9.8		
Construction	0.8	1.4	1.5	1.7	1.9	2.0	2.1		
Transportation	5.2	4.5	4.1	4.3	4.3	4.0	3.6		
Agriculture	0.1	0.2	0.1	0.1	0.2	0.2	0.2		
Residential	49.2	71.6	67.5	69.2	74.2	79.4	84.3		

Source: JICA Study Team

5.1.2 Heat Demand Forecasting

(1) Model Configuration

1) Concept and Structure

As shown in Figure 5.1.1-1, heat demand sub-model is one of the three sub-models in the structure. The basic concept as well as the electric power demand model, the simulation result from macroeconomic sub-model will be incorporated into the heat demand sub-model as explanatory variables. Population is available as an external variable.

In this section, the modeling construction will focus on the heat demand of Tashkent City. The structure of the model is relatively concise because Tashkent City has only two types of consumer contracts. The two types of contract are residential contract and commercial contract (included the public service). Variable to explain the heat demand will be calculated based on the macroeconomic sub-model and estimation formula of residential floor area and number of building.

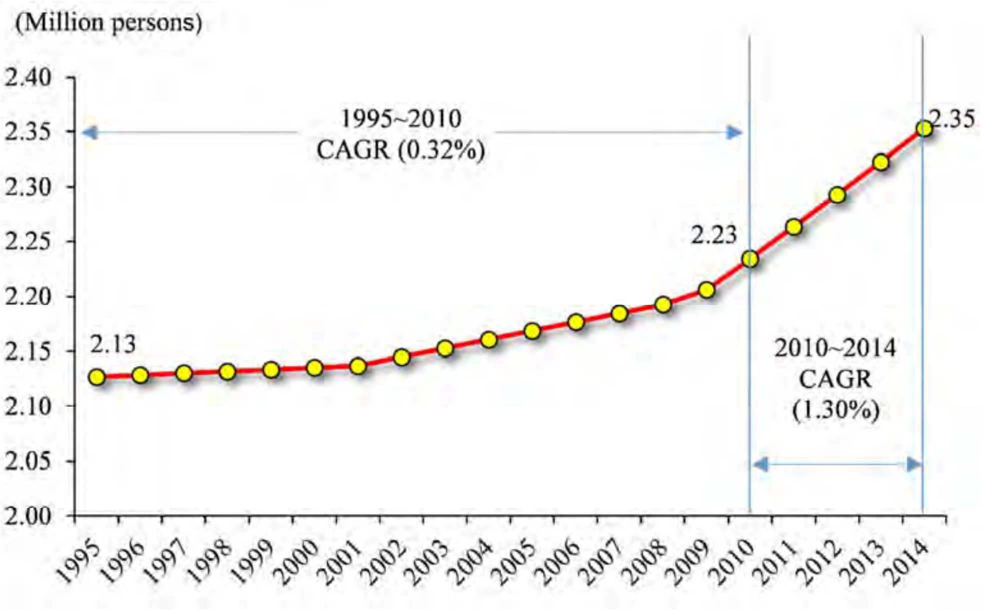
2) Projection Period and Data

The forecast period of the model is 17 years, from 2013 to 2030. Historical data of heat demand from 1995 to 2013 are provided by the Tashteprocentral, and the historical population data of the Uzbekistan State Statistics Committee database for Tashkent City are referred. Because the data are not in time series, some of the data have been calculated by estimation.

(2) Assumptions

1) Population Factor

According to Russia's Institute of Geography, population of Tashkent City increased at an average annual rate of 1.54% from 1979 to 1989, increasing the population from 1.785 million in 1979 to 2.079 million in 1989. However, the population growth rate of the city has been low after the independence although it has again increased recently. The average annual growth rate of Tashkent City population was 0.32% from 1995 to 2010, but 1.3% from 2010 to 2014. The main reason of population growth after 2010 is deeply related to the Uzbekistan’s high economic growth observed in the same period. According to the statistical data of the Asian Development Bank (ADB), the urbanization rate of Uzbekistan is rapidly expanding, and it increased from 35.8% in 2008 to 51.2% in 2013. United Nation Statistic Division has estimated the world major urban population from 2014 until 2030. According to this data, the population of Tashkent City will reach 2.839 million by 2030, growing at an average annual rate of 1.18%.



Note: CAGR, Compound Average Growth Rate
Source: State Committee of Statistics, Uzbekistan

Figure 5.1.2-1 Population Trend of Tashkent City (1995–2014)

Table 5.1.2-1 Population Projection of Tashkent City (2014–2030)

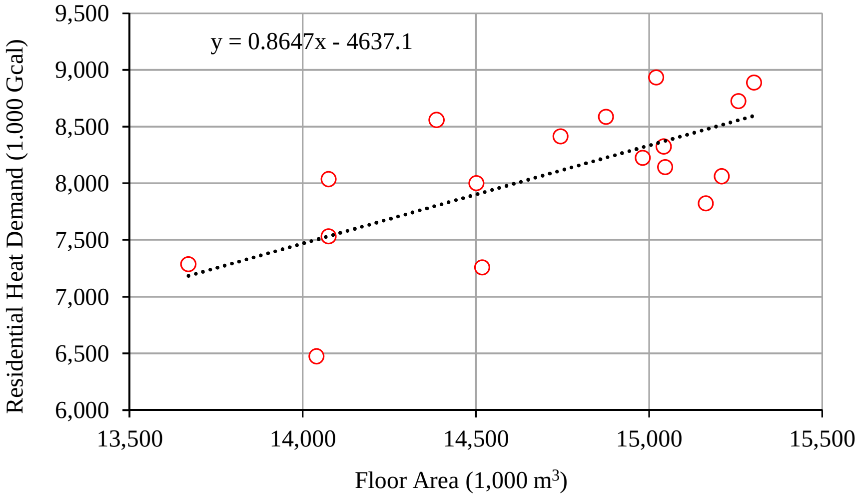
Year	Population	CAGR 2030/2014 (%)
2014 (Actual)	2,352,900	1.18
2030	2,839,000	

Source: United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Prospects: The 2012 Revision, DVD Edition. http://esa.un.org/unpd/wup

2) Floor area of Heat Supply

As described in Section 3.2.2 of Chapter 3, the number of new houses in Tashkent City is increasing. The heat supply floor area increased from 13.25 million square meters in 1994, to 15.3 million square meters in 2013, at an average annual rate of 0.76%. Increase in housing units is mainly due to the population increase. In the model, the relation between heat supply floor area and population has been calculated and heat supply floor area by 2030 has been simulated. Simulation results show that the heat supply floor area will increase at an average annual rate of 0.79% and reach 17.5 million square meters by 2030.

The figure below shows the correlation diagram of the dwelling floor area and the residential heat demand. Both found to have a certain correlation. According to the regression analysis, the elasticity of floor area to the residential heat demand is 0.86. However, the coefficient of determination is as low as 0.45. Floor area by itself, as a variable, is not enough to describe the heat consumption in residential area. In order to adjust the model estimation equation, the residential heat demand of the previous year will be used as an explanatory variable of the current year demand in the modeling equation.



Source: Tashteprocentral

Figure5.1.2-2 The Correlation and Linier Regression of Residential Heat Demand and Floor Area

(3) Simulation Results

Based on the assumptions described above, the heat demand of the Tashkent City from 2013 to 2030 is simulated. Heat demand of Tashkent City will increase at an average annual rate of 0.8% until 2030 and will reach 11,870 Tcal in 2030. Heat demand of residential sector will increase at an average annual rate of 0.9% in the same period. In year 2030, the share of heat demand of residential sector will account for 86.7% pf the total heat demand of Tashkent City, and it is expected to lead the heat demand in the future. Particularly, the population growth leads to expansion of housing floor space, and finally to increased heat demand.

On the other hand, the heat demand of commercial sector was shrinking after the independence until 2010. But since 2010, the increase of economic activity in the country has caused the decrease in demand for heat in Tashkent City. Moreover, the heat demand of commercial sector was increasing slightly until 2013. The activation of the service sector in Tashkent City is expected to increase the heat demand of the commercial sector. However, the diversification of heat supply system is also progressing, that the increase in demand may not be high. Heat demand of commercial sector will increase at an average annual rate of 0.1% by 2030.

Table 5.1.2-2 Heat Demand Projection for Tashkent City (2013–2030)

Description	Actual (Tcal)				Estimation (Tcal)				CAGR 2030/2013 (%)	
	2000	2005	2010	2013	2015	2020	2025	2030	2020/ 2013	2030/ 2013
Total Heat Demand	11,134	10,275	9,341	10,437	10,517	10,852	11,323	11,871	0.6	0.8
Residential	8,036	8,414	7,821	8,887	9,000	9,366	9,811	10,287	0.8	0.9
Commercial	3,098	1,862	1,520	1,550	1,517	1,486	1,511	1,584	-0.6	0.1

Source: JICA Study Team

5.2 Optimal Size and Output of the Equipment

(1) Output of each unit, total output, heat-to-power ratio

1) Description of cogeneration system

Cogeneration system is a system of generating two or more types of energy, such as electricity and heat, using one type of fuel, and the system is characterized by a very high efficiency. In this project the natural gas is to be used as fuel. The natural gas can be used as fuel for not only the thermal power plants generating steam but also for the systems using gas turbines and gas engines to generate electricity, and the excess heat is utilized for generating and delivering heat as steam or hot water.

Characteristics of each energy generation system are described below.

Gas engine plants are compact, and the technical progress of the recent years has led to the production of some of very efficient plants of this type. However, these systems require frequent equipment checks, and, thus, are not suitable for continuous operation. Also, this type of plants can generate relatively small amount of thermal energy.

Conventional steam-based power plants are often of large scale and its efficiency decreases at smaller scale plants. However, this type of systems has no limitation on the generator's output as it is possible to increase the heat used by the generator by increasing scale and output of the boiler.

Systems based on gas turbines are compact and suitable for continuous operation. Also, implementation of cogeneration, i.e. installing equipment to capture and utilize the exhaust after electricity generation, allows simultaneous delivery of electrical and thermal energy, substantially increasing the overall plant efficiency.

Systems with turbines or engines of small to medium scale are used for factory automation, air conditioning and lighting, and they are also used by factories and office buildings with relatively high consumption of electricity and heat. On the other hand, in case of district heating or large-scale manufactures, where the consumption levels of electricity and heat are high, systems based on boilers and steam turbines or gas turbine systems are more suitable.

The plants using boilers and steam turbines use the thermal energy from the combusted fuel to generate steam of required conditions, which then spins a steam turbine which drives an electrical generator, and the heat of extraction steam and back pressure steam is utilized. The higher the heat-to-power ratio the higher the coefficient of fuel heat utilization. However, it may be difficult to build a highly efficient plant of this type when electricity generation at certain fixed scale is required.

In case the gas turbine cogeneration is used, it is possible to build a plant with efficiency of 70–80 % and heat-to-power ratio of approximately 2.

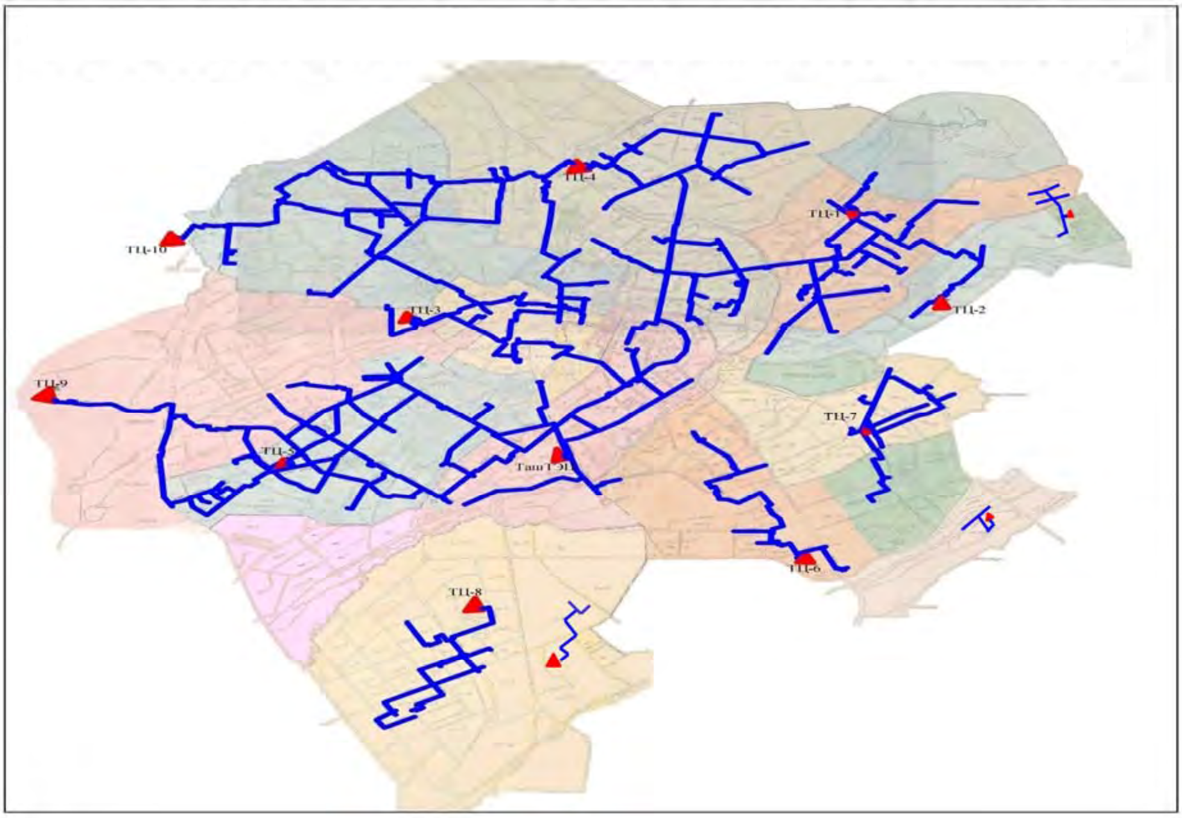
Uzbekistan is aiming at enhancement of power supply capabilities through effective use of fuel while meeting the current state of the heat demand. Gas turbine cogeneration systems meet these requirements and thus are considered for this project.

2) Output of electricity and heat generation

This project plans to construct a gas turbine power plant consisting of four units, each with one 27 MW generator and a 40 GCal/h heat-recovery boiler (heat-to-power ratio: approximately 1.7). Thus the plant's total output will be 108 MW and 160 GCal/h.

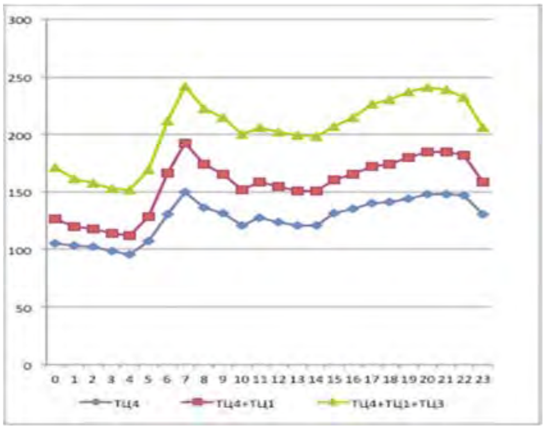
Generally, cogeneration systems are operated to fulfill the heat demand, and the electric power generation output depends on heat production operational conditions. However, it may lead to a decrease in the plant's efficiency, especially during the low workload periods, depending on the nominal capacity. Hence, demand and output needed to ensure high efficiency even in low workload periods were calculated for this plan.

Based on the hot water delivery related data obtained at the adjacent TC-4 boiler station, minimal demand for the summer period has been calculated, which is 90 GCal/h under basic operation. The maximum demand even considering the relatively stable demand during the daytime (excluding early morning) and evening has been calculated at 120 GCal/h. This means that the Uzbekistan side plan has excessive planned output. On the other hand, the age of the boilers, and also the similarity of the situation at TC-1 and TC-3 should be noted. Taking this into consideration the possibility of expanding the target area of hot water delivery into the areas currently covered by district boiler stations adjacent to TC-4 has been studied. It has been confirmed that the total heat demand for TC-4, TC-1 and TC-3 is stable at 160 GCal/h, even during the minimal consumption period in summer (see Figures 5.2-1 and 5.2-2). As demonstrated in Figures 5.2-3 and 5.2-4, during the last three years there has been a trend of increasing hot water consumption and daily demand during the minimal demand period. Also, based on the actual data of TC-4, TC-1 and TC-3 on minimum hot water consumption per unit of time for the period starting from 2013, and also the heat energy forecast from Chapter 5.1 (average annual increase in 2013–2020 is 0.6 %, and in 2013-2030 is 0.8%), it can be assumed that the minimum heat consumption per unit of time will reach the indicated level in the first half of 2020 (Figure 5.2-5).



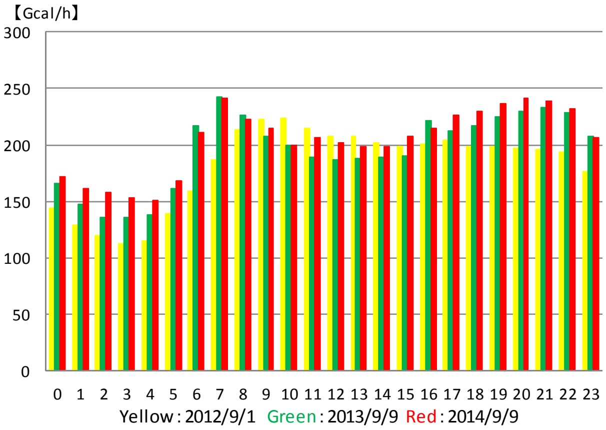
Source: based on TashTETs materials

Figure 5.2-1 The main heating pipelines of Tashkent



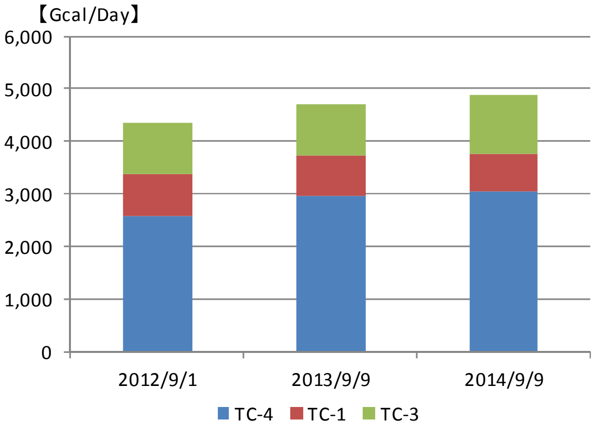
Source: Expert investigation group

Figure 5.2-2 Daily workload during the minimal hot water demand period for TC-4 and adjacent boiler stations (September 9, 2014)



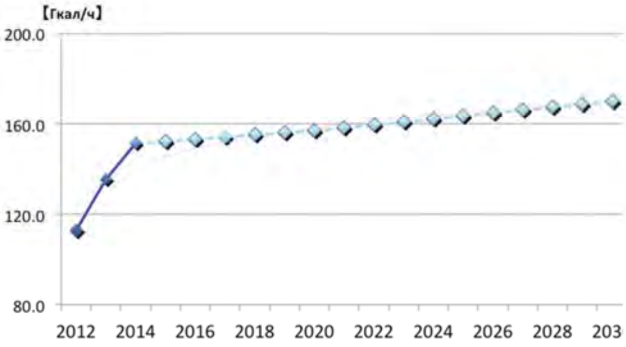
Source: Expert investigation group

Figure 5.2-3 Daily workloads during the minimal hot water demand period for TC-4 and adjacent boiler stations for 2012–2014.



Source: Expert investigation group

Figure 5.2-4 Daily hot water demand during the minimal demand period for 2012–2014



Source: Expert investigation group

Figure 5.2-5 Forecast of minimal hot water consumption in a time unit (actual data for 2012–2014 and forecast up to 2030)

However, to expand the heat delivery network, it is very important to consider the capabilities of the pipelines. As it has been pointed in Paragraph 3.2.3, during summer and in emergency cases there is cross delivery of heat between the designated delivery areas. Thus, based on the actual data on the delivery of heat by TC-4 to the areas assigned to the adjacent TC-1 and TC-3, it is assumed that an expansion is possible through development of a such district heating network that would enable continuous supply in the summer period.

Based on the above mentioned, it can be said that on condition of expansion of heat delivery area, heat output corresponds to that of the plan prepared by the Uzbekistan side. To expand the heat delivery area from the points of view of demand-supply adjustment and construction of a heating network for a continuous supply in the summer period, it is necessary that TashTeploTsentral, which controls the production of hot water, and TashTeploEnergo, which is in charge of the management and maintenance of heating networks, reach an agreement. In the Chapter 7.1.2, it is shown that organizations that are in charge of heat delivery in Tashkent - TashTETs, TashTeploTsentral, TashTeploEnergo - have reached agreement on the adjustment of overall workload by operating TashTETs-2 at full output and regulating the operation of TC-4 and adjacent boiler stations (TC-1, TC-3, TC-10). An agreement has also been reached on expansion of heat delivery area by joining the heating networks permanently.

Regarding generation of the electric power, all generated power is planned to be submitted into the power grid, with the exception of the plant demand for the engine operation. One of conditions for this is leveraging the existing power transmission network infrastructure. The capability of power transfer to the places of connection to the power grid is evaluated at 100-130 MW. Based on the plan developed by Uzbekistan side and taking into consideration the difference in the output between boiler stations' network pumps and gas turbine units' equipment, the electric power generation output has been set at 120 MW.

3) Output of each unit (including the heat-to-power ratio) and overall output

Based on chosen output for generation of heat of 160 GCal/h and electric power of 120 MW, as a basic configuration to reach the most effective utilization of energy, and also considering measures to minimize interruptions at failures, the option of several units consisting of one gas turbine generator and one heat-recovery boiler has been selected over the option of a single unit.

Output of each unit has been set based on the operation and maintenance requirements, to ensure the best conditions. Options with 2-4 units have been evaluated. The results of the analysis are shown in Table 5.2-1.

Table 5.2-1 Comparison of cogeneration systems configuration options

Configuration	2 units	3 units	4 units
Heat generation output	160 GCal/h	160 GCal/h	160 GCal/h
Electric power generation output	120 MW	120 MW	120 MW
Unit output	60 MW + 80 GCal/h	40 MW + 53.3 GCal/h	30 MW + 40 GCal/h
(heat-to-power ratio)	(1.55)	(1.55)	(1.55)
Reliability and operational characteristics	△	○	◎
Impact in case of one unit halt	Broad	Relatively small	Small
Time for compensation of output by adjacent boiler stations in case of a failure	Existing boilers (100 or 180 GCal/h) are used to compensate the output and much time is required.	Time needed to compensate is relatively short due to usage of existing boilers (100 GCal/h). But partial workload operation of the boilers (100 or 180 GCal/h) causes decrease in energy usage efficiency.	Time needed to compensate is relatively short due to usage of existing boilers (50 or 100 GCal/h). Partial workload operation of the boilers (100 GCal/h) causes decrease in efficiency but not as big as in other options.
Maintainability and serviceability	The unit size is much bigger than that of other options, and thus service time and down time increase. Also, with one unit down the station output decreases to half, which is bigger than that of other options.	Size is similar with basic configuration and service time is similar. However, with less number of units the cost of maintenance is lower.	Basic requirements
	△	◎	○
Economic indicators	Gas turbines of this type have lower temperature of working gases and boilers' size increase and design of new equipment are necessary.	Heat-recovery boilers differ from standard type (30–40 GCal/h) and design of new equipment is necessary.	Heat-recovery boilers of standard type (30–40 GCal/h) are used and they only need to be adjusted to the station's conditions.
	×	△	○
Overall evaluation	×	△	○

In case the 2-unit configuration is chosen, each unit will need an 80 GCal/h heat-recovery boiler. However, as gas turbines of this type have low temperature of working gases, the boiler output needs to be increased and design of new equipment is necessary. This is why this option is not feasible for its cost.

The 3-unit option heat generated at each gas turbine is greater than that of the 4-unit option. So, to ensure efficient use of the heat, boilers output must be increased from the standard 30 40 GCal/h and also new equipment must be designed and manufactured.

Thus, the 4-unit option has been chosen, which ensures less time to compensate the loss and has less impact than other options in case of a failure, has been chosen. This option also allows maximum efficiency of energy use at the standard configuration.

(a) Output of each unit (including the heat-to-power ratio)

30 MW class gas turbine generator (1 unit) + 40 GCal/h class heat-recovery boiler (1unit)
Heat-to-power ratio (= heat/electric power, where heat is converted) is
$40x10^6$ / ($30 \text{ x } 10^3 \text{ x } 860$), i.e. approximately 1.55.

(b) Overall output

Overall output of the 4-unit configuration is 120 MW for electric power and 160 GCal/h for heat energy generation.

5.3 Project Concept

5.3.1 Gas Turbine Unit

Gas turbine unit is the most critical equipment constituting a core of the cogeneration turbine unit and the system of gas turbine unit control, so it is not an exaggeration to say that its characteristics, reliability and operational suitability will influence on the production result after the start-up. Typically, the order of development and design of specific equipment costs higher. Boilers and steam turbines, although they have standard design, may be designed and manufactured specifically to match the specification of an order. With regard to gas turbines, the necessary installation, unlike the boilers and steam turbines, is usually selected from already developed and designed standard options.

Table 5.3.1-1 shows the available range of gas turbines in the market for electricity generation turbines of 30 MW.

Table 5.3.1-1 Specifications of gas turbines of 30 MW class

Manufacturer	Company A	Company B	Company C	Company D	Company E
Gas turbine type	Multistage industrial gas turbine	Multistage industrial gas turbine	Aviation gas turbine	Aviation gas turbine	Aviation gas turbine
Type	H-25 (32 C)	SGT-700	LM2500 + PK	RB211-GT61DLE	SwiftPac25DLN
Electricity production [MW]	32.0	32.2	28.4	32.1	25.5
Fuel consumption level [kJ/kwh]	10346.1	9764.7	9653.9	9159.1	9453.5
Volume of exhaust gas [kg/s]	93.9	93.4	82.2	93.8	84.8
Exhaust gas temperature [°C]	563.9	552.2	511.1	509.4	457.8

Source: Gas Turbine World 2013 Handbook Specified indicators correspond to ISO standards

Commercial flow gas turbines for electricity production are divided into industrial and aviation turbines in their structure. The first type is stationary and designed to work for a long time, and the latter is developed as an aircraft engine and gas generators are attached to the turbine output to drive the generator.

Aviation gas turbines have characteristics of aviation engines, and due to the high degree of pressure increase their thermal efficiency is high; Moreover, because of the thin shell and rotor and transformed structure, the start time is small, and suitable for frequent start-ups and shutdowns. They are often used during peak hours and to drive equipment. However, as shown in Table 5.3.1-1, due to the low temperature of the exhaust the energy efficiency of the entire system, responsive to the regeneration of heat energy exhaust, is low too, compared to the industrial gas turbines. Moreover, the service life of basic construction and inspection intervals is small, and inspections and repairs require shutdowns, which make them unsuitable for prolonged start-up. In addition, for inspection and repair needs it is necessary to bring round modules of compressor and burners of the turbine separately to the manufacturer. There is also a rental contract for modules and turbines as a unit, and if there is a manufacturer's service center near the construction site, the repairs can be made on the spot by changing the individual modules; the reduces the plant shutdown duration. However, there is no any service outlets at the construction site because it is in a country which is doubly land-locked, and the transportation is not convenient and not cost-effective. In addition, in the case of rental, the transportation time increases, increasing the rental costs, which in economic terms has numerous negative sides.

Industrial gas turbines are stationary, designed for continuous uninterrupted operation, and their details including the body and rotor, are thicker and stronger than aviation gas turbines. Due to their rigid construction they are resistant to deformation, but they are easily subject to a thermal shock, and although the start-up time is a little longer, the service life of basic construction is long and trouble-free operation is possible. Moreover, from the very beginning of the design it is planned to operate these turbines at heat plants and it is desirable not only to generate electric power by the turbine itself, but also to improve the workshop efficiency as a whole, taking into account waste heat recovery, so many turbines have high temperature exhaust gas. In addition, the shell splits the compressor, the burner and turbine part into the upper and lower parts and, the rotor is usually one-piece that enhances ease of repair on the spot.

Gas turbine plant, introduced to this production, can produce supplies for central heating of houses of the population and has a high effectiveness in generating not only electricity, but also heat recovery, and can also provide a stable and smooth operation in the winter. Therefore, taking into account the geographic conditions of the place of the project, it was decided to choose the industrial gas turbine type.

Table 5.3.1-2 Comparison of gas turbine types

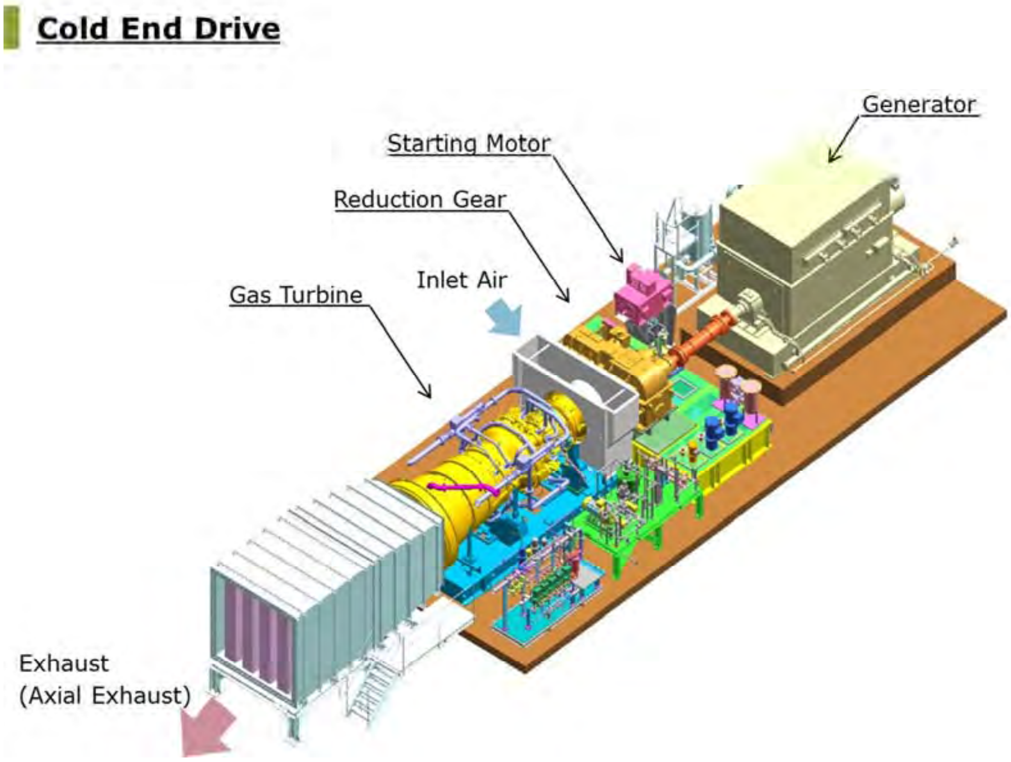
Properties	Aviation gas turbine		Industrial gas turbine (selected)	
	Features	Score	Features	Score
Design	Slim body, transforming design	—	Rugged shell, tough construction	—
The service life of parts	Usually a short lifespan	△	Usually a long lifespan	○
Start-up	Reaction to temperature changes: Quick, Quick start-up, Critical voltage: Little → Frequent enabling and disabling: Suitable	○	Response to temperature change: Slow, Critical voltage: High → Frequent enabling and disabling: Not suitable	△
Uninterrupted operation	Requires maintenance approximately every six months, with a full shutdown	×	Requires maintenance approximately every 2 years, with a full shutdown	○
Maintenance				
Possible to repair on the spot	Originally designed for repair at the plant (round modules)	×	Originally designed for repair on the site (shell divides the part into a top and bottom)	○
Shutdown durtion	The amount of work necessary for the preparation of replacement modules: small	○	The volume of work necessary for assembly and disassembly :large	△
Expenses	The frequency of inspections, parts replacement: large Transportation(cargo volume):large (whole modules) ※	×	The frequency of inspections, parts replacement: rare Transportation(cargo volume)small (individual parts)	○
Specifics	The degree of increase of pressure: high → gas turbine efficiency: high; gas turbine output: large	—	Exhaust gas temperature: high → additional generation of electricity: large; equipment efficiency: high	—

Legend:
○: good, △: fair, ×: bad, —: Exempt
Source: JICA Study Team

The figure below is an example of a gas turbine of company A in Table 5.3.1-1.

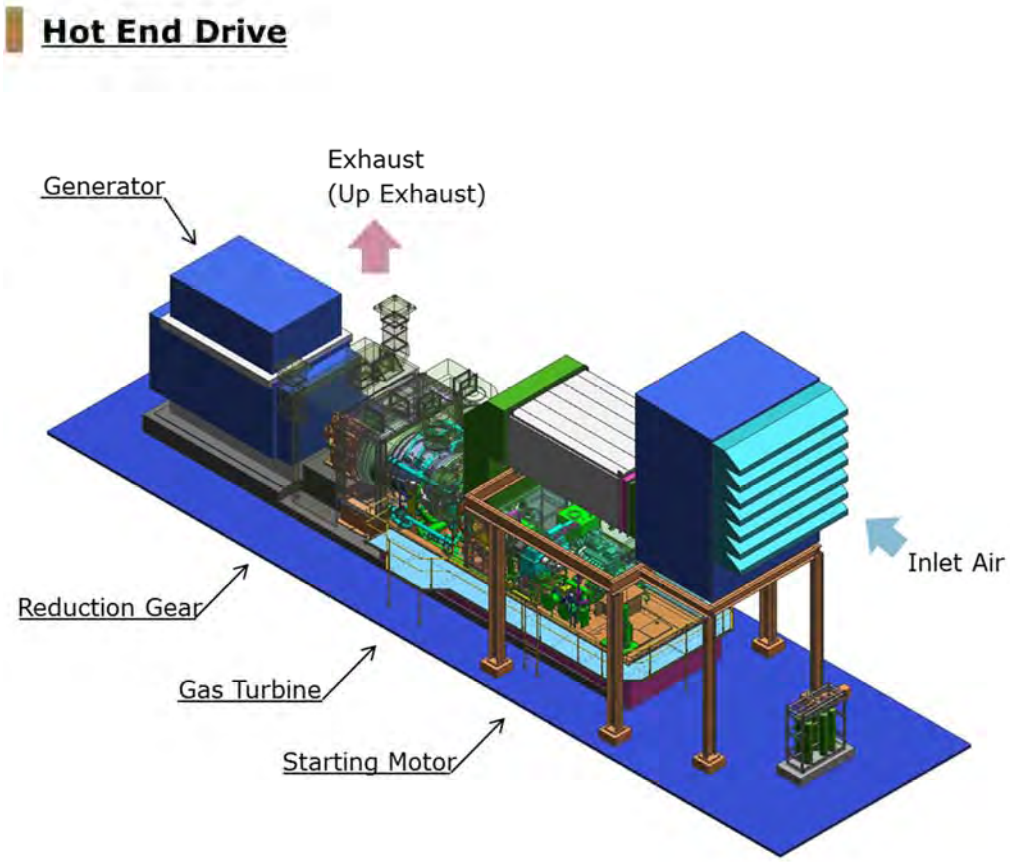
In order to reduce the level of nitric oxide in the exhaust gas, the burner with low and dry nitrogen oxides emissions is selected; this makes it possible the reduction of the temperature of the flame by uniform combustion of pre-prepared homogeneous mixture.

There are types of exhaust pipes: Cold-End Drive (drive from the cold end), and Hot-End Drive (drive from the hot end). The model of Company A represents both types.



Source: manufacturer’s materials

Figure 5.3.1-1 Cold-End Drive Diagram SAMPLE



Source: manufacturer’s materials

Figure 5.3.1-2 Hot-End Drive Diagram SAMPLE

Features of each of the drives and score on the site of the project are presented in Table 5.3.1-2. considering all sides, including the freedom to locate a drive, Hot-End Drive was selected.

Table 5.3.1-3 Comparison of gas turbine drives

	Cold-End Drive		Hot-End Drive (Selected)	
	Features	Score	Features	Score
Output of electricity	Base	○	Approximately0.3 MW	△
Exhaust gases	Base	△	Approximately3 °C	○
Location	It extends in the direction of the axis of gas turbine (including boiler)	△	It is possible to install the boiler at right angles to a gas turbine	○
Transportation	Fencing, base, additional devices are transported individually	△	It is packed during shipments to the plant, and practically all devices are placed on the base, and transported packed in the enclosure.	○
Works on site	A large amount of work of additional devices installation, assembly of fence right on the spot is necessary	△	Thanks to the package, a small amount of work after installation on the base is necessary	○

Legend:
○: good, △: fair
Source: JICA Study Team

5.3.2 Heat Recovery Boiler

Heat Recovery Boiler-boiler uses the heat of the exhaust (outflow) gases of gas turbine and converts it into the energy used to heat water for hot water supply. Methods of regeneration of heat from exhaust gases are discussed below.

(1) Vapor recovery

In this system the water is regenerated into steam of high temperature and high pressure (about 200-400°C, 2-4 kg/cm^2) in the recovery boiler, and later it is transformed into hot water of 60-80 °C in the heat exchanger for supply to the population.

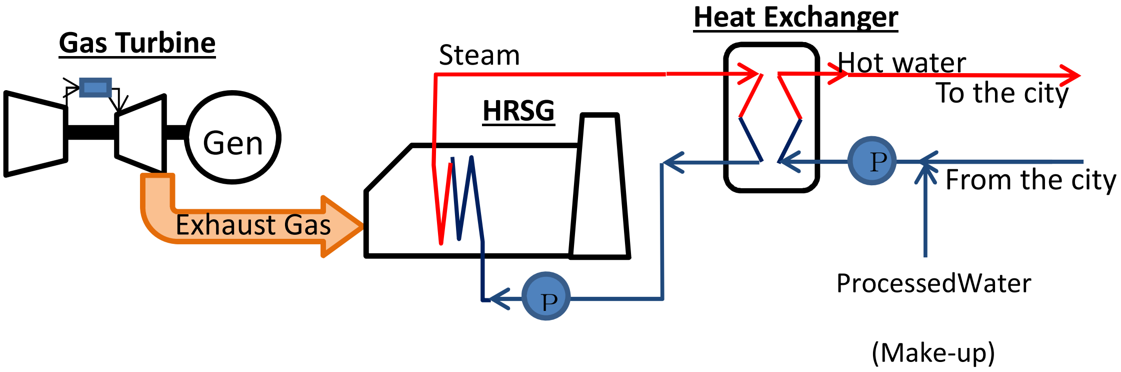


Figure 5.3.2-1 Simplified diagram of gas turbine unit system with vapor recovery

(2) Regeneration of hot water

In this system, the water is directly regenerated into hot water in the recovery boiler for hot water supply.

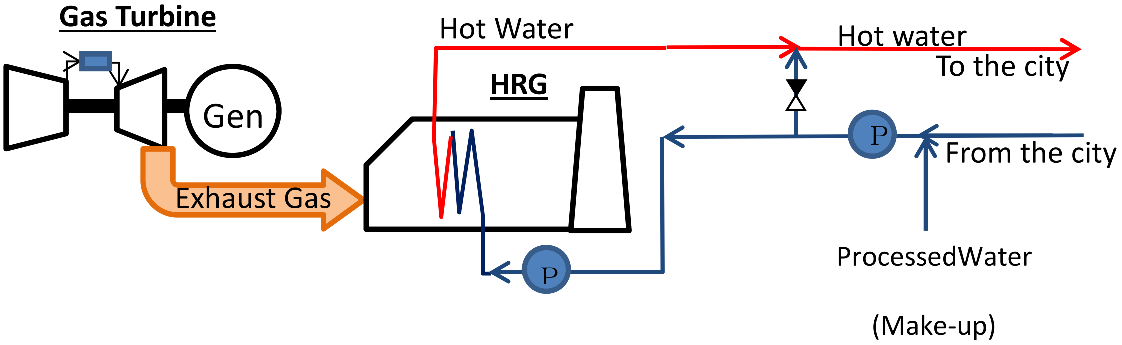


Figure 5.3.2-2 Simplified diagram of gas turbine system with hot water regeneration

(3) Regeneration of hot water (through heat exchanger)

The water is first regenerated into hot water in the heat recovery boiler in this system, and later the same as in (1), this water is transformed into water of 60-80 °C in the heat exchanger for the supply to the population.

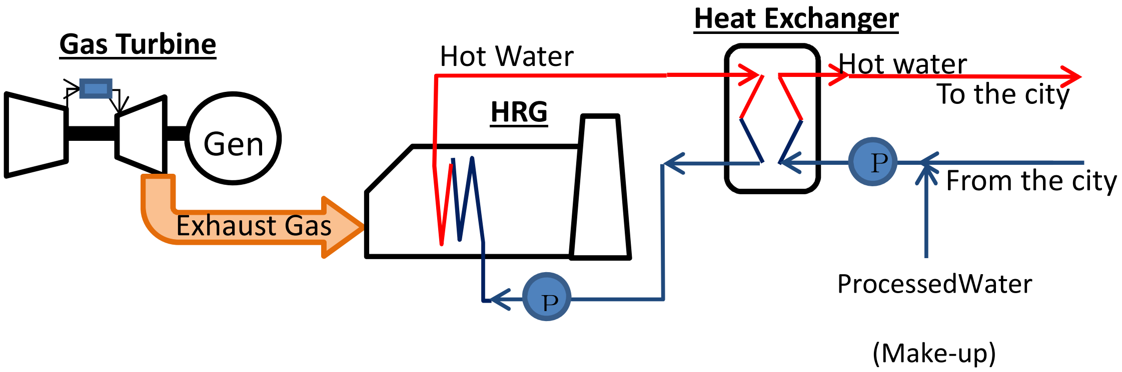


Figure 5.3.2-3 Simplified diagram of gas turbine system with hot water regeneration (Via a heat exchanger)

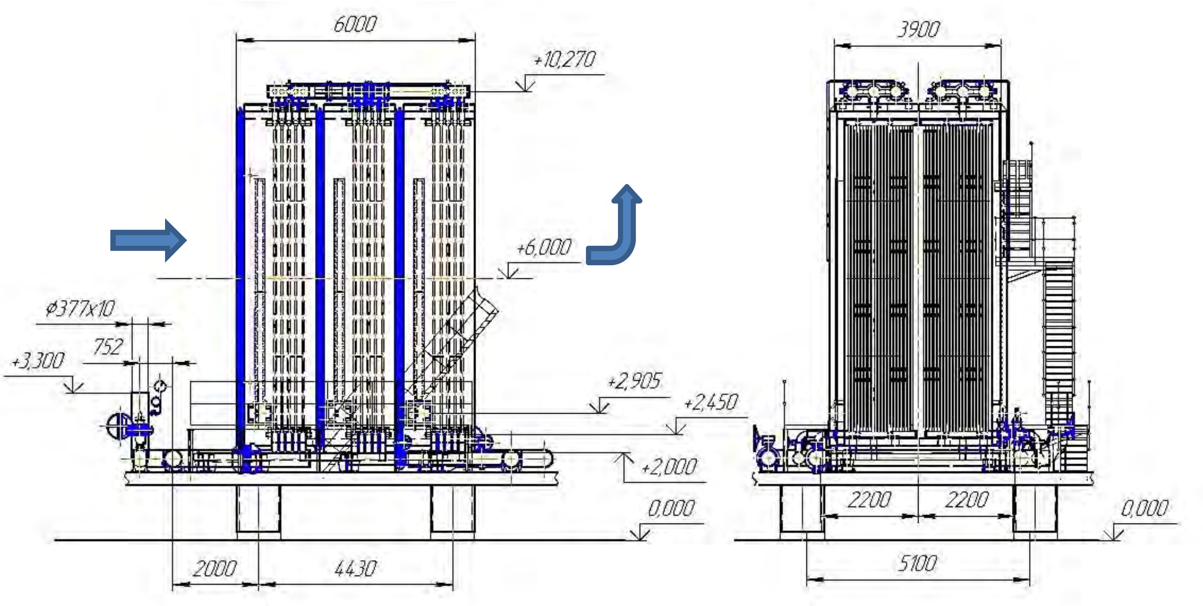
When using method (1) there are problems with the financial side when commissioning the equipment and during its operation. Because the boiler operating conditions are strict, the requirements for the quality of the material, the thickness of the pipe used in the boiler will be high, and, therefore, the initial costs for the commissioning of the equipment and its contents will also be large. Since steam is produced, feed water quality requirements will be high and it will be necessary to install an appropriate system of water treatment system. Since steam is injected into the heat exchanger, the equipment specification for exchanger as the high pressure vessel will be higher, which simultaneously increases expenses. In addition, to ensure that condensation definitely occurs in the heat exchanger, certain decisions will need to be taken into account when designing.

In method (2), there are some difficulties with heat recovery. That is, to supply hot water to the population its winter temperature must be 80 °C, and in the summer 60 °C, that is a low temperature compared to the temperature of the exhaust gases from the gas turbines, which are used by the boiler. Moreover, since a feed water temperature at the inlet of a hot water boiler shall be above 50 °C, in order to get the required temperature at the boiler outlet, the temperature increase of water inside the boiler shall be from 10 °C to 30 °C, which is very small. In order to regenerate the exhaust gases energy, it is required to either increase the volume of the water inside the boiler to the limit or to receive water of high temperature at the outlet of the boiler, and then mix it with the water of low temperature and thus obtain the required water temperature.

Method (3) offers solutions for the problems of methods (1) and (2). The hot water of the boiler circulates in a closed ring and then through the heat exchanger in which it is regenerated into hot water for public water supply; thus, it turns to the water of required temperature. Boiler water, unlike steam boiler, may have lower quality, and can be used apart from the water for the hot water supply. In order to maintain 50 °C water temperature at the inlet to the boiler, and in order to avoid erosion by carbon dioxide, the level of heat exchange with water for hot water supply can be adjusted using the amount poured into the feed water boiler in a cyclic mode. Since there is a heat exchange between hot water and hot water in the heat exchanger, it is possible to use a plate heat exchanger distinguished by its filling coefficient and reliability. This is a device where numerous layers of metallic plates and gaskets alternate, and where heat exchange between heating and heated water liquids occurs.

Experience in applying the same system consisting of gas turbine, water boiler and heat exchanger exists in other CIS countries. For the present project we selected the method of heat regeneration (3) that allows to efficiently getting heat when installing and operating the simplest system of water treatment system for the boiler.

The design diagram of proposed boiler is shown in Figure 5.3.2-4.



Source: from manufacturer's materials

Figure 5.3.2-4 Heat Recovery Boiler design scheme

This boiler is installed transversely, with lateral flow of exhaust gases. Intake and exhaust manifolds are installed at the bottom of the boiler, and the distribution manifold at the top. Finned tubes of heat exchanger are installed perpendicular to the flow of exhaust gases inside the boiler.

In the boiler itself, there is a bypass air valve which regulates the temperature. The bypass allows the outflow of exhaust gases from the channel with heat exchange tubes to the bypass channel, and through the heat supplied to the hot water can be regulated. However, in this case heat exchange does not occur, and exhaust gases from the gas turbine as in the gas turbine of simple cycle are released to the atmosphere, and hence energy loss occurs. Temperature control with this function is not reasonable, and therefore was excluded from consideration of heat balance in Paragraph 5.3.6. Heat exchange produced in the system after the greatest collection of exhaust gases heat of gas turbine is carried out as presented in Paragraph 5.3.6 by regulating heat volume with the help of liquid volume change passing through the heat exchanger and deaerator heater of hot water for water supply and extra water.

5.3.3 Equipment for Water Treatment

(1) Purification of feed water

Data on the water required at TashTC-2 are presented in Table 5.3.3-1.

Table 5.3.3-1 Water supply at TashTETs-2

Water designation	Water quality	Source of supply
Water for hot water supply	Soft water rigid component: 220 μg-eq/kg	Water supply TC-4
Feed water for the boiler, incremental water	Soft water rigid component: 2μg-eq./kg (presumably)	Water supply TC-4 (requires repeated treatment)
Water for coolant in the equipment	Equivalent to untreated water (waterworks)	waterworks
Coolant water for blow-down water in the boiler	Equivalent to untreated water (waterworks)	waterworks
Purified water for gas turbine compressor	equivalent to desalted water ※See Table 5.3.3-2	waterworks (requires repeated treatment)

Regarding incremental water for hot water supply, it is agreed to supply water of 20 °C obtained by softening hard water Na+ by cation exchange resin at the equipment for water treatment at TC-4. In this case, the volume of water supplied by the equipment for water treatment at TC-4 equals to 4.300 m^3/h, and it is necessary to reach the total amount of water used at TashTETs-2 and TC-4 in winter and summer. In winter, even after commissioning of TashTETs-2, the territory of water supply of TashTETs-2 and TC-4 remains common, and increase of water generation at TashTETs-2 reduces operation of heating boiler at TC-4. Therefore, as the total volume of water required for the TashTETs-2 and TC-4 does not change, the expansion of the water treatment equipment is not considered necessary. During the summer period, TashTETs-2 provides hot water for the whole supply area of TC-4 and parts of supply areas of TC-1, 3, 10. In fact, TashTETs-2 heat balance confirms that , even if TC-4 does not supply hot water, the supplied water volume in the summer period meets the need which makes water treatment equipment expansion unnecessary.

Water supplied by TC-4 fails to remove dissolved oxygen. In order to remove dissolved oxygen the heating is required, and in terms of rational use of heat at the heating plant it is advisable to obtain this heating using exhaust gases of gas turbine. With regard to the deaerator, it is planned to install it at TashTETs-2 simultaneously with the heating to remove dissolved oxygen to comply with the Uzbek standard, according to which the concentration of dissolved oxygen in the supplied water shall be less than 20 μ g/kg.

Regarding the feed water for the recovery boiler, in order to monitor the content of the boiler directly receiving outflow heat of gas turbine, it is desirable to separate it from the control of hot water supply system circulating in the area. Assuming that it is necessary to further reduce the rigid component to suppress the oxide layer on heat transfer pipes, the system is planned so that the treated water supplied by TC-4 (according to the verified data, the rigid component is 220 μ g-eq./kg) would repeatedly pass through Na+ cation exchange resin, and this would reduce the rigid component to the target 2 μ g-eq./kg. The installed capacity of this cation exchange resin covers the volume of blow-down feed water to increase the water quality in 4 operational recovery boilers, and it is enough to conduct water treatment and water filling during start-up of one recovery boiler after repairs.

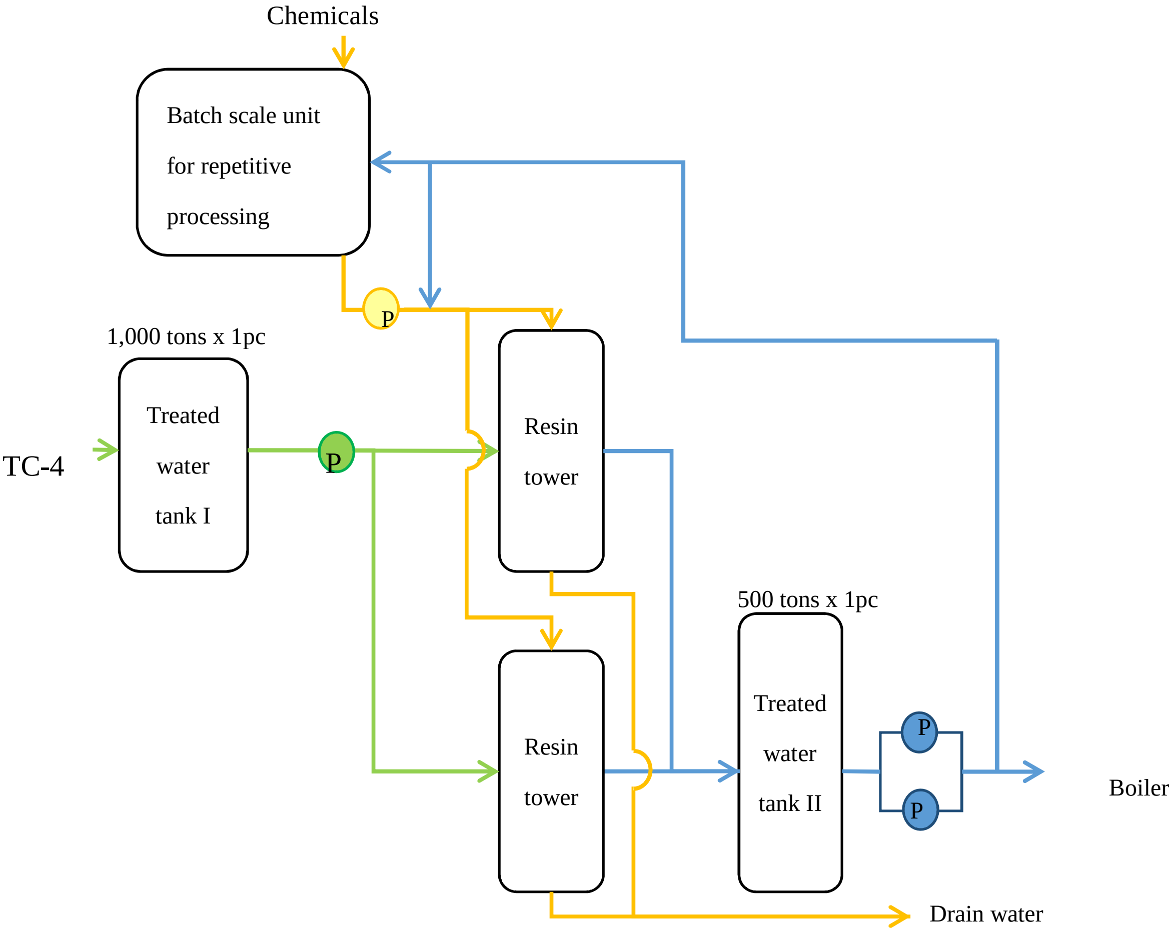


Figure 5.3.3-1 Simplified system of water treatment plants required for the boiler

Moreover, as for the maintenance of the characteristics of gas turbine air compressor, it is needed to periodically wash compressor blades; this requires clean water. Required indicators of water for cleaning are given in Table 5.3.3-2.

Table 5.3.3-2 Required indicators of water for washing compressor blades

Item	**Required indicators**
Water consumption	Approximately 100 l/min
Pressure	Approx. 0.3 kg/cm^2 (G)
The total content of dry residual	< 100 ppm
Total content of alkaline metals (Na + K)	< 25ppm
Other metals *	< 1.0 ppm
pH	Approx. 7

* Other metals that cause high temperature corrosion (e.g., lead, vanadium, etc.)

Source: JICA Study Team

Because there is a Na+, which cannot be removed by Na+ cation exchange resin at the water treatment equipment for producing boiler feed water and water for hot water supply, separate equipment is necessary for water treatment. Even assuming that it will be impossible to wash blades of several units simultaneously, the equipment output will be still enough to treat 2m^3/h of water. Based on the output and compactness, reverse osmosis membrane is considered to be a suitable type.

(2) Drain water treatment equipment

Hot water, boiler water and blow-down water for cooler are planned to be drained to the nearby Karakamish River as industrial wastewater.

In order to produce hot water, treated water obtained from TC-4 is used without changes; therefore the drain water quality is practically the same as the treated water at TC-4. With regard to the boiler water, treated water cleanup is performed to the level of quality required for the operation of the boiler, but it is planned to process the water by Na+ cation-exchange resin without application of chemicals. Thanks to this, except during the reuse of resin, concentration of chlorides increases slightly due to the influence of sodium chloride, and the quality of wastewater remains almost equal to the quality of treated water from TC-4. In fact, the TC-4 tap water is also handled by the Na+ cation exchange resin, but, as shown in Table 5.3.3-3, the percentage of chloride increase before and after water treatment (2.85 → 6.85 mg/l) is small in compared with the standard (300 mg/l).

Regarding coolant for the gas turbine, gas compressor etc., it is planned to receive tap water from Suvsoz and use it in the contactless circulation system that leaves wastewater quality almost equal to the tap water.

Based on the above, the quality of the treated water was compared with that of TC-4, tap water of Suvsoz, and with quality standard of sewage into the river Karakamysh (see Chapter 8) to confirm the need of equipment for waste water treatment. The result revealed that all the indicators correspond to the standards. On the other hand, because quality standards of drain water require that temperature increase in the river after drain would not exceed 3 °C, despite a lack of equipment for treatment of waste water, it is planned to mix and cool high temperature blow-down water of TashTETs-2 in the tank for waste water and only after that drain it to the Karakamish River.

Also, in the extraordinary cases, where impurities of fats and oils are in the blow-down water, this project considered oil-water separation equipment.

Table 5.3.3-3 Results of comparative analysis for indicators of drain waters quality standard with treated water from TC-4 and tap water

Name	Measurement unit	Wastewater quality standard	Treated water from TC-4 Analysis result	Tap water Analysis result
Ph	-	6.5–8.5	8.2	8.0
Suspension	mg/l	15	n/a	2.4
Residue after evaporation	mg/l	1,000	159	140
Oils and fats	mg/l	0.1	0.02	n/a
Nitrites	mg/l	0.02	n/a	n/a
Nitrites	mg/l	9.1	2.2	2.4
Sulfates	mg/l	100	18.5	18.5
Chlorides	mg/l	300	6.65	2.85
Ammonia nitrogen	mg/l	0.5	n/a	n/a
Phosphates	mg/l	2.5	n/a	n/a
Iron	mg/l	5.0	0.25	0.3
Copper	mg/l	1.0	0.036	0.041
Zinc	mg/l	1.0	0.063	0.173
Biochemical oxygen demand, BOD	mg/l	0.1	n/a	n/a

Source: Results of lab analysis at TashTETs

Domestic sewage is scheduled to be drained into domestic wastewater piping of Suvsoz.

5.3.4 Equipment with High-Pressure Gas-Fuel System

Specific requirements for fuel at the gas turbine inlet are presented in Table 5.3.4-1.

Table 5.3.4-1 Requirements for fuel at the inlet to the gas turbine

(application of burner with low emission of nitrogen oxides)

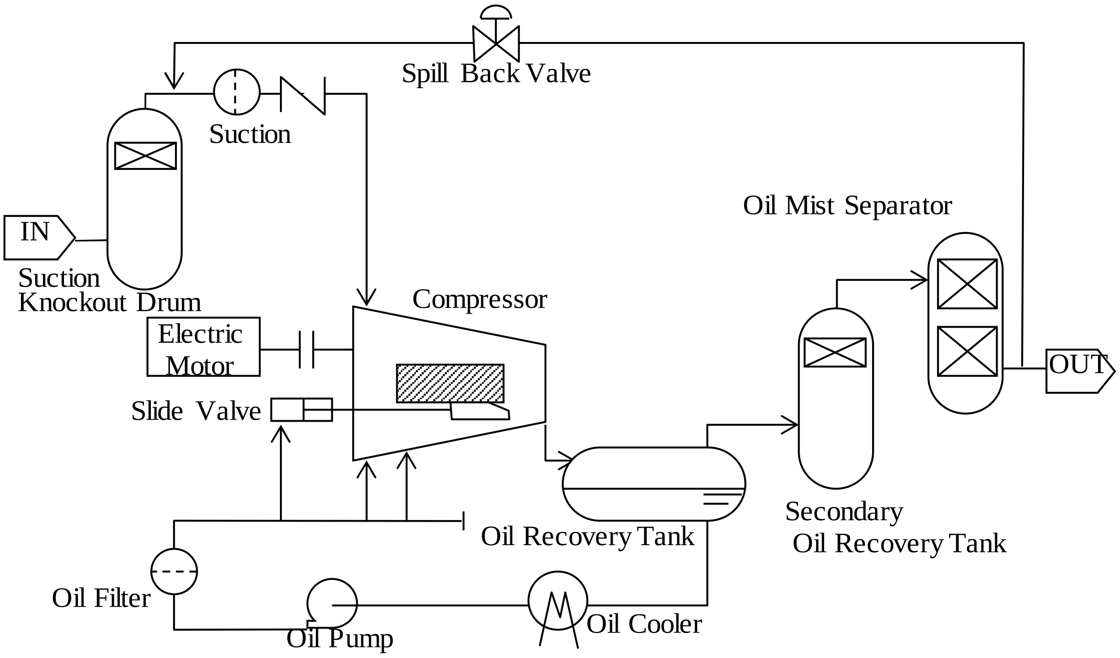
Name	Table of Contents	
Pressure in the discharge line	2.61-2.90 kg/cm^2 (g)	
Permissible pressure rate of change	<±70 kPa	
Water	0	
Content of fats and oils	≦0.5 ppmwt	
Solid body	<600 ppbwt, particle diameter <10 μm	
Metals content	Na+K < 1 ppmwt V < 0.5ppmwt Pb < 1 ppmwt Ca+Mg < 2 ppmwt	
Sulphur content	≦20 ppm	
Composition	Min.(Volume %)	Max.(Volume %)
CH_4	85	100
C_2H_6	0	10
C_3H_8	0	10
C_{4+}(paraffin)	0	4
CO	0	10
H_2	0	3
O_2	0	3
CO_2	0	4
N_2	0	10

Source: JICA Study Team

As the pressure in the supply of fuel gas in Uzbekistan is low, approximately 0.3 kg/cm^2, it is necessary to increase the pressure in order to use it at the inlet of the gas turbine. In addition, it is necessary to make sure that the pressure at the inlet of the gas turbine is below the limit. Therefore, a screw compressor of fuel gas will be installed at TashTETs-2, which constantly controls the discharge pressure on the basis of specific changes of pressure on the part of supply and loads change on the part of gas turbine.

The screw compressor of fuel gas, which is planned to be installed, will cool down compressed gas, lubricate the screw and produce sealing between the rotors by injecting lubrication oil to the unit during compression. In the process of compression, oil is mixed with gas, but after the compression of the gas in the equipment for regeneration of oil located in the lower layer, and the gravitational separation and oil removal by an oil filter (separator) occur. As a result, the level of oils and fats content at the inlet to the gas turbine is reduced to the standard limits.

Regulation of emission and emission pressure will be conducted by the method of combination of the flat gate valve, which controls the air volume of the compressor itself, and the recirculation valve, which controls the volume returned from the discharge to the suction side. Thus, the strength and tracking are combined (the benefits of recirculation valve) and reduced power consumption during partial load (the advantage of flat gate valve).



Source: JICA Study Team

Figure 5.3.4-1 Diagram for the system of oil filled screw compressor

It is advisable to maintain the pressure at the inlet to the fuel gas compressor high to a possible extent. Low pressure at the inlet increases the size of the compressor, electric motor and consumed power. Therefore, it is greed to set pressure at 0.3 kg/cm^2, a typical value of the of the fuel gas supplied in Tashkent city.

The study team found that in the winter period, when the need for fuel gas increases, the pressure in the supply system of Toshshkhargaz falls. Therefore, in line with adoption of measures in the form of tested equipment of NEDO energy saving model project (the Japanese organization for development of new energy and industrial technologies), we require to install inTashTETs-2 a special line to supply fuel gas directly from the distribution station of Uzneftegaz to reduce the influence on the gas consumption inside Tashkent city. As a counter plan, the Uzbek side offered to reduce the installed pressure at the inlet of the fuel gas compressor, but we believe that the reason for reduction in gas pressure of Toshshakhargaz supply system is lack of gas volumes, and therefore this may not be the ultimate solution.

As a measure to remove water and solid bodies which can be brought in by the party supplying the fuel gas, it is scheduled to set a duplex filter on the top side of the fuel gas compressor and to separate liquids at the suction.

5.3.5 Electric Equipment

(1) Electrical equipment inside the station such as generators

Electrical equipment consists of the generators and exciters, and additional equipment such as air cooling equipment, equipment for the main oscillator circuit connecting the generator and transformer.

Electricity produced by the generator is separated from the electricity required for the needs of the station, and goes to a transformer; then, it increases to the voltage level of the formation line at the distribution point, and after that it is sent from the secondary bushing of high voltage to the distribution point. With regard to voltage of generator, it is decided to obtain standard 11 kV from the power of equipment and increase it up to110 kV at the power distribution point by a booster transformer (Primary/Secodary: 11kV/110kV); and after that it is planned to connect it to a new distribution point through buried cable route. As the formation of structure of power sources for new generating equipment inside the station, for each of the 4 generators a special transformer will be installed inside the station which will supply electric energy corresponding to energy of each unit.

This transformer inside the station will combine the starter transformer, use the reverse power receiving method during start-up and reduce the amount of switchgear (circuit breaker) of circuit 110kV.

So, from the stand point of economic rationality, there would be not redundancy of high voltage circuits inside the station, and the standard structure, which led to many good results in Japan, will be applied. Regarding low voltage, energy through a unit auxiliary transformer, mounted as a unit, will be reduced to the level of the voltage of the Motors Control Center (MCC). Therefore, the electricity consumed inside the station is supplied to the auxiliary equipment of gas turbine cogeneration facility and to the switchgear equipment and control device, passing from the switchyard through the main transformer and transformers inside the station during start-up, and passing from generators through unit transformers and the switchgear during normal operation.

Besides, the direct current power supply and the system of uninterrupted electricity supply are also installed as a whole unit, and electricity reception is possible from the common system of the Motor Control Center (MCC) as a backup power supply.

Figure 5.3.5-1 presents a block diagram of the electric circuits.

Power supply for lighting and switchboard of the serviced territory may be carried out through a common system of the Motor Control Center (MCC) split into turbine houses.

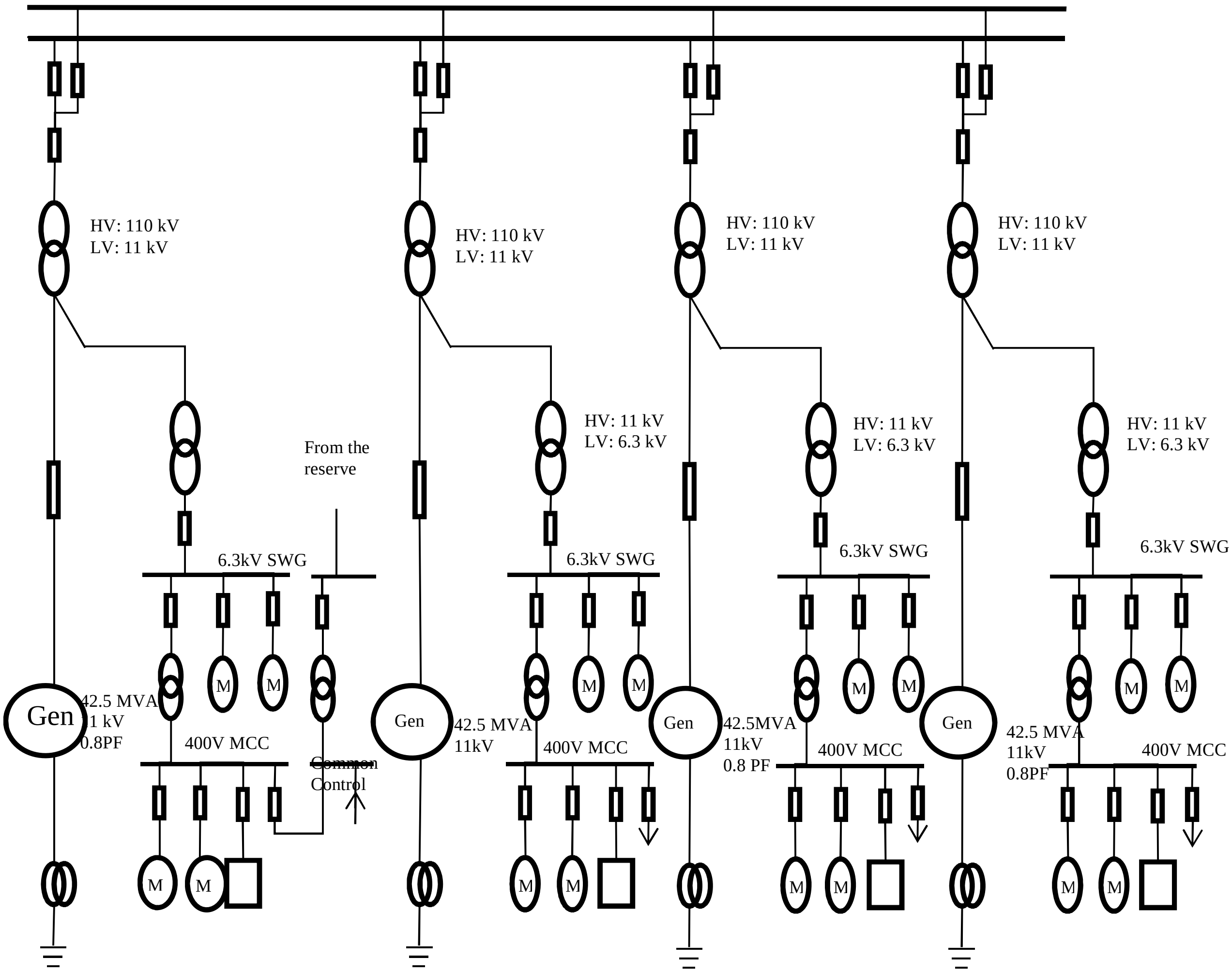


Figure 5.3.5-1 Single line diagram of electric circuits for generators and etc. inside the plant

(2) Control and supervision of the operation

Constant supervision and management of new cogeneration gas turbine equipment like a recovery boiler, etc. will be performed using the man-machine interface (MMI) from operational oversight rooms (hereinafter referred to as the Control Room) built next to the turbine house. In this equipment, the standard Operator Station (hereinafter referred to as the OPS) is used. The OPS has good results in Japan and abroad and has a function of dialog with the operator and is operated by a mouse. The client server consists of an LCD monitor, keyboard, mouse, network connectivity equipment, printer, and so on. This operator station gives the ability to control and shutdown of the equipment and apparatus; it also chooses and sets the operation mode of power generating units and generator powers, and in addition, it displays a diagram of the whole system, schema of separate systems; it allows, if required, to select an image among numerous images of analogue trend, signal images; it makes possible the immediate or continuous supervision over the process and state of actuating elements, supervision over deviations in the equipment operation and acquisition of full information on the status of equipment with a notice (signal). In addition, it allows making a record of data, creating reports, and other control functions. Moreover, in case of an emergency, it is planned to install an external push-button control.

Typically, the supervision of equipment is made through the operator control station monitors installed in the control room, but given the maintenance work, such as trial launches during periodic inspections and adjustments to the programs, it is planned to install an Engineering Work Station Operator Station escort group (hereafter EWS/OPS) in the Control Panel room next to the control room and to use it when necessary.

Control of the equipment and apparatus of the plant is planned to be conducted by the modern control digital equipment equipped with functions such as a controller of shutdowns sequence and accessories, continuous control of generators power and regulation of production volume. The control will be conducted from the premises (the room with a control panel) with the air fans next to the control room.

Besides, for protection of equipment and control of correct equipment operation, the interlock function is required. In addition to installing software in the control equipment for protection of generators and turbines, etc., as well as for the production as a whole, hardware schema are composed using novoltage contact which ensure high reliability of protection.

Moreover, since it is necessary to safely shutdown equipment in the event of a power outage, redundant methods of power supply are planned. Power supplying for the control equipment is planned to be realized by the uninterruptible power system equipped by a battery with the energy volume required for safe shutdown.

Figure 5.3.5-2 presents the simplified diagrams of the system.

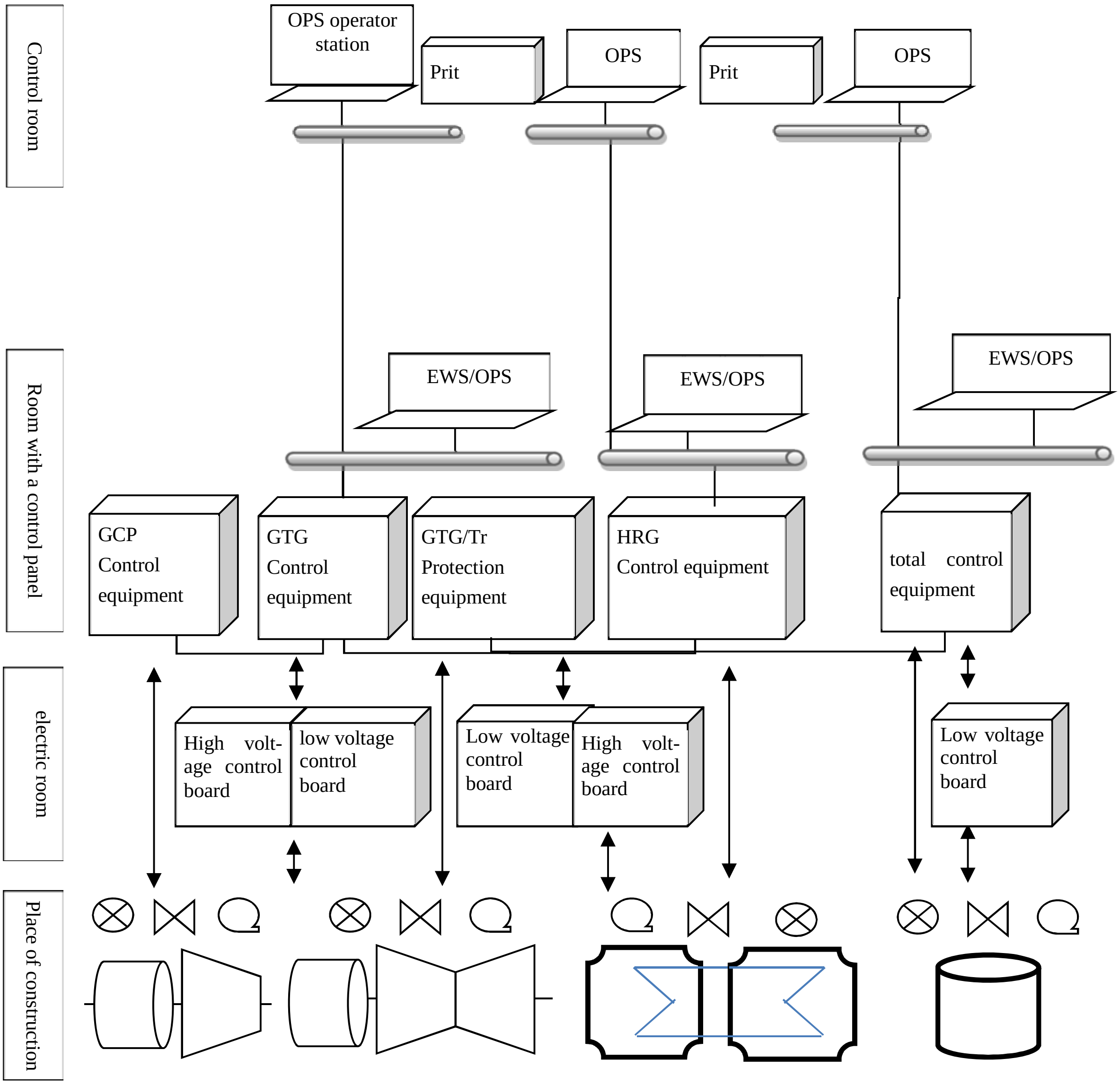


Figure 5.3.5-2 Simplified diagram of control and supervision system

5.3.6 System Configuration and Layout Plan

(1) System configuration

It is a system that improves energy utilization efficiency, with a power generation gas turbine plant as a core. Together with the generated power, which is transmitted to 110 kV line after it has been boosted by the transformer, the system makes possible the supply of hot water by means of directing high temperature gases downwardly through the exhaust heat recovery apparatus.

A schematic system configuration is shown in Figure 5.3.6-1, and the features of the system configuration are described below.

Taking into consideration the difference in the quality of water in the exhaust heat recovery apparatus and water in the hot water system, a heat exchanger divided into the exhaust gas heat recovery unit and the unit turning the recovered heat for hot water reheating is installed. It should be noted that while placing the water treatment device as water quality adjustment in water supply system used in the heat recovery side, it is planned to install pumps in hot water system taking into account the difference in operation depending on the season (water is circulated through the hot water network in winter, but not in summer). Among rotating equipment, circulating cooling system with water as cooling medium is planned to use for gas turbine power generation unit, which has bearing lubrication oil, and for fuel gas compressor.

In order to ensure stable gas pressure necessary for combustion in a gas turbine, a fuel gas compressor is installed as a part of fuel supply system.

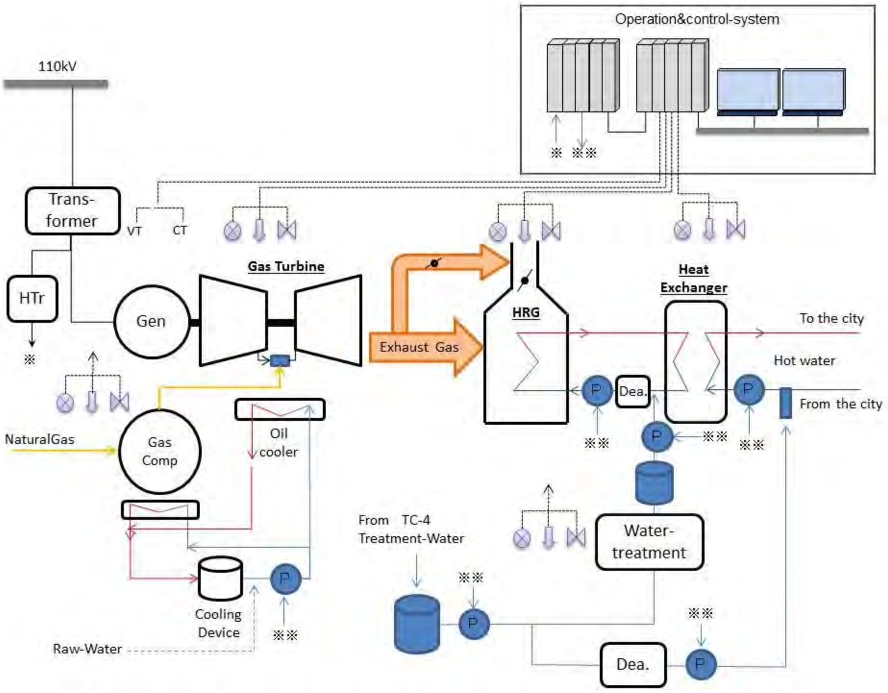


Figure 5.3.6-1 Schematic configuration of the system

It is planned to set 4 units of turbine cogeneration systems (hereinafter referred to as “GTCS”), each of which consists of 1 gas turbine and 1 exhaust heat recovery boiler. Taking into consideration stability of the plant and cost-effectiveness based on sharing of the heat exchange system and auxiliary equipment, as well as operability (Table 5.3.6-1), two GTCS units will be united into 1 group, the plant will consist of two groups. Figure 5.3.6-2 shows a general diagram of the hot water supply system comprising an exhaust heat recovery boiler.

Table 5.3.6-1 Analysis of the structure of GTCS equipment and the availability of spare equipment

		Stable operation	The initial costs and maintenance costs	Operability	Notes
Per each piece of GTCS equipment separately	In case of no spare equipment	×	◎	×	A full stop of operation of the entire unit is required during the regular maintenance of heat exchangers, filters, etc.
	In case when there is spare equipment for each piece of gas turbine equipment	◎	×	△	Low cost benefits. There must be a large amount of spare equipment, and this causes idling of a large amount of equipment (efficiency of equipment usage is low).
In case of sharing of spare equipment (for the entire station)		△	○	△	The amount of spare equipment can be minimized. However, there is a risk of confusing the main equipment with the spare equipment during construction/operation.
In case when every 2GTCS pieces are united into a system and spare equipment is provided for each of such systems (selected)		○	△	○	The amount of spare equipment can be minimized. The risk of confusing the main equipment with the spare equipment during construction/operation can be avoided, as the equipment is distributed separately by systems.

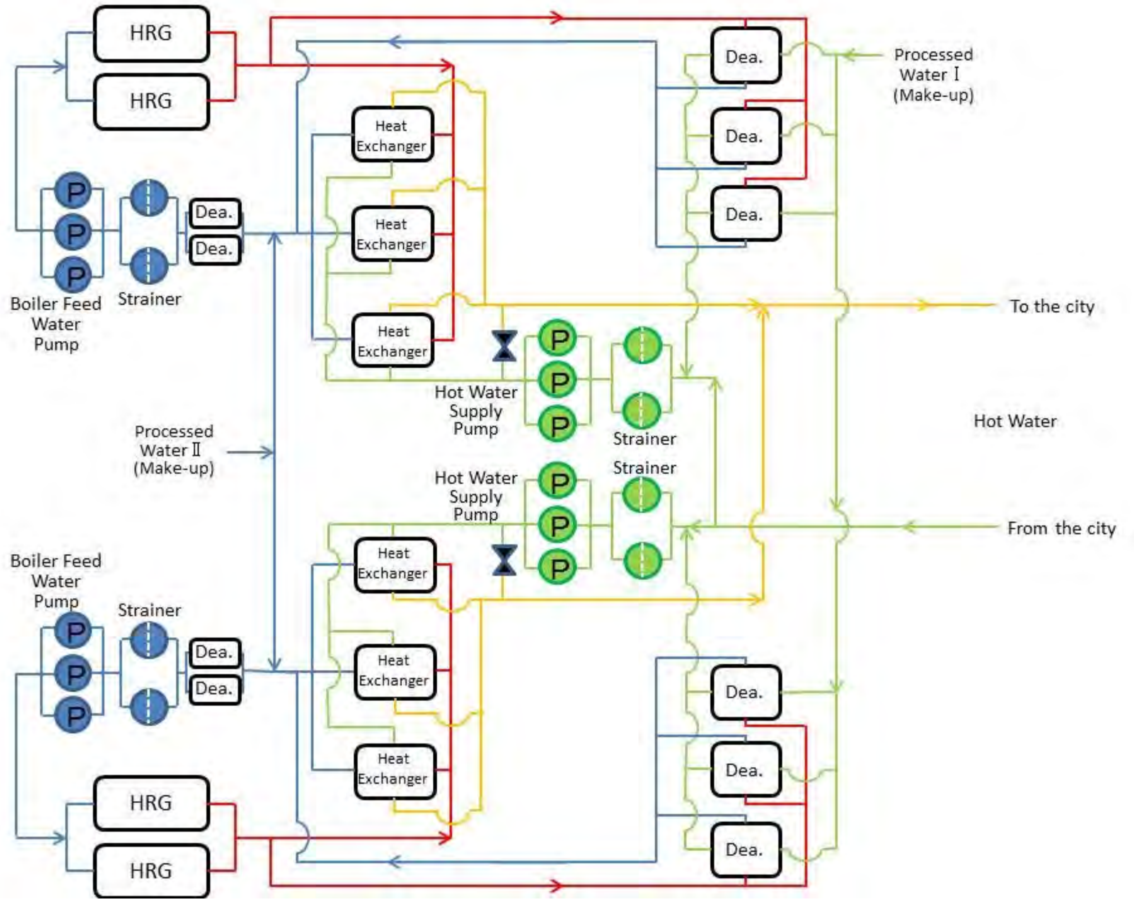


Figure 5.3.6-2 Schematic diagram of TashTETs-2 hot water supply system

In order to make possible cleaning of the heat exchanger when its performance reduced due to soiling, 2 main heat exchangers and 1 spare heat exchanger are installed in each system, based on the full capacity of 1 HRG per each heat exchanger.

In order to make possible cleaning of the strainers of boiler feed water pump and hot water supply pump, 1 main pump and 1 spare pump are installed in each system, based on the full capacity of 2 HRGs per each pump.

Three (3) main deaerators for make-up water for hot water supply are installed in each system, based on the full capacity of 2 of the 3 HRGs of each group deaerators for hot water supply in summer. In winter, when return water from the area can be used, each system may operate with 1 main deaerator and 2 spare deaerators.

Operating states of the plant as a whole in winter and summer periods are shown in Figures 5.3.6-3 and 4.

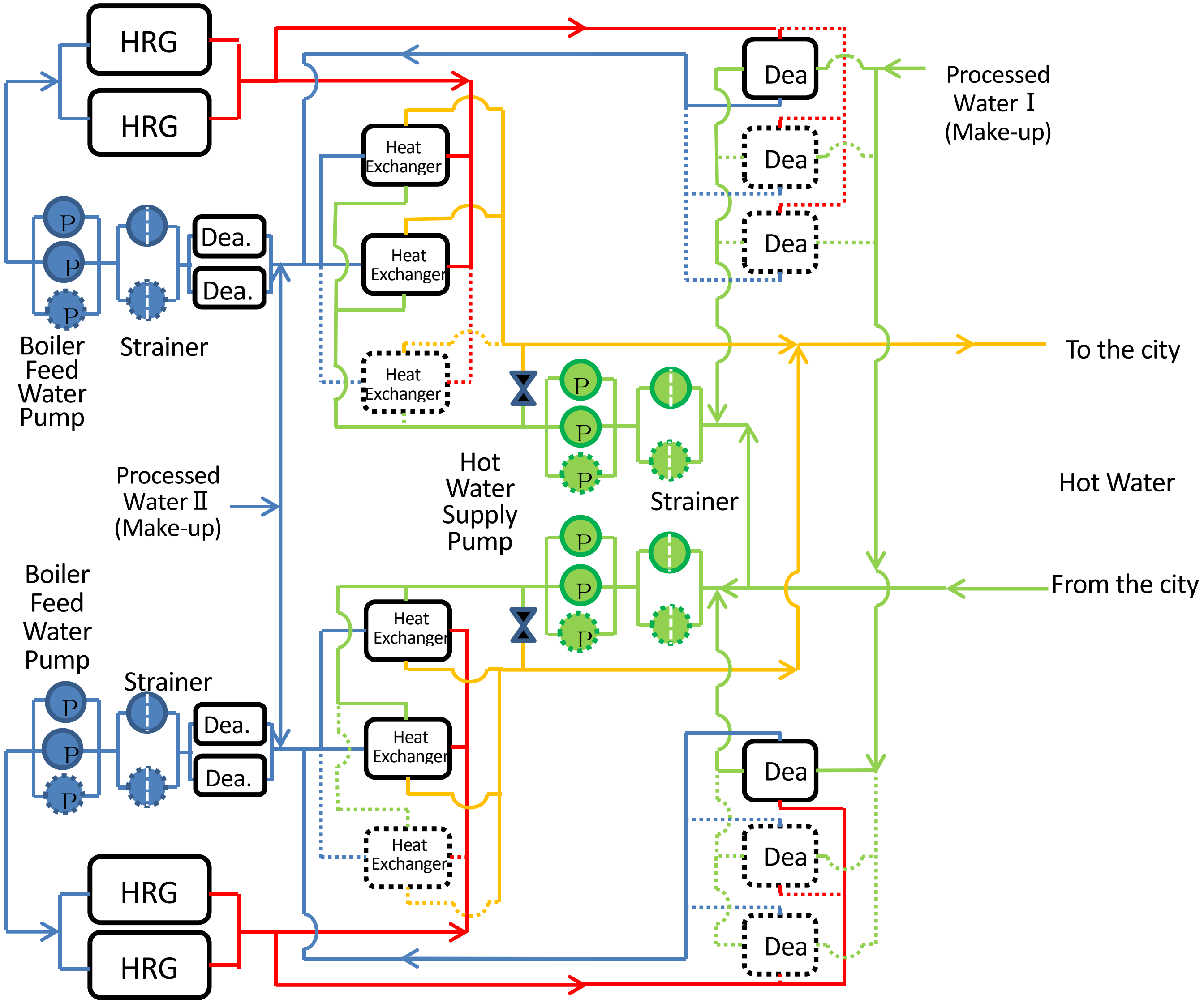


Figure 5.3.6-3 Schematic diagram of TashTETs-2 hot water supply system (during operation in winter)

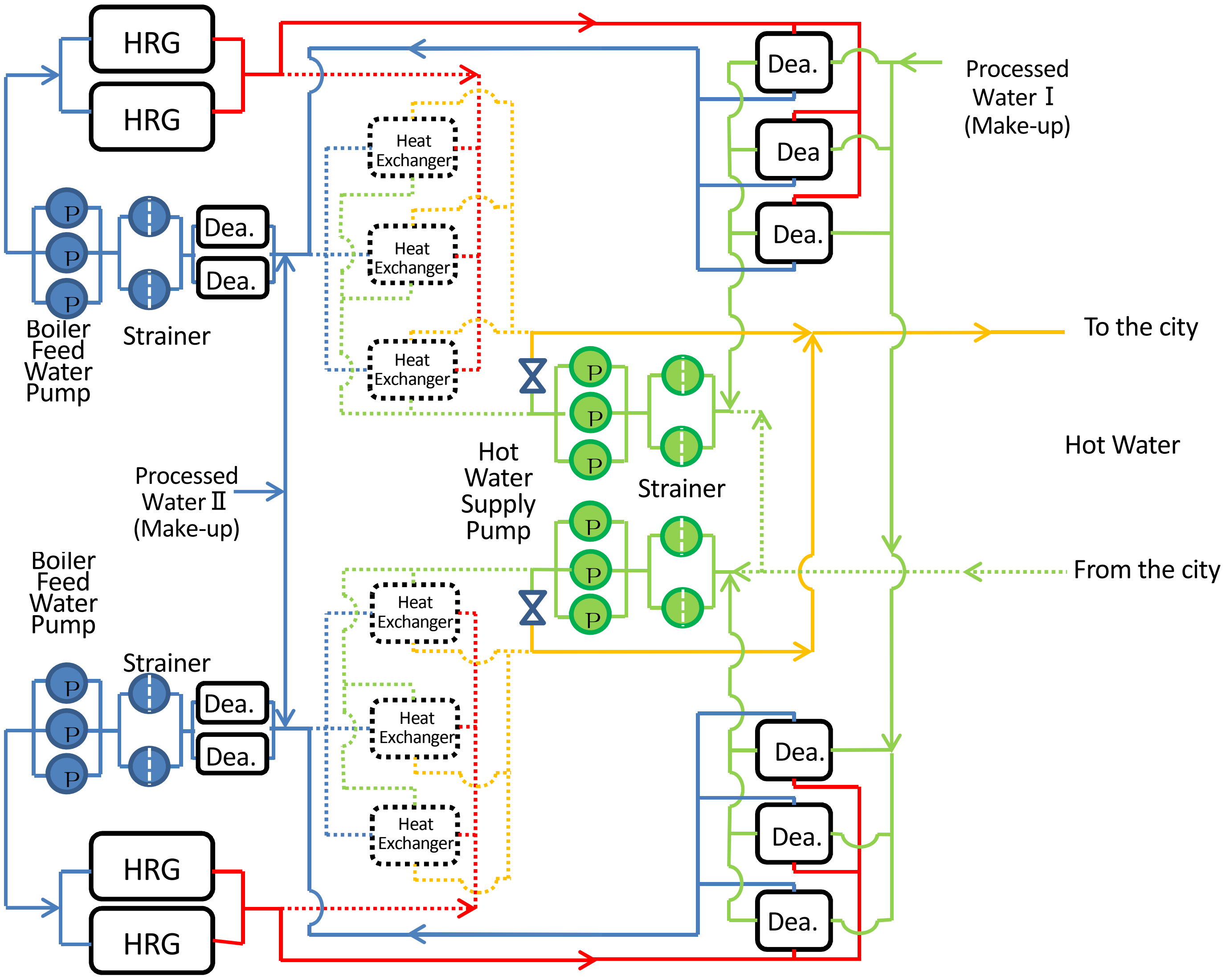


Figure 5.3.6-4 Schematic diagram TashTETs-2 hot water supply system (during operation in summer)

(2) Heat balance

The diagrams Figure 5.3.6-5 show the expected heat balance per 1 GTCS unit. Two (2) cases of base load operation of the gas turbine are shown for winter, and Two (2) cases for summer, depending on the outside temperature.

In winter heat is carried by means of the return water of 55 °C (70%) and the make-up water for hot water supply of 20 °C (30%). The make-up water for hot water supply is heated up to 55°C in the deaerator pre-heater, using hot water at the outlet of the recovery boiler as a heat source, and after deaeration it is mixed with return water; then, having exchanged heat with the hot water at the outlet of the recovery boiler in the heat exchanger, it turns into hot water with the temperature of 80 °C supplied to the area.

The return water does not exist in summer, and only the make-up water for hot water supply of 20 °C from TC-4 is used as a source of heating. The make-up water is heated up to 60 °C in the pre-heater of the deaerator, and is supplied to the area after deaeration. From the viewpoint of thermal balance the heat exchanger is not used in summer.

The amount of heat exchange is adjusted by varying the flow rate of the water passing through the HRGs, heat exchangers and make-up water deaerator preheaters. The boiler feed water pump and hot water supply pump regulate emissions of water by means of the ability to change the number of rotations of the motor by controlling the inverter.

Mode	Winter
Ambient Temperature	0 ℃
Atmospheric Pressure	960 hPa
Relative Humidity	50 %
Electrical Output	31 MW
Heat Output	38.9 Gcal/h

G : Flow	t/h
P : Pressure	kg/cm^2
T : Temperature	°C
H : Enthalpy	kJ/kg

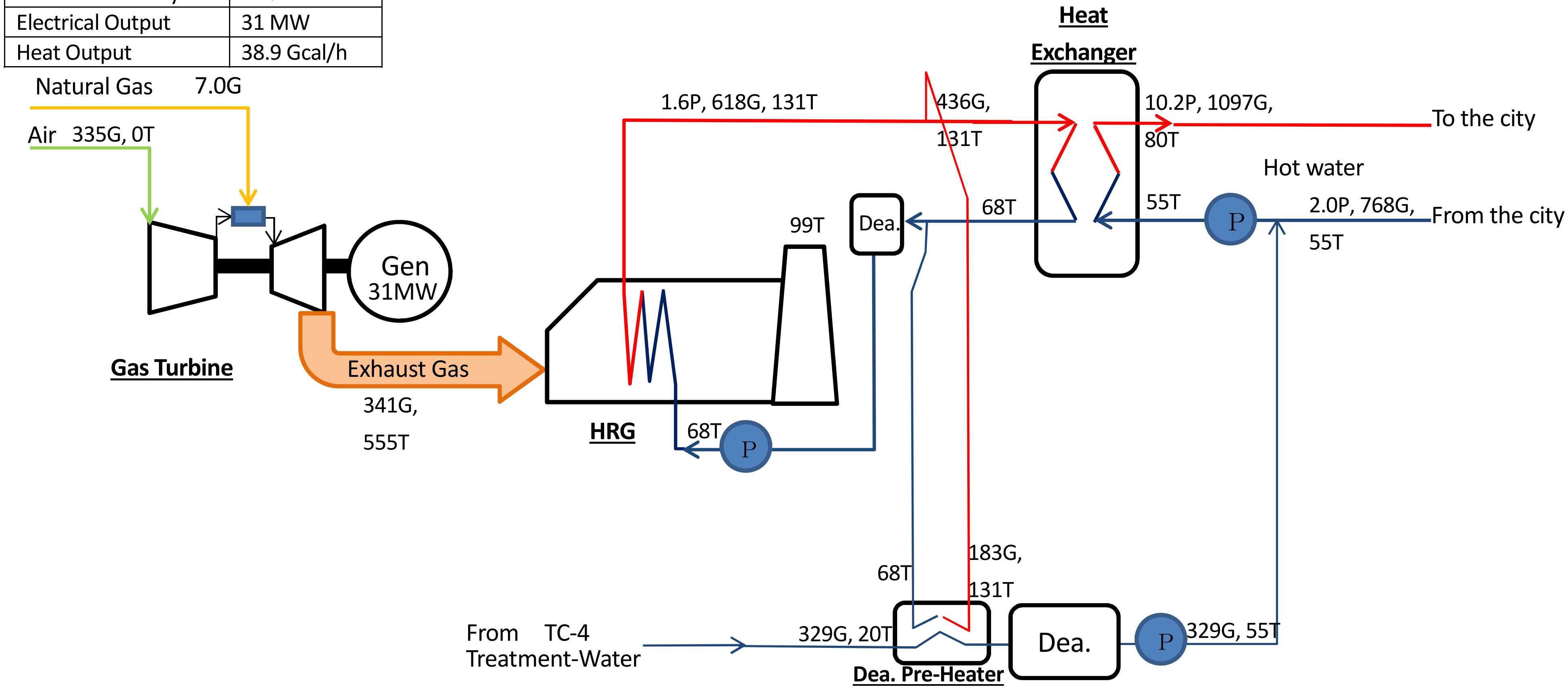
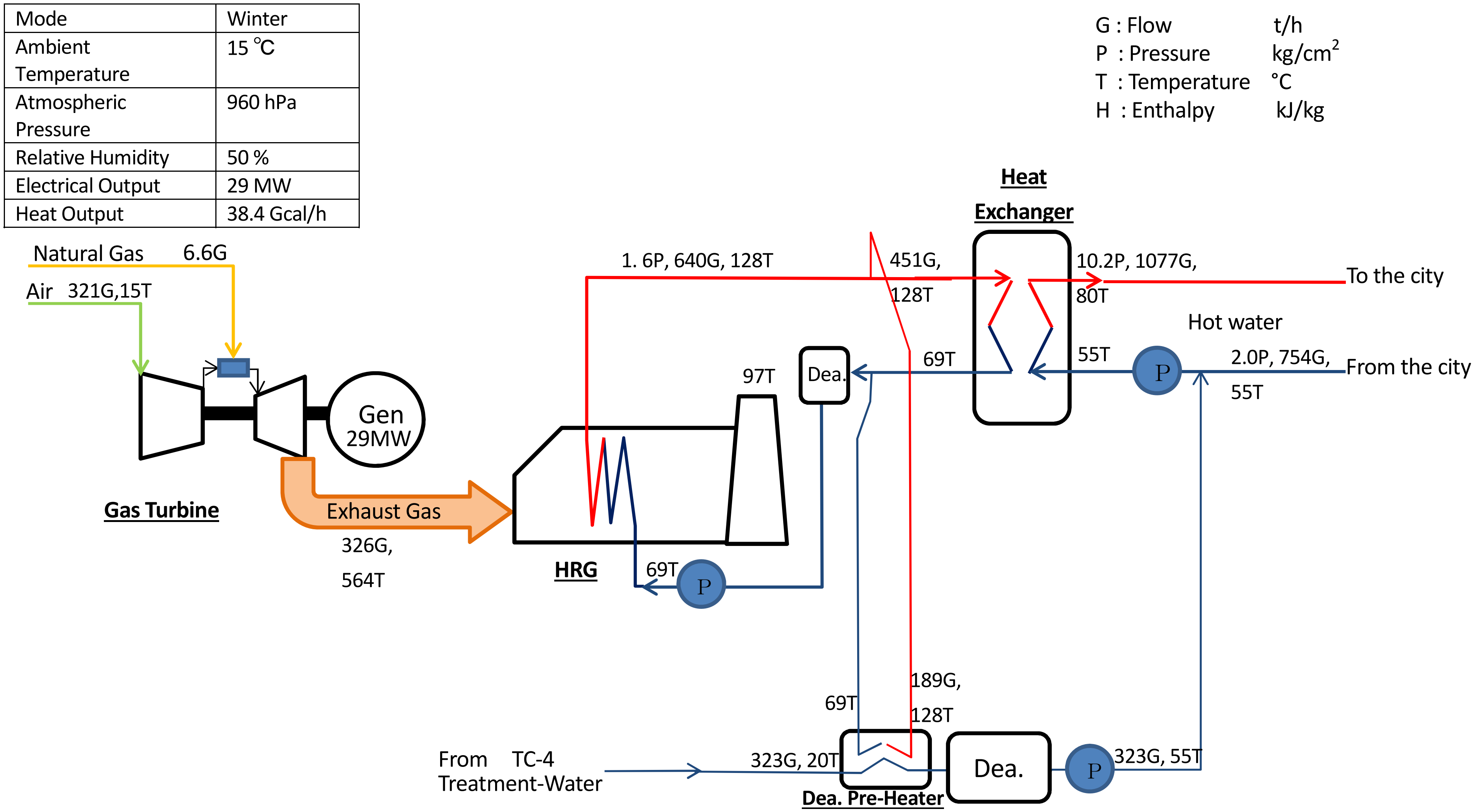


Figure 5.3.6-5 Unit heat balance diagram (winter mode; supply hot water temperature 80 ℃, ambient temperature 0 ℃)



Mode	Winter
Ambient Temperature	15 ℃
Atmospheric Pressure	960 hPa
Relative Humidity	50 %
Electrical Output	29 MW
Heat Output	38.4 Gcal/h

G : Flow	t/h
P : Pressure	kg/cm^2
T : Temperature	°C
H : Enthalpy	kJ/kg

Figure 5.3.6-6 Unit heat balance diagram (winter mode; supply hot water temperature 80 ℃, ambient temperature 15 ℃)

Mode	Summer
Ambient Temperature	45 ℃
Atmospheric Pressure	960 hPa
Relative Humidity	50 %
Electrical Output	23 MW
Heat Output	36.4 Gcal/h

G : Flow t/h
P : Pressure kg/cm^2
T : Temperature °C
H : Enthalpy kJ/kg

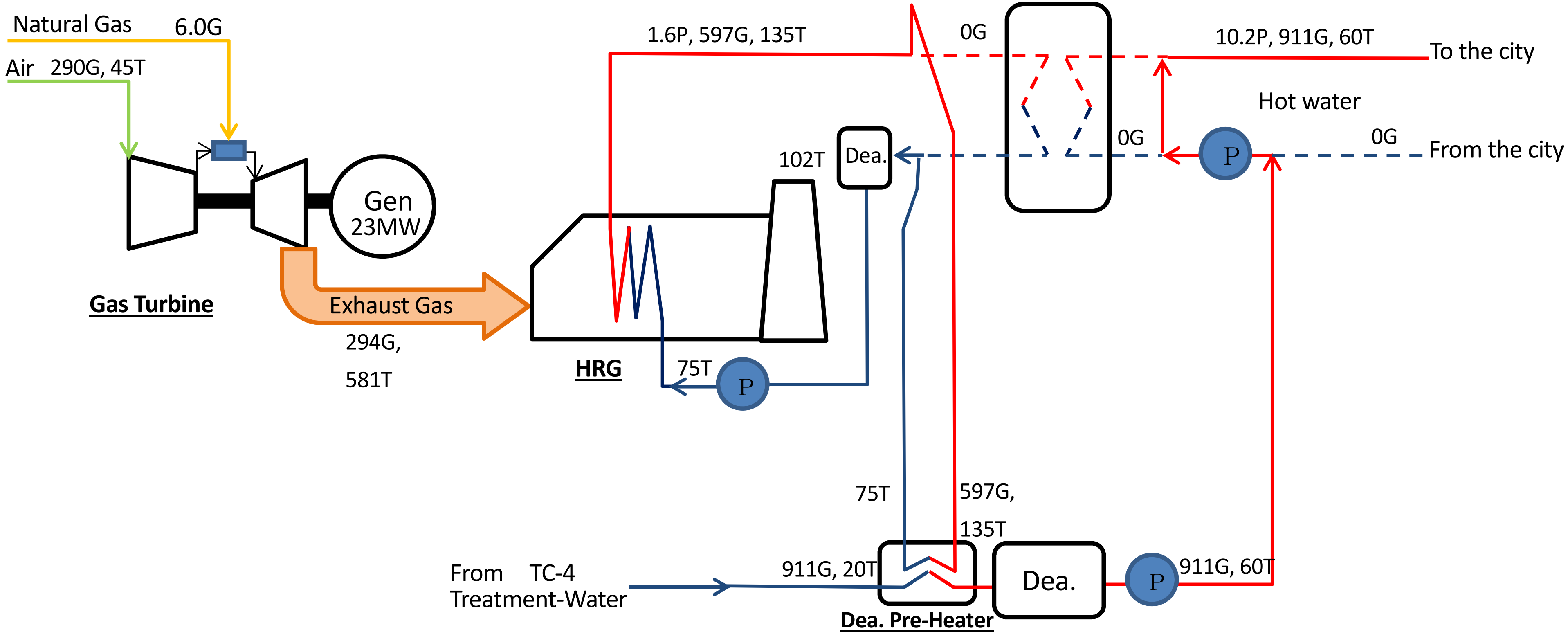


Figure 5.3.6-7 Unit heat balance diagram (summer mode; ambient temperature 45 ℃)

Mode	Summer
Ambient Temperature	15 ℃
Atmospheric Pressure	960 hPa
Relative Humidity	50 %
Electrical Output	29 MW
Heat Output	37.7 Gcal/h

G : Flow	t/h
P : Pressure	kg/cm^2
T : Temperature	°C
H : Enthalpy	kJ/kg

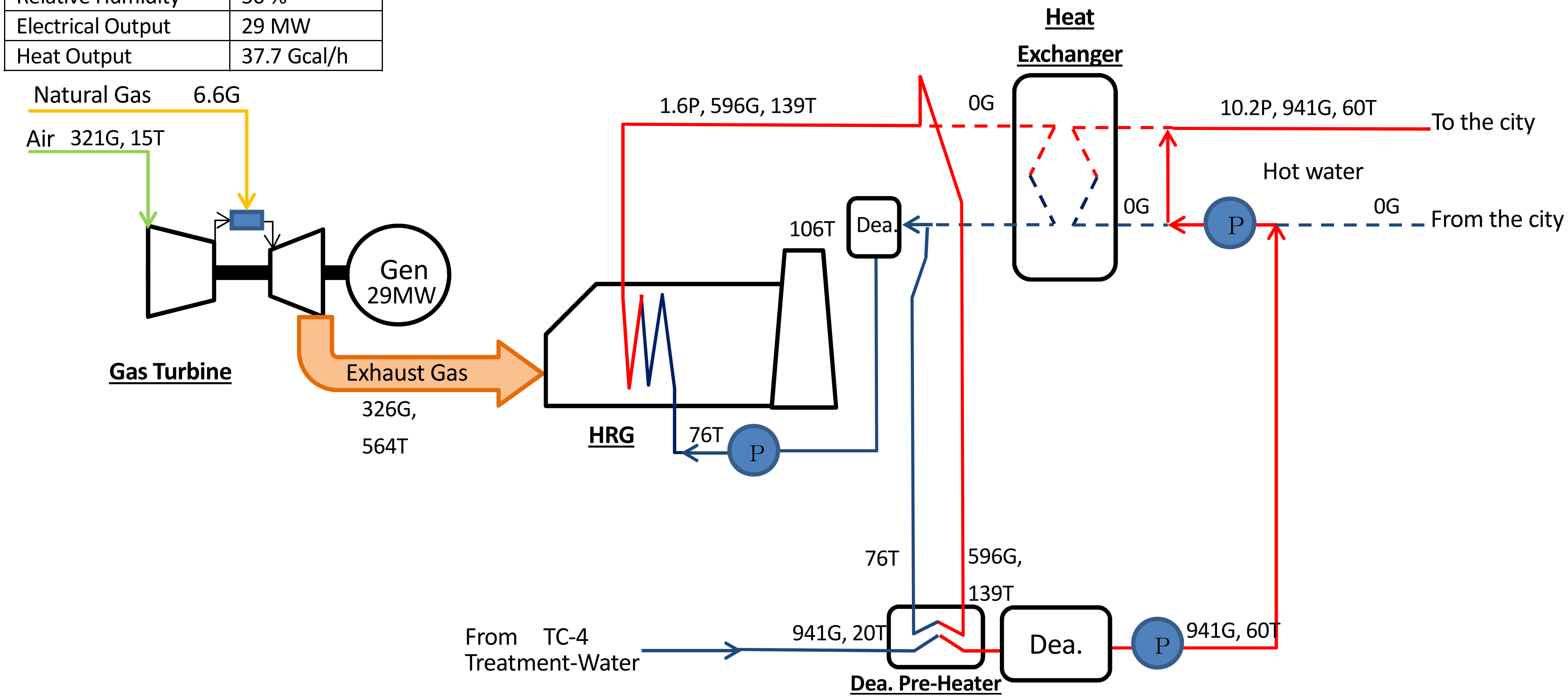


Figure 5.3.6-8 Unit heat balance diagram (summer mode; ambient temperature 15 ℃)

(3) Outline specifications of major equipment

a. Gas turbine

Type	Simple open cycle uniaxial type
Capacity	Output: 32.3 MW (design value), 34 MW (maximum power generation end output); Exhaust gas: 96.6 kg / s, 561 ℃ (design value)
Number of units	4
Notes	Combustion system: premixed combustion (natural gas), Start-up system: an electric motor drive

b. Exhaust heat recovery equipment

(a) Exhaust heat recovery boiler

Capacity	40 GCal / h
Number of units	4
Notes	Primary side fluid: gas turbine exhaust gas 96.6 kg / s, inlet 561 ℃ (design value); Secondary side fluid: hot water 1.6 kg/cm^2, temperature at the inlet 55 ℃ (minimum), temperature at the outlet 150 ℃ (maximum); Heat recovery and re-heating is conducted via the closed scheme of the secondary side circulatory system.

(b)Supply hot water heating heat exchanger

Capacity	40 GCal / h
Number of units	6
Notes	Primary side fluid: hot water (hot water from boiler) 1.6 kg/cm^2, temperature at the inlet 150 ℃ (maximum), temperature at the outlet 55 ℃ (estimated minimum) Secondary side fluid: hot water (hot water supply) 1.0 kg/cm^2, temperature at the inlet 20 ℃ (estimated minimum), temperature at the outlet 100 ℃ (estimated maximum) The heat recovery and re-heating is conducted via the closed scheme of the primary side circulatory system.

c. Generator

Model	Three-phase synchronous generator; horizontal type; rotating magnetic field
Capacity	42.5 MVA
Number of units	4
Notes	Power factor: 0.8; rated voltage: 11 kV; frequency: 50 Hz; number of poles: 2 or 4; rotating speed: 3,000 or 1,500 rpm; excitation method: brushless; forced air indirect cooling type; generator main circuit phase separation bus; configured with the circuit breaker; neutral grounding device.

d. Main transformer

Capacity	43 MVA
Number of units	4
Notes	Rated voltage is 11 kV / 110 kV, and oil-filled self-cooling; It is connected to the generator main circuit side by phase separation bus on the primary side; Secondary side is connected to the switching station equipment via underground culvert path

e. Fuel gas compressor

Type	Oil-cooled screw type
Capacity	Airflow: 11,000 Nm ^{3} / h Fuel gas inlet pressure: 0.3 kg/cm^2 (G), fuel gas outlet pressure: 2.9 kg/cm^2 (G)
Number of units	4
Notes	A knockout drum at the outlet (foreign substances separation tank)

(4) Layout plan

Layout is to be done according to the plan described below (for a to c). It was confirmed that it is possible to widen the territory by removing the 25 m railway embankment. It should be noted that the possibility of removing the railway embankment was confirmed in the records of “Temir Yo`llari” railway company.

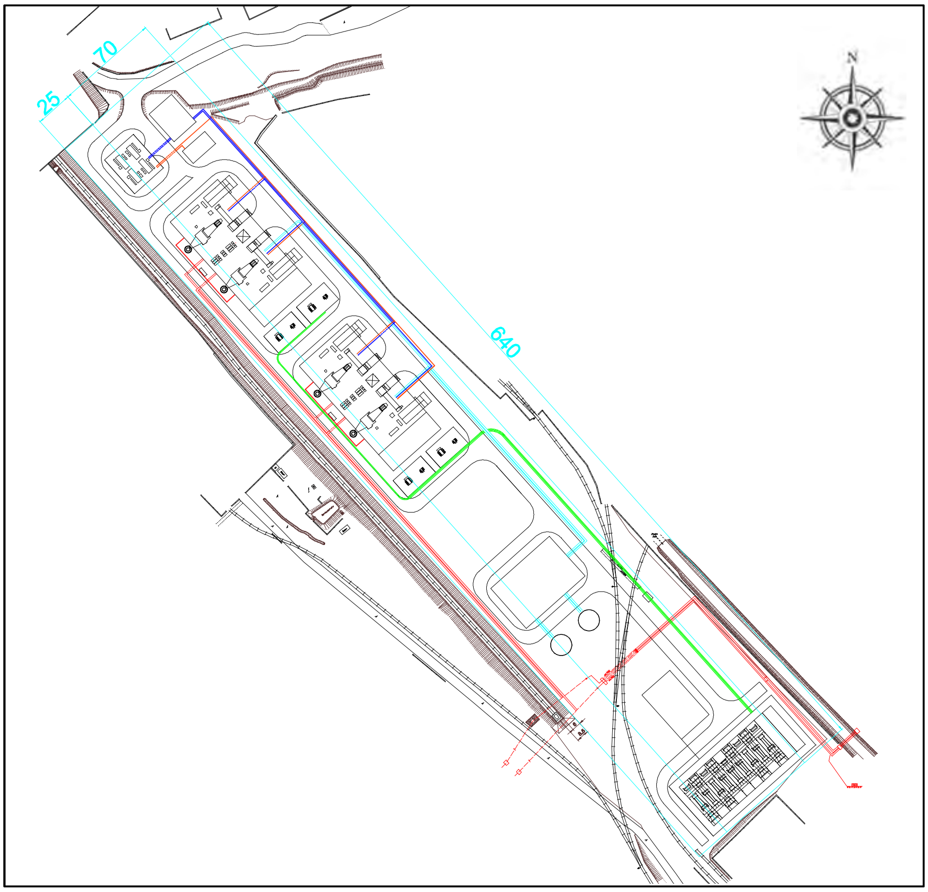


Figure. 5.3.6-9 Equipment layout plan

a. Equipment configuration

- Gas turbine generator, heat recovery boiler, main generator and other generators, fuel gas compressor, chimney - 4 units of each.
- Shared facility includes water purification equipment, tanks for treated water, tanks for storing raw water, fuel collection and check points, cooling systems, switching stations, office buildings.
- Pipelines (fuel, hot and cold water pipelines, etc.) and the 110 kV electric line cover the main

external routes inside the station (including underground facilities).

b. Conditions of the surrounding area

- Connection points of the fuel gas and raw water systems to external systems will be located in the northeast.
- Connection point of the transmission line and the switching station will be located in the southwest.

c. Layout strategy

- There will be roads constructed for fire services around the buildings.
- If possible, crossing of the fuel pipe and 110kV electric line will be avoided.
- It is necessary to minimize the extent of relocation of the existing buildings.
- Transformers will be located in the open air.

(5) Public utilities connection plan (raw water, hot water, drainage)

Below is the outline of connection to public utilities communications in the Project - the raw water, drainage, etc. It should be noted that in this regard, agreements were reached between TashTETs and organizations controlling the relevant public utilities (SuvSoz, Tashteploenergo and Tashteplotsentral).

a. Raw water (agency: SuvSoz)

- It is planned to make a spin-off from the main pipe of SuvSoz, which is close to the construction site, and set a flowmeter, which would serve as a demarcation point, on the territory of the site.
- The section from the main pipe to the demarcation point will be under the jurisdiction of SuvSoz, and the section from the demarcation point to TashTETs (including the flowmeter) will be under the jurisdiction of TashTETs.

b. Make-up water / treated water (agency: Tashteplotsentral)

- The demarcation point is pipe fittings (flanges) located on the border of the territory of TC-4.
- The sections on both sides of the demarcation point will be under the jurisdiction of the respective companies.

c. Water for hot water supply, including return water (agency: Tashteploenergo)

- Relocation of pipelines from the site is the responsibility of Tashteploenergo.
- Connection to the main pipeline of Tashteploenergo is planned (System M-1).
- After the demarcation point has been defined, the areas on both sides of the demarcation point will be under the jurisdiction of respective companies.

d. Drainage system

-- General drainage (agency: SuvSoz)

- Transfer of the pipes buried at the construction site is the responsibility of SuvSoz.
- After the demarcation point has been defined, the areas on both sides of the demarcation point will be under the jurisdiction of the corresponding companies.

-- Industrial drainage

-Agency: TashTETs (section from TashTETs-2 to Karakamysh river)

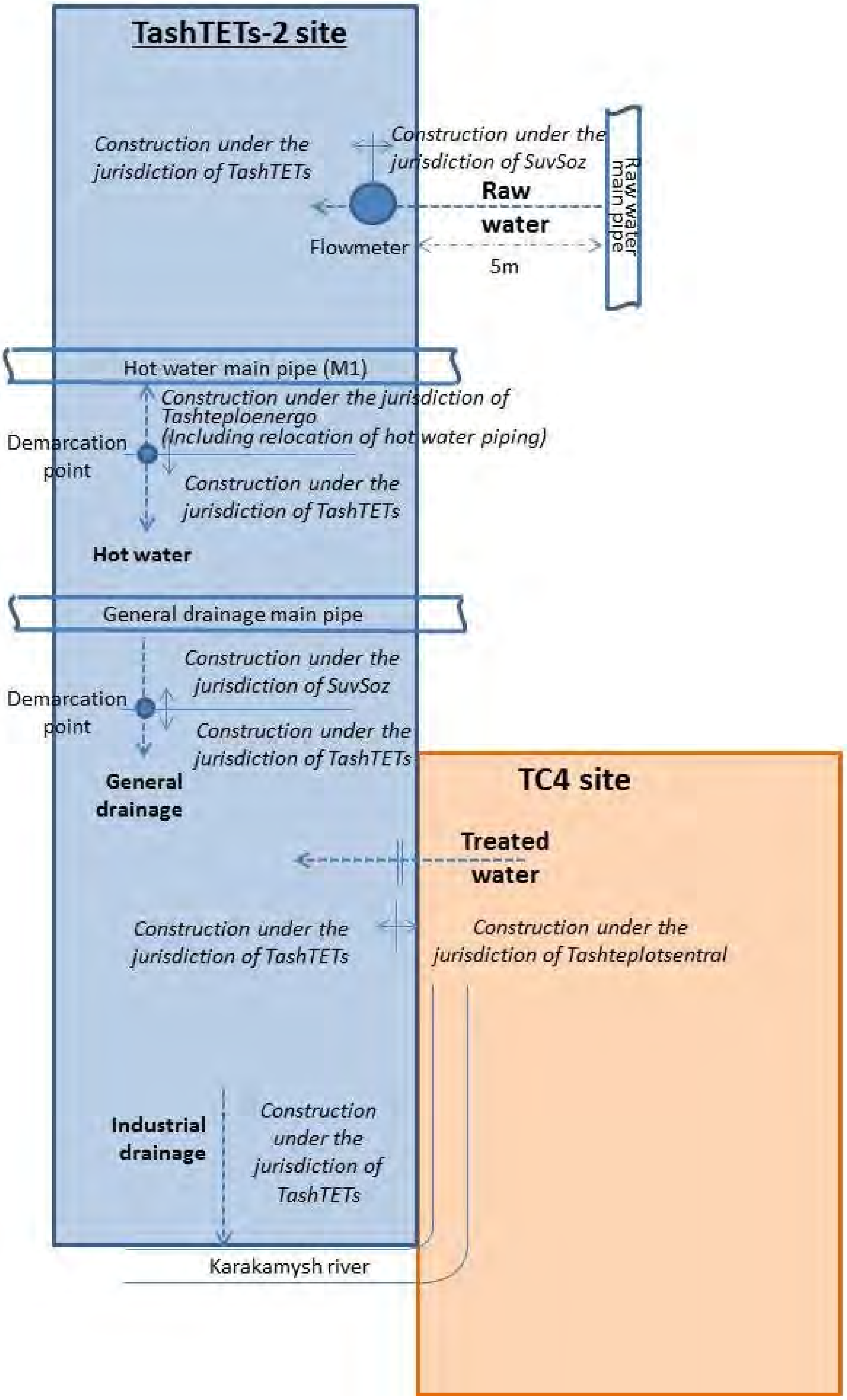


Figure 5.3.6-10 Public utilities connection plan

(6) Removal and relocation plan

The facilities above and below ground of the construction site, described in Section 4.2.1, will be removed or relocated as follows:

- It is planned to remove 96,000 m^3 of soil and sand (including waste). The place of burial is in Akhangaran area, which is 52 km away from the construction site, and the excavated material will be transported by trucks.
- It is planned to remove 25 m of the existing 45 m railway embankments (i.e., 60,000 m^3 of material) to widen the site (soil and sand will be used on the construction site as embankments).
- Since the railway to TC-4 is required for operation, it will not be removed and is planned to be used.
- It is planned to transfer 640 m of power lines and 7 support towers to off-site locations (refer Fig. 5.3.7.1 for more details).
- It is planned to relocate 350 m of hot water pipe within the area, since it is an obstacle to the construction of the switching station.
- It is planned to relocate 600 m of drainage pipe within the area, since it is an obstacle to the construction of a gas turbine plant, etc.
- It is planned to use the existing gas pipeline and raw water pipeline, not eliminate them.
- As the power lines culvert overlaps with the road in a particular area, it is planned to strengthen the culvert in this area.

5.3.7 Connection to the System and Equipment for Power Transmission

5.3.7.1 Transferring the Existing 110 kV Power Transmission Line

At the moment, there is an almost 640 m long overhead 110kV power transmission line within the site, and it is used for power supply of Chukursay Substation (owned by the railway company), located in the south-east of the site, and Dok Substation, located over the railway to the west of the site. This power transmission line is an obstacle to the construction of TashTETs-2 and there is no place for its transfer within the site (Fig. 4.1-1 and 4.2.1-1).

Therefore, it is planned to transfer the sections of power transmission line that branch off to Chukursay Substation and to Dok Substation, which pass through the construction area to off-site locations.

5.3.7.2 Power Transmission Facilities

In Uzbekistan, the 110kV voltage class power transmission line is designed to ensure 100 % transmission capacity even in case of N-1. It is allowed to overload power lines of 6–10 kV class under N-1 up to + 30 % during operation, but overloading of power lines of 35 kV class is prohibited.

As the maximum capacity of the equipment in this Project is 128 MW, the underground cable for connection to the system must pass an electric current of 839 A.

① Estimated maximum current parameters during operation
The maximum capacity of the equipment in this Project: 128 MW
Estimated maximum current: 839 A = 128 MW ÷ (√3 × 110 × 0.8 kV)

② The required heat capacity of the underground cable: 839A = 839A × 100%

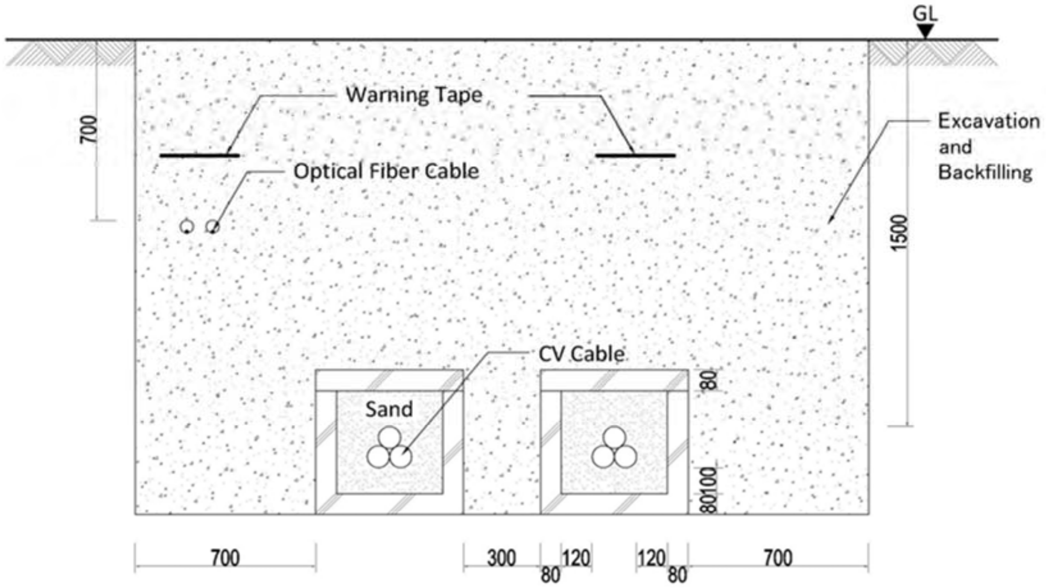
Based on the aforementioned specifications, the underground cable for connection to the system should be two lines of CV copper conductor of 1800 mm^2. Power transmission equipment features are shown in the Table 5.3.7.2-1.

Table 5.3.7.2-1 Specifications of transmission facilities

No.	Equipment / Item	Specifications
1	110kV underground cable	
	1) Model	XLPE
	2) Size	1800 mm^2
	3) Conductor	Copper
	4) Sheath type	PVC (anti-termite)
	5) Sheath	Sheath made of aluminum or lead for direct instillation
2	Optical fiber cable	
	1) Mode	Single-mode
	2) Wavelength	1310 nm or 1550 nm

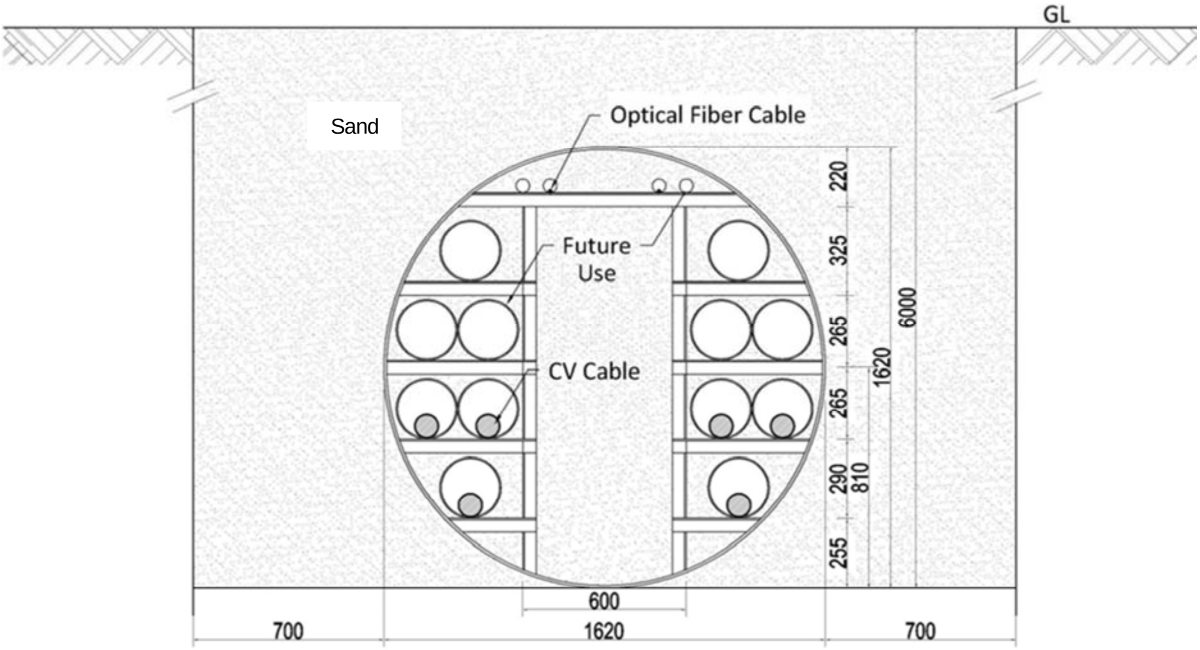
Based on the ESP interview, the adopted criteria for considering the size of the cable are as follows:
soil basal temperature: 27 ℃
soil heat resistance: 2.0 ℃ m/W

The method of cabling is based on the method of cabling of the existing cable in the area of Severnaya Substation and Soyilgoh Substation, is shown in Figure 5.3.7.2-1. The section crossing the railway is shown in Figure 5.3.7.2-2.



Source: JICA Study Team

Figure 5.3.7.2-1 Scheme of burying of the underground cable (under the road)

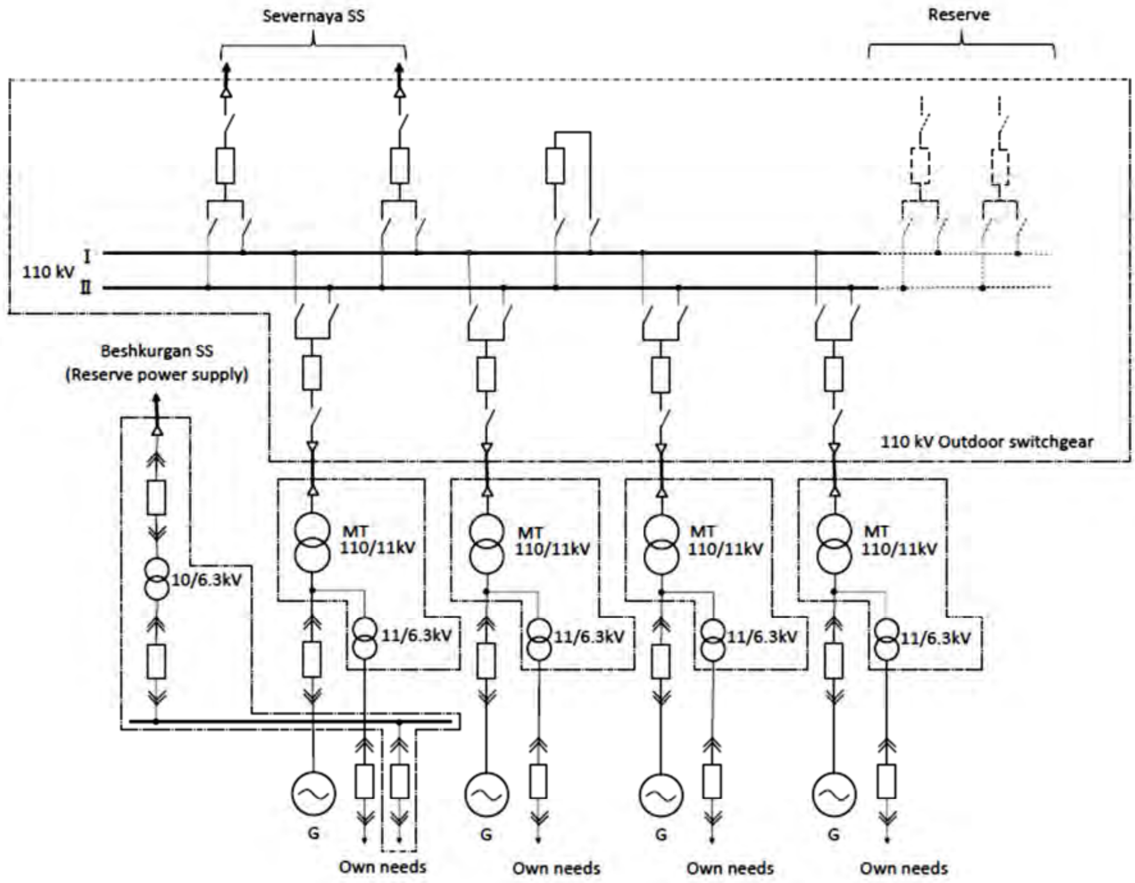


Source: JICA Study Team

Figure 5.3.7.2-2 Scheme of burying of the underground cable (under the railway)

5.3.7.3 Transforming Equipment

Figure 5.3.7.3-1 shows the diagram of single-line connection in the 110 kV switching station and transformer block of TashTETs-2.



Source: JICA Study Team

Figure 5.3.7.3-1 Single line diagram of connection of TashTETs-2 110kV switching station and transformer block

The scale of the equipment of 110 kV switching station required in this Project consist of connection of 4 110 kV / 11 kV main transformers, wiring of two 110 kV power lines (to Severnaya Substation), two main buses, one bus tie.

Given that it is possible to provide enough space at the site and from the viewpoint of economy, the switching station will be of the outdoor and air-insulated type.

With regard to the method of routing of 110 kV power transmission lines, an underground cable as shown in Section 5.3.7.2 will be laid (with installation of a cable head).

It should be noted that besides the aforementioned necessary scales of the switching station, there must also be some space reserved for the installation of 2 more power transmission lines in the future.

All transformers at the station, including the main transformer, will be combined into blocks together with generators and will be laid beside each turbine plant. The structure of cable equipment from the high pressure side of the main transformer to the generator and various facilities at the station is described in the previous Section 5.3.5.

It should be noted that as a reserve power source for the case when stopping the operation of the entire station and for generator start-up power backup, it is planned to draw a 10 kV (or 6 kV) cable from Beshkurgan Substation, situated in the northwest of the station.

5.4 Study on Connection to Existing Network

5.4.1 Connection Candidate

Taking into account that TashTETs-2 consists of 4 units with 32 MW and the total output is 128 MW, 110 kV is adequate for the transmission of voltage from economical point of view.

The plant is planned to be built in the adjoining site of the existing Tashkent Heat Supply Station, and in order to study on how to connect the TashTETs-2, the existing network in the surrounding area is investigated. As shown in Figure 5.4.1-1, the candidates can be arranged in order of distance as follows:

Chukursai Substation (110/6 kV, for power transmission to Uzbekistan National Railway and Tashkent CHP) and Beshkurgan Substation (110/10/6 kV): 0 km; Severnaya Substation (110/35/6 kV): 1.9km; Navoiy Switching Station: 3.3 km; Keles Substation (220/110/10 kV): 5.4 km; and Ozodlik substation (220/110/35 kV): 7.3 km

The transmission capacity of the transmission line to Chukursai or Beshkurgan has too small, of 333A (57 MW power factor 0.9 assumed), to transmit the power generated by TashTETs-2 in summer. It can not transmit the power even under normal condition of both 2 circuits without fault. Moreover, since six stations are branched from the line, the connection to this line is impossible from the standpoint of network protection. Therefore, Severnaya Substation, Navoiy Switching Station and Keles Substation are selected as the candidates of the connection point since they are close to TashTETs-2, and further study is carried out.

Source: JICA Study Team

Figure 5.4.1-1 Geographical location of systems around TashTETs-2

5.4.2 Study Case

Study cases are shown in Table 5.4.2-1. It is assumed that 110 kV network connecting to TashTETs-2 is interconnected to the main grid at Keles 110kV bus, since Keles-Navoiy line has a large transmission capacity with double conductor and has robustness.

Table 5.4.2-1 Study cases

Case	connected to	Transmission line	Length
1	Keles	Overhead & Under ground	4.6km +3.6km
2	Navoiy	Under ground	7.1km
3	Severnaya	Under ground	3.3km

Source: JICA Study Team

5.4.3 Load Forecast in Every Substation

Seven switching stations exist in the 110kV network of the connection candidate which belongs to 220/110kV Keles Substation. The load in 2020, the completion year of TashTETs-2, is forecasted, based on the actual record of the load in 2014. The growth rate is assumed as 2 % considering the current actual values.

The result is shown in Table 5.4.3-1. Since these substations are located in the central area of Tashkent City, the load pattern is urban-type which has little difference between summer and winter. Therefore, the loads in summer are selected for the study, because the transmission capacity in summer decreases to 60 % of that of in winter.

Table 5.4.3-1 Substation load forecast

Unit: kW

Substation	Actual record in 2014		Forecasted load in 2020	
	Summer	Winter	Summer	Winter
Kukcha	4,896	6,120	5,513	6,892
Vistovochnaya	17,000	18,700	19,144	21,058
Sogban	33,788	30,600	38,048	34,459
Bibliotechnaya	8,568	11,968	9,648	13,477
Severnaya	66,802	55,892	75,225	62,940
Soyilgoh	26,240	32,598	29,548	36,708
Yunusabad	26,520	24,820	29,864	27,950
Total	183,813	180,697	206,991	203,483

Source: JICA Study Team

5.4.4 Network Analysis

5.4.4.1 Power Flow Analysis

The power flow analysis results are shown in Figure 5.4.4.1-1 and Table 5.4.4.1-1.

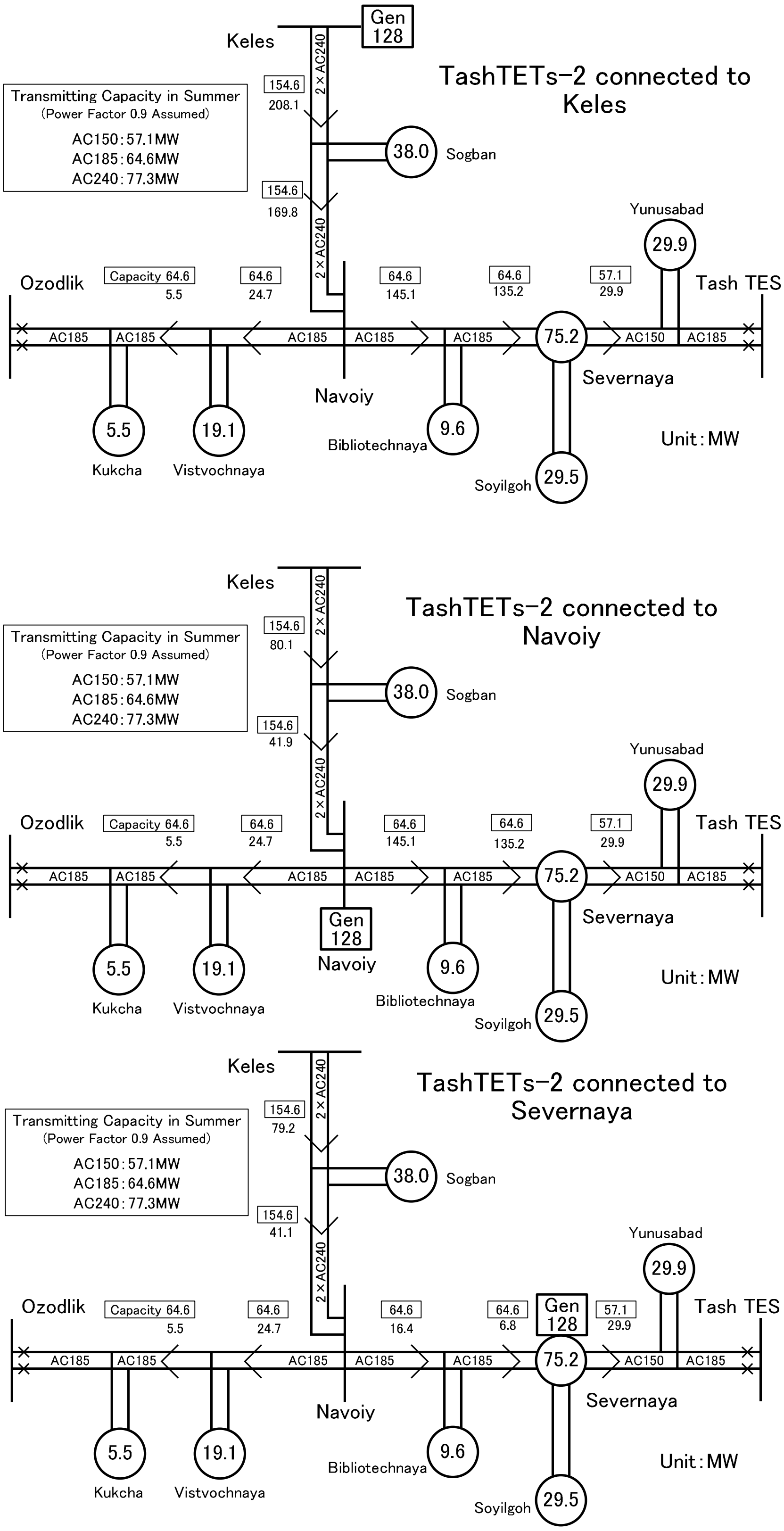
In Case 1, a heavy power flows from Keles to Severnaya, which is a load center of this network, and as a result, overloading occurs in 4 lines (Keles-Sogban, Sogban-Navoiy, Navoiy-Bibliotechnaya and Bibliotechnaya-Severnaya). Specially, even under normal condition without fault, overloading occurs in Navoiy-Bibliotechnaya-Severnaya line because it has small transmission capacity, 64.6 MW per circuit.

The total transmission loss reaches 1,720 kW, and this value is 1.34 % of TashTETs-2’s power generation, 128MW.

In Case 2, overloading occurs in 2 lines under normal condition (Navoiy-Bibliotechnaya and Bibliotechnaya-Severnaya), and the total transmission loss reaches 1,090 kW.

On the contrary, in Case 3, since TashTETs-2 is located near Severnaya, the load center, the transmission length from TashTETs-2 to the load is short, and relatively small powers flow in all lines. The largest power (79.2 MW) flows in Keles-Sogban line, and no overloading occurs.

Therefore, the total transmission loss is only 230 kW, which is less than one seventh of Case 1.



Source: JICA Study Team

Figure 5.4.4.1-1 Power flow in each line and transmission capacity

Table 5.4.4.1-1 Power flow and transmission loss

Transmission line		Transmission Capacity* per circuit (MW)	Power flow (MW)			Transmission loss (kW)		
From	To		Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Keles	Sogban branching point	154.6	**208.1**	80.1	79.2	548	112	74
Sogban branch	Navoiy	154.6	**169.8**	41.9	41.1	62	8	4
Navoiy	Vistvochanaya branch	64.6	24.7	24.7	24.7	18	16	16
Vistvochanaya branch	Kukcha branch	64.6	5.5	5.5	5.5	0	0	0
Navoiy	Bibliotechnaya branch	64.6	**145.1**	**145.1**	16.4	178	178	2
Bibliotechnaya branch	Severnaya	64.6	**135.2**	**135.2**	6.8	572	568	2
Severnaya	Yunsabad branch	57.1	29.9	29.9	29.9	30	30	28
Subtotal		-	-	-	-	1,408	912	126
TashTETs-2	Keles or Navoiy or Severnaya		128.0	128.0	128.0	312	178	104
Total			–	–	–	1,720	1,090	230
		* Capacity in summer with assumed power factor of 0.9	**Red: Overloaded Especially overloading occurs in Navoiy-Bibliotechnaya-Severnaya even under normal condition**			Red: Largest loss in the line		

Source: JICA Study Team

5.4.4.2 Voltage Analysis

The next condition is set for the voltage analysis.

Condition: 100 % voltage at TashTETs-2 110 kV bus and Keles 110 kV bus (connection point to main grid)

Table 5.4.4.2-1 shows the voltage analysis results. The maximum voltage drops of 2.05 % is at Yunusabad Substation for Case 1. On the other hand, for the Case 3 voltage drop volume is very small for any case and maximum is 0.49 % for Yunusabad.

Table 5.4.4.2-1 Voltage at 110kV buses

Station	Voltage (%)		
	Case 1 Keles	Case 2 Navoiy	Case 3 Severnaya
Keles	100.00	100.00	100.00
Navoiy	99.12	99.53	99.71
Severnaya	98.12	98.53	99.67
Sogban	99.17	99.53	99.67
Vistovochana	98.99	99.41	99.58
Kukcha	98.97	99.39	99.56
Bibliotechna	98.88	99.30	99.69
Yunusabad	97.95	98.37	99.51
Soyilgoh	98.12	98.53	99.67
TashTETs-2	100.00	100.00	100.00

Source: JICA Study Team

5.4.4.3 Short Circuit Current Analysis

A short circuit current on 110 kV bus of TashTETs-2 power station can be calculated as only 2.3 kA. As a representative of all cases, the analysis for Case 3 is carried out, and the study result is shown in Table 5.4.4.3-1. The short circuit currents in all busses of 220 kV and 110 kV are much less than the maximum allowable values of 31.5 or 40 kA (circuit breaker rating). No problem exists.

Table 5.4.4.3-1 Short circuit current

	Station	Bus voltage	Short circuit current (kA)
Case 3	Severnaya	110	10.23
	Navoiy	110	10.57
	Keles	220	25.77
		110	10.90

Source: JICA Study Team

5.4.4.4 Stability Analysis

The next condition is set for the stability analysis.

Condition: Fault occurs at 0 ms and the faulted line is opened at 100 ms (220 kV and 500 kV) or 150 ms (110 kV).

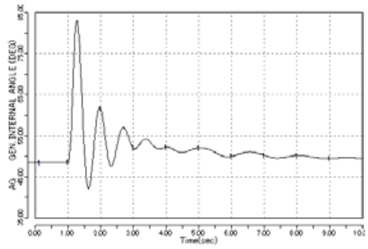
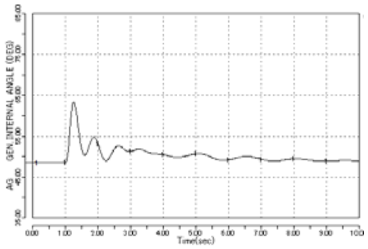
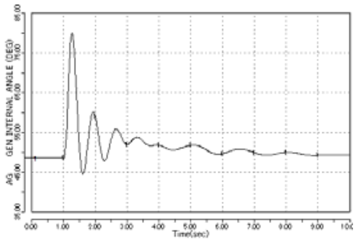
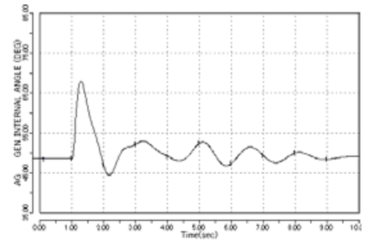
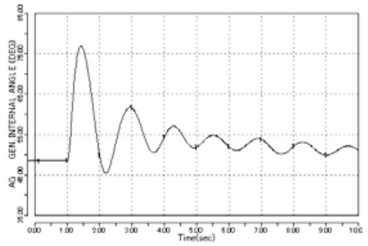
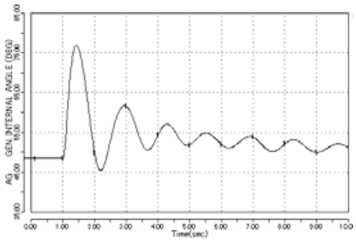
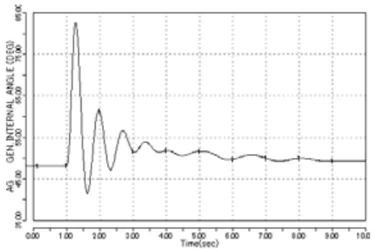
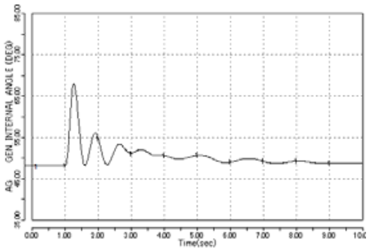
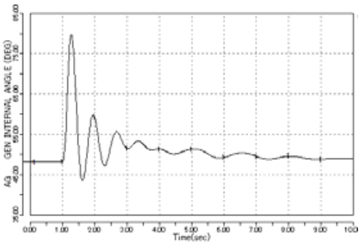
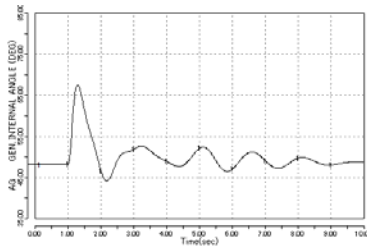
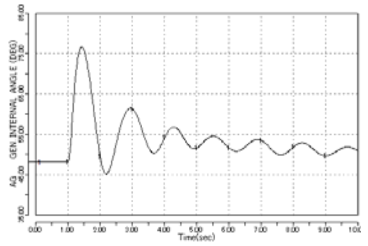
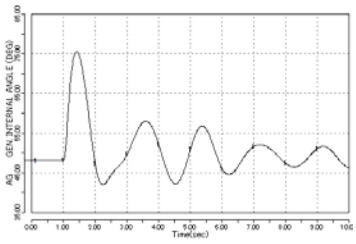
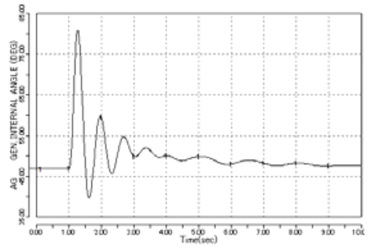
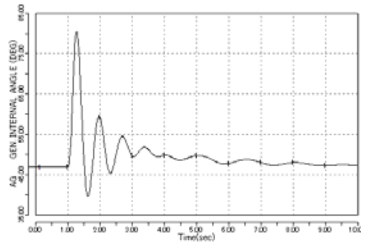
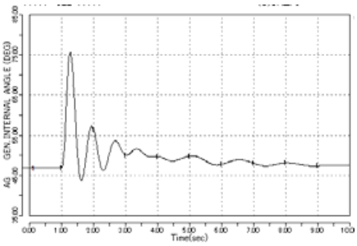
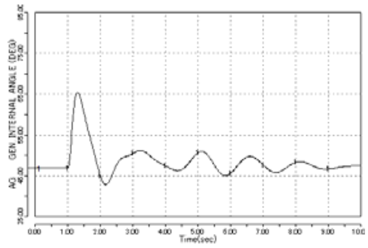
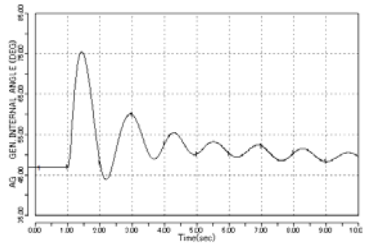
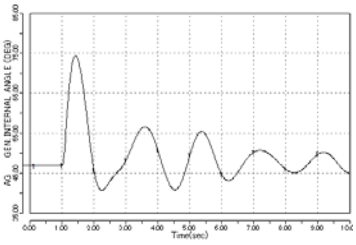
The cases for the stability analysis are shown in Table 5.4.4.4-1. The severe fault conditions in which the fault occurs at locations very close to the power station or on the line with relatively heavyload are assumed.

As shown in Figure 5.4.4.4-1, generator voltage angles fluctuate widely after the fault occurs, but the fluctuation converges with time. Therefore, the stability can be maintained in all cases.

Table 5.4.4.4-1 Cases for stability study

Case	Voltage	Faulted line	Faulted point	Fault clearing time
Case 1-A	110 kV	TashTETs-2－Keles	TashTETs-2	150 ms
Case 1-B		Severnaya－Navoiy	Severnaya	
Case 1-C		Navoiy－Keles	Keles	
Case 1-D	220 kV	Keles－Tash TES	Keles	100 ms
Case 1-E	500 kV	Tash TES－Shimkent	Tash TES	
Case 1-F		Tash TES－Tashkent	Tash TES	
Case 2-A	110 kV	TashTETs-2－Navoiy	TashTETs-2	150 ms
Case 2-B		Severnaya－Navoiy	Severnaya	
Case 2-C		Navoiy－Keles	Keles	
Case 2-D	220 kV	Keles－Tash TES	Keles	100 ms
Case 2-E	500 kV	Tash TES－Shimkent	Tash TES	
Case 2-F		Tash TES－Tashkent	Tash TES	
Case 3-A	110 kV	TashTETs-2－Severnaya	TashTETs-2	150 ms
Case 3-B		Severnaya－Navoiy	Severnaya	
Case 3-C		Navoiy－Keles	Keles	
Case 3-D	220 kV	Keles－Tash TES	Keles	100 ms
Case 3-E	500 kV	Tash TES－Shimkent	Tash TES	
Case 3-F		Tash TES－Tashkent	Tash TES	

Source: JICA Study Team

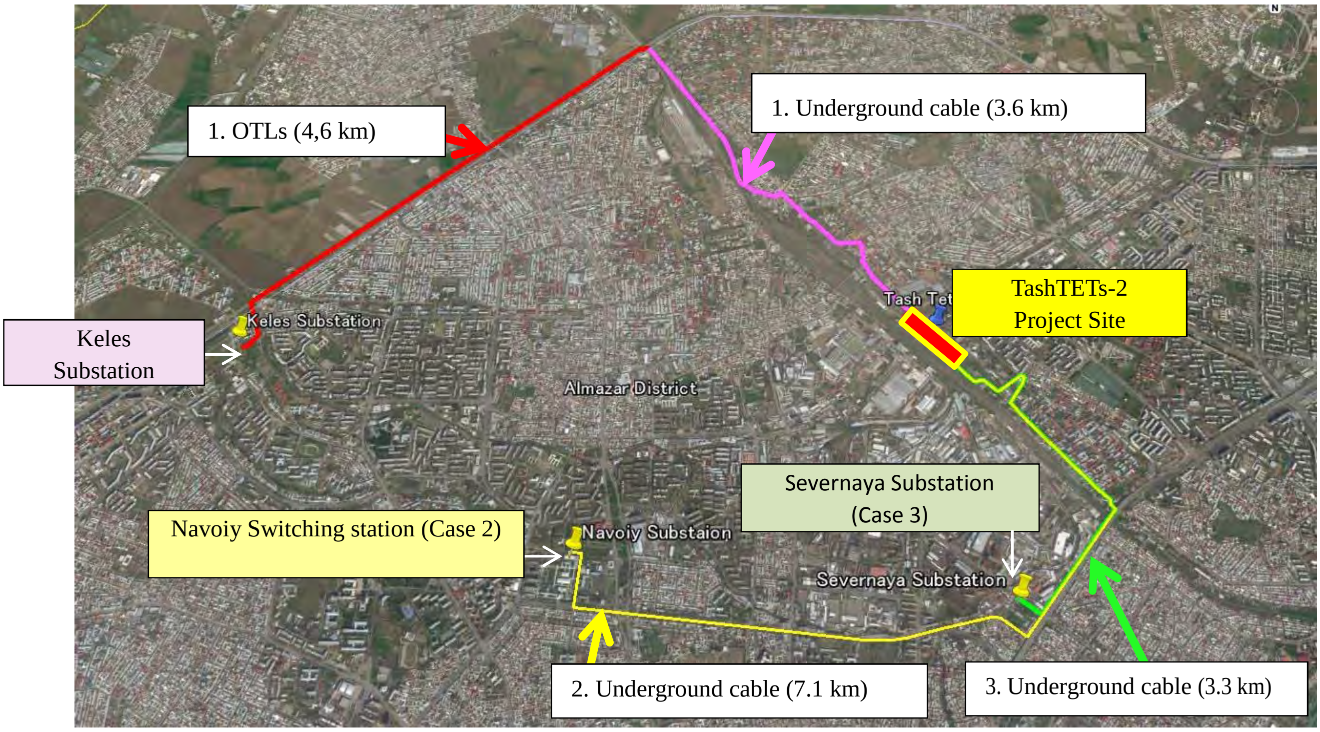
Case 1-A 	Case 1-B 	Case 1-C 
Case 1-D 	Case 1-E 	Case 1-F 
Case 2-A 	Case 2-B 	Case 2-C 
Case 2-D 	Case 2-E 	Case 2-F 
Case 3-A 	Case 3-B 	Case 3-C 
Case 3-D 	Case 3-E 	Case 3-F 

Source: JICA Study Team

Figure 5.4.4.4-1 Generator internal voltage angle fluctuation

5.4.5 Transmission Line

Cases of connection to electrical power grid are shown in Figure 5.4.5-1.



Red and pink: Keles Substation (Overhead Transmission Lines 4.6 km + underground cable 3.6 km)
Yellow: Navoiy Substation (underground cable 7.1 km)
Green: Severnaya Substation (underground cable 3.3 km)

Figure 5.4.5-1 Cases of connection to electrical power grid

・Case 1 (Keles Substation)

The electric power is transmitted by the underground cable along the railway tracks, and by the overhead transmission lines after the railway intersection with the highway and up to Keles Substation. The total length of the lines is 8.2 km. There are residential houses in the area between the TashTETs-2 and railway, but due to low traffic, the cable laying operations may be performed by one-way traffic. At the exit from the residential area, the cable is laid along the railway, between the road and residential houses. However, there is enough space t for cable laying and there is no need to remove the inhabitants. In some cases, the house land plots are situated too close to the cable and inspection is required, with possible purchase of land. Since the gas pipeline is laid along the railway tracks, it is necessary to conduct inspection and undertake further actions before starting the cable laying to ensure accuracy of the laying work. After the railway and the highway intersection point, the lines will run above the highway. There will be no need of resettlement of inhabitants, accordingly. The highway authority is incorporated into the municipal regional administration, and the regional administration will assist with permits for installation jobs, as well as with traffic restrictions during operations.

・Case 2 (Navoiy Switching Station)

The electric power is transmitted from the TashTETs-2 to the Navoiy Switching station by the underground cable. The total length of lines is 7.1 km. The cable will be laid from the TashTETs-2 to the south-east along the railway tracks. In locations where railway intersects with the highway the cable will run under the railway track and then along the highway to the Navoiy Switching Station. Along the railway tracks, the cable will be laid under the tracks in the residential area. Since the traffic is low and bypass road is available, the cable laying operations will be carried out by limmiting the traffic. The water and sewer pipes, hot water pipes and communication wires are already in place in some of the area planned for the cable laying, and this may result in changing the route of part of the cable. The highway is multilane and it is possible to perform operations by restricting the lanes in use. According to SCRC "Uzbekistan Railways" (UTY), the cable may be laid under the railway tracks, but the cable laying plan should be submitted to UTY for approval. The approval process may take about one month.

・Case 3 (Severnaya Substation)

The cable runs along the same route as in Case 2, and its length is 3.3 km. The situation along the cable route is the same as that of Case 2.

Installation of the electric power transmission facilities in each of the abovementioned Cases seems to be practical.

5.4.6 Substation Facility

・Case 1 (Keles Substation)

The 110 kV Keles Substation has 2 lead terminals and 2 more lead terminals are planned. It was also established that for the standby purposes 3 lead terminals may be added (standby support structures for 3 lines and extended busbar have been already installed). As far as there are already two 200 MVA, 220/110 kV transformer units installed at the Keles Substation, connection of the 110 kV line to this substation requires revising the lockout relay system of transformers given possible reverse power flows.

・Case 2 (Navoiy Switching Station)

The 110 kV Navoiy Switching Station is an indoor Secondary Gas Insulated Switchgear. The available cable leads have connection points for 8 lines. In case of connection to the underground cable, there is no need to increase the quantity of lead terminals. Or otherwise, in case of overhead transmission lines (hereinafter referred to as "OTL") installation, 2 units shall be supplied because no leads are available (place for installation is available), and also the leads direction must be designed so that no obstacles to the already existing lines on leads are created.

・Case 3 (Severnaya Substation)

The 110 kV Severnaya Substation has a vacant space for 1 line, but as compared to the existing OTL leads the space is somewhat confined, and depending on equipment dimensions, the insulation distance from the ground may be insufficient. On the other hand, there is enough space in the substation area for construction of an additional lead for two lines by extending the bus on both ends.

Considering the existing bus overloads, it is important to make a plan providing for replacement of the bus in case of increased number of leads for TashTETs-2 connection.

Table 5.4.6-1 shows details of all TashTETs-2 connection Cases.

Table 5.4.6-1 Cases of TashTETs-2 connection to substations

Position	Case 1 Keles	Case 2 Navoiy	Case 3 Severnaya
Equipment type	Outdoor	Indoor, Secondary Gas Insulated Switchgear	Outdoor
Available lines (suitable for use)	No	Available (8 lines) For cable laying	Available (1 line) But frontage is narrow
Possibility of adding lines	Possible (3 lines) Support structures installed	Possible (2 lines)	Possible (2 lines)
Main activities	Busbar expansion (2 lines) Assembly of switchgear facilities (2 lines)	No (for underground cable) Adding units (2 lines) (for OTLs)	Busbar expansion (2 lines) Assembly of switchgear facilities (2 lines) Replace existing buses (enhancement)
Overall evaluation	○ (good)	◎ (excellent) (for underground cable) △ (fair) (for OTLs)	○ (good)

Source: JICA Study Team

Considering the matter in terms of transformer equipment, Case 2 (Navoiy) is the most advantageous subject for using the underground cabling, since it requires almost no extra equipment and operations. However, other cases are also suitable for plant connection to the electrical power system seeing that it is possible to add OTLs in the territory of substations.

5.4.7 Economical Efficiency

The cost of connection to the electrical power system (cost of OTLs, switchgears and installation jobs) in all the three Cases is almost similar. The cases in the order of increasing cost are as follows: Case 3 (Severnaya), Case 1 (Keles), and Case 2 (Navoiy).

5.4.8 Overall Evaluation

The summary of this study is shown in Table 5.4.8-1.

Since items of Case 3 are superior to that of all o cases, the connection to Severnaya (Case 3) is selected.

Table 5.4.8-1 Overall evaluation

Item		Case 1 Keles	Case 2 Navoiy	Case 3 Severnaya
Network analysis	Voltage	△ (fair)	○ (good)	◎ (excellent)
	Power flow	× (bad) Overloading in 2 lines Severe overloading occurs even under normal (N-0) condition N-1: 4 lines	× (bad) Overloading in 2 lines Severe overloading occurs even under normal (N-0) condition N-1: 2 lines	○ (good) N-1: No overloading
	Transmission loss	× (bad) 1,720kW	△ (fair) 1,090kW	○ (good) 230kW
	Short circuit current	Much less than 31.5 or 40kA of circuit breaker rating, no problem exists		
	Stability	Network can be operated stably, even in case of severe fault occurrence		
Transmission line		△ (fair) underground cable and OTLs	△ (fair) laying operations under the railway tracks required	△ (fair) laying operations under the railway tracks required
Substation facility		○ (good) 2 lines may be assigned operations to extend lines required	◎ (excellent) 2 lines may be assigned operations to extend lines not required	○ (good) 2 lines may be assigned operations to extend lines required
Economic efficiency		○ (good)	△ (fair))	◎ (excellent)
Overall evaluation		× (bad)	△ (fair)	○ (good)

Source: JICA Study Team

Chapter 6 Fuel Supply Planning

Chapter 6 Fuel Supply Planning

6.1 Supply and Demand Situation of Natural Gas and Its Potential

6.1.1 Supply and Demand Situation of Natural Gas and Its Total Potential in Uzbekistan

According to the Ministry of Economy of the Republic of Uzbekistan (MOE), data and information on natural gas are treated as confidential, which we have not been able to access any data and information whose submission was requested through the questionnaire to the MOE to date. Accordingly, statistical data disclosed by energy research organizations (departments) such as the International Energy Agency (IEA) and British Petroleum (BP) cannot be used in the current Section 6.1. The contents of Section 6.1 are specified hereinafter using statistical data disclosed by energy research organizations, subject to amendments as required and after obtaining data and information treated as confidential.

(1) Inspection of reliability of statistical data issued by energy research organizations

If using the above-mentioned statistical data, the sources of such statistical data on natural gas are not necessarily clear, which means some sort of inspection work is necessary concerning the reliability and accuracy of the statistical data. As mentioned above, though the data on natural gas for the entire Uzbekistan are confidential, data on the volume of natural gas purchased by Uzbekenergo JSC for the past decade was obtainable. These data were also cross-checked with statistical data issued by the energy research organizations.

Since Uzbekistan is a double landlocked county, where LNG transportation is not feasible, natural gas cannot be stored basically except as reserves in abandoned mines (underground gas storage facilities). Accordingly, the volume purchased by Uzbeknergo can be considered consumed. Conversely, IEA’s data on natural gas includes statistical data on natural gas consumed by thermal power stations and heat and power stations. Concerning the latter, the natural gas volume consumed by small-scale heat and power stations is included in statistical data as well as those consumed by Uzbekenergo JSC (and its affiliated companies). However, as the gas volume consumed by small-scale stations is negligible[1], natural gas consumptions shown on IEA’s statistical data can be regarded as consumption by Uzbekenergo JSC. Figure 6.1.1-1 shows a comparison between the data of Uzbekenergo JSC and the IEA.

According to Figure 6.1.1-1, the difference between both sets of data is minimal. Though the difference in terms of absolute value for 2007 and 2008 exceeds 10%, this is a deviation split into plus and minus sides and the difference excluding the data for these two years is less than a few percentage.

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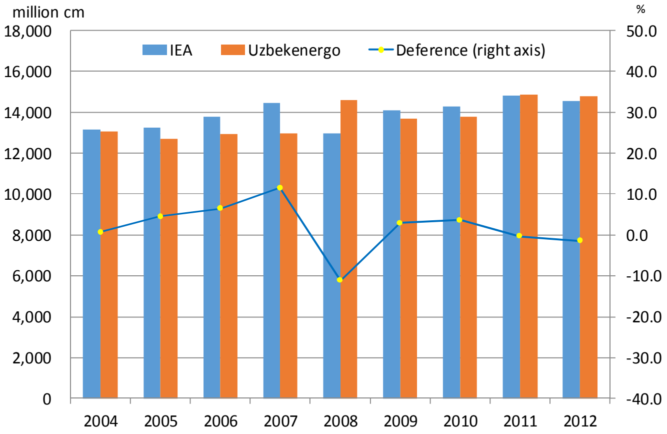
[1] According to IEA’s data for 2012 for instance, the natural gas volume consumed for power generation and heat and power supply was 11,793 ktoe, but that consumed for small-scale heat and power supply was as small as 30 ktoe. Since the unit used by the IEA is “ktoe”, a comparison in Figure 6.1.1-1 was made in terms of million cm, using a conversion of 1 million cm = 0.8121 ktoe.

In particular, these two sets of data are effectively consistent for the five-year period since 2009 and the average deviation is as little as 1.6% for nine years.

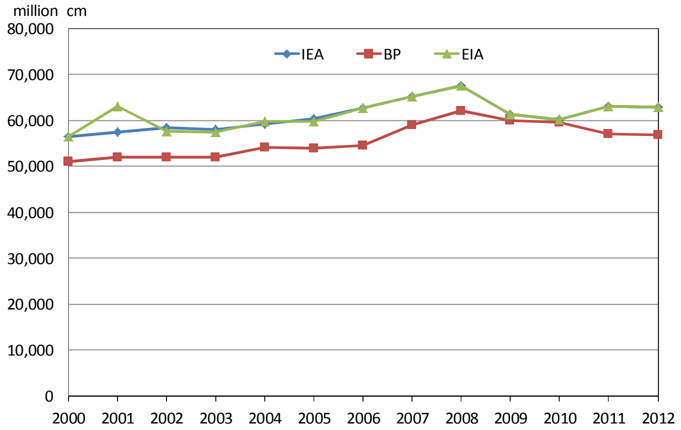
The natural gas volume for power generation use comprises only 26% of primary energy consumption. Strictly speaking, even if the data on gas consumption for power generation held by Uzbekenergo JSC data and the IEA almost coincide, it does not necessarily mean that the IEA's data coincides with gas consumptions by other sectors. However, since domestic data on gas consumption of the industrial sector with various users and the residential sector for example, is not expected to be obtainable for the time being at least, statistical data of energy research organizations were utilized, provided that such data were deemed as virtually coincident with other sectors.



Source: Prepared by the JICA Study Team based on Uzbekenergo JSC and IEA data

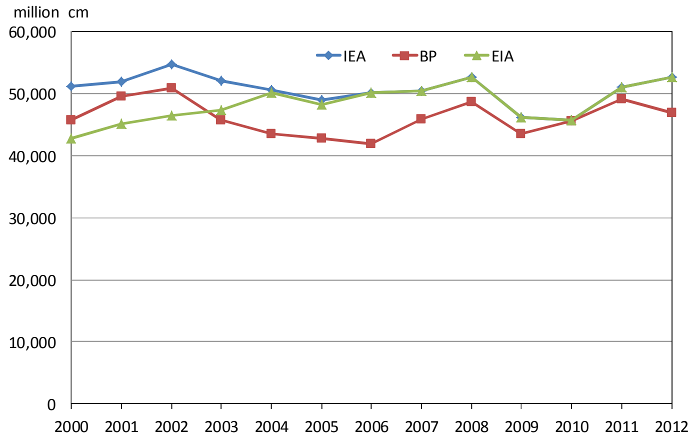
Figure 6.1.1-1 Comparison of Uzbekenergo JSC and IEA data on natural gas consumption

The following step involved a comparison of statistical data among energy research organizations. Energy research organizations with data generally utilized included the EIA (U.S. Energy Information Administration) as well as the above-mentioned IEA and BP. Figures 6.1.1-2 and 6.1.1-3 show a comparison of data on natural gas consumption in Uzbekistan among these 3 energy research organizations.



Source: Prepared by the JICA Study Team based on various data

Figure 6.1.1-2 Comparison of data on natural gas production among energy research organizations



Source: Prepared by the JICA Study Team based on various data

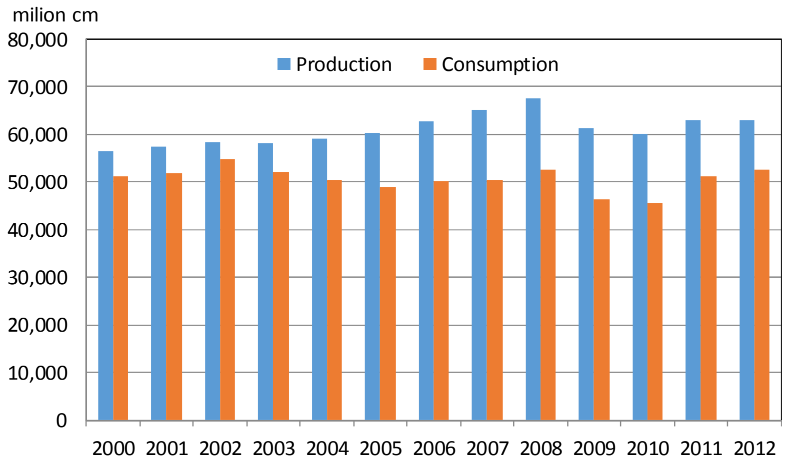
Figure 6.1.1-3 Comparison of data on natural gas consumption among energy research organizations

According to these figures, IEA's and EIA's data coincided for around a decade until 2012, which stands to reason, since the EIA data is basically quoted from that of the IEA. Conversely, BP's data shows relatively smaller values (difference of around 8% in production and consumption). IEA's data were mainly utilized in Section 6.1, while BP's data were quoted for comparison where necessary, for the following reasons:

1. IEA data coincide with Uzbekenrgo data, as shown in Figure 6.1.1-1,
2. EIA also quotes IEA data and
3. IEA data are generally well utilized.

(2) Supply and Demand Situation on Natural Gas

Figure 6.1.1-4 represents natural gas production and consumption in Uzbekistan for the period 2000 to 2012.



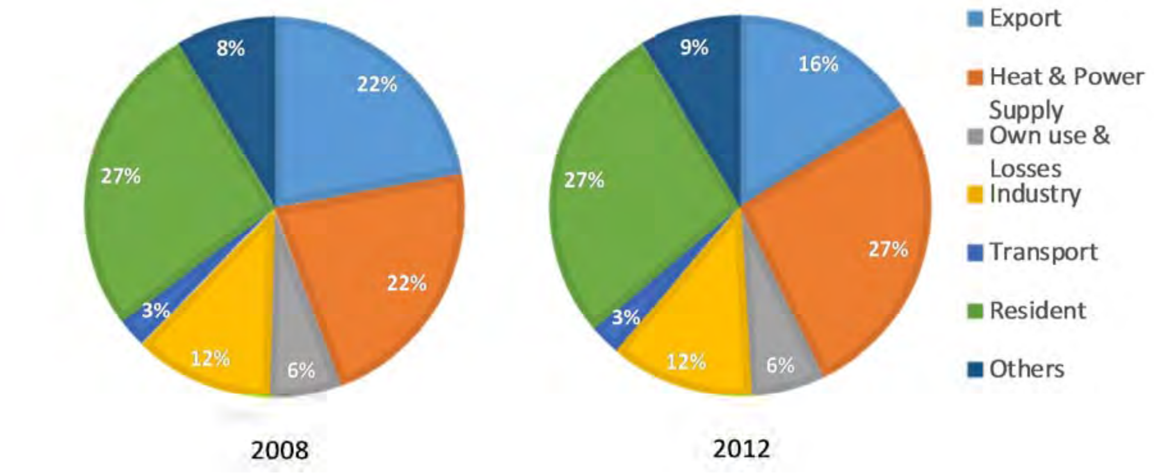
Source: IEA

Figure 6.1.1-4 Change in natural gas production and consumption

According to Figure 6.1.1-4, natural gas production increased up to 2008, but then declined and has shown minimal change ever since. Conversely, although natural gas consumption decreased slightly in 2009 and 2010, there was little change since 2000. The annual growth rates of production and consumption over 13 years were as little as 0.84 and 0.23 % respectively.

As the difference between production and consumption can be considered nearly equal to export, exports begun to increase from around 2003, peaking in around 2009, but have been declining in recent years. This is because consumption remained on the same level while natural gas production was decreasing since 2009, whereupon the scope to export decreased.

Figure 6.1.1-5 represents the application structures of natural gas in 2008 and 2012. The share of exports decreased in 2012 compared with 2008 and the share of consumption for power generation and heat and power supply uses increased correspondingly. There was almost no change in the share of other applications between 2008 and 2012.



Source: Prepared by the JICA Study Team based on various data

Figure 6.1.1-5 Application structure of natural gas

In Uzbekistan, the supply and demand of natural gas are completely government-controlled and the government starts examining the supply and demand for the forthcoming year in the summer of each previous year, ultimately seeking the approval of the President, which is expected at the end of the year. The major procedure is specified in the Cabinet Resolution of Ministers No. 169, dated 24 June, 2014; the major contents of which are shown in Table 6.1.1-1. A rough schedule to determine supply and demand for the forthcoming year is specified in Clause 3 of the Resolution and shown in Figure 6.1.1-6, whereby the meeting result with Uzbekneftegas is taken into consideration.

In addition, Appendix 2 Common Concept for Supply and Acceptance of Natural Gas of the Resolution is strikingly similar to “Purchasing Contracts for Natural Gas No. 10002”, which includes individual contracts in its contents. The latter contracts apply to natural gas purchase in TC-4 (see Table 6.1.2-6 shown later). Judging from the issuance date of both documents, the former contracts are considered to reference the latter contracts as general purchase contracts. Accordingly, when the purchase contracts of natural gas for TashTETs-2 are concluded, the contracts will be prepared based on the former contracts.

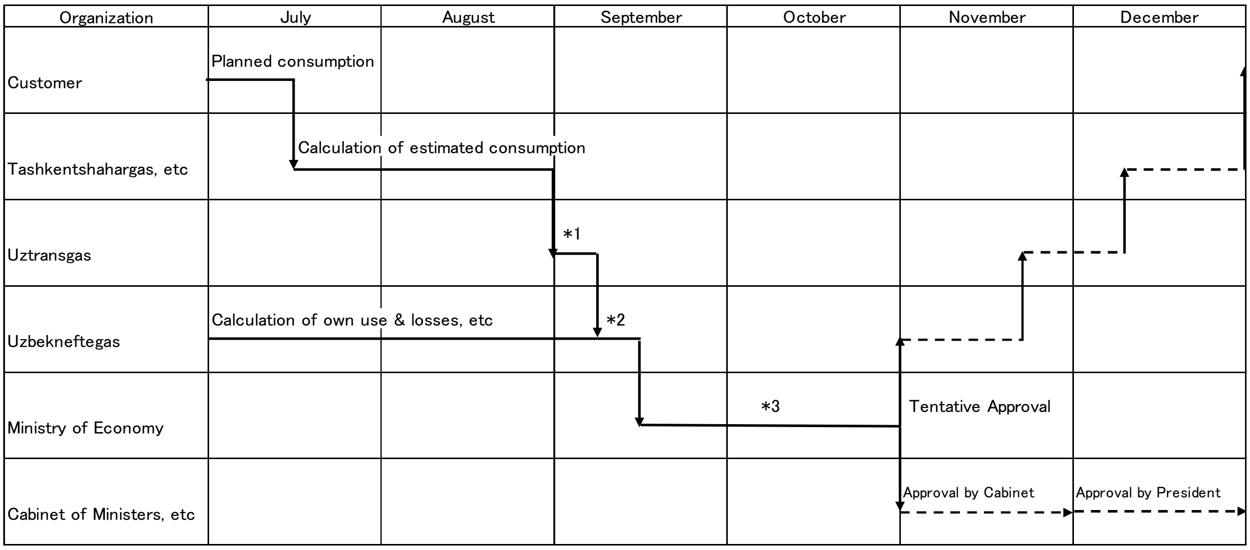
Table 6.1.1-1 Table of Contents of the Cabinet Resolution of the Ministers No. 169

"About Approval of Rules of Natural Gas Consumption in Economic Sectors"

1. General Conditions
2. Main Definitions
3. Determination of Demand of Natural Gas
4. Settlement of Document To Develop the Gas Supply Project
5. Technical Requirement of the Project Design Document
6. Requirement of the Commissioning Works for Gas-Consuming Equipment
7. Acceptance of Commissioning for Gas-Consuming Equipment
8. Conclusion of Gas Supply and Acceptance of Natural Gas
9. Order of Gas Supply to Consumers
10. Order of Payment Settlement of Supplied Gas
11. Gas Metering
12. Rights and Obligations of Suppliers and Consumers
13. Rational Use and Safety Use of Gas and Norms
14. Liability for Breaking the Rules for Gas Consumption

Appendix 1. Scheme of Relations between Suppliers and Consumers of Natural Gas
Appendix 2. Common Concept for Supply and Acceptance of Natural Gas
(Common Purchase Contracts of Natural Gas)

Source: the Cabinet of the Ministers' Decree No. 16



*1) Calculation of nationwide consumption
*2) Preparation of balance table on reserves/resources data and supply/demand data, taking into account of reserves, transportation capacity, export volume, etc
*3) Investigation of reserve data and balance table on supply/demand

Source: Prepared by the JICA Study Team

Figure 6.1.1-6 Procedure to determine supply and demand of natural gas for the forthcoming year

As shown in Figure 6.1.1-6, nationwide major natural gas consumers submit the planned gas consumption for the forthcoming year to their local gas supply companies like Tashkentshahargas by 15 July. Gas supply companies then calculate the estimated gas consumption and submit accounts of the estimated gas supply for the forthcoming year to Uztransgas by 1 September, taking demand for residential and other consumers using small amounts of gas. Uztransgas adds up the estimated gas consumption accounts from nationwide gas supply companies and submits the total consumption to Uzbekneftegas by early September. Reflecting the application by Uzbekenergo JSC as the biggest consumer (of ten power stations, 8 purchase gas directly from Uztransgas) and its own use and losses and taking the balance of resources and distribution as shown in Table 6.1.1-2 into consideration, Uzbekneftegas calculates gas supply and demand for the forthcoming year. Finally, Uzbekneftegas prepares the balance table on supply and demand (draft). This balance table is submitted to the MOE by 15 September.

Table 6.1.1-2 Factors of gas supply and demand balance

I. Resources	II. Distribution
1.1. Gas production	2.1. Internal gas consumption (nationwide)
1.2. Pumping of natural gas back from UGSF (underground gas storage facilities)	2.2. Own needs and losses
	2.3. Export
	2.4. Pumping of natural gas to UGSF

Source: Prepared by the JICA Study Team based on the interview result with Uzbekneftegas

In Table 6.1.1-2 Clause 1.1 is calculated taking possible extraction from every well into consideration. Clauses 1.2 and 2.4 relate to the storage of gas in summer and its release in winter to meet an increase in demand. Depleted gas fields at the end of their service lives are generally utilized for gas storage.

The MOE investigates and determines gas supply and demand, taking of industry policy, the economic growth forecast for the forthcoming year and balance with other type of fuels into consideration. The determination made by MOE is just temporary and the approval of the Cabinet of Ministers followed by that of the President are also required for official determination, although the determination of the MOE is substantively final. The outcome of the determination is notified to Uzbekneftegas in parallel with the submission to the Cabinet of Ministers and the notification is made in reverse order to that of the planned demand application, one after another. Finally the notification is made to consumers from around the end of one year to the beginning of the next. Even if the Cabinet of Ministers requires any change, this only involves minor adjustments of exports and there is generally minimal impact on domestic demand.

As mentioned above, since the gas supply is determined taking resources and distribution into account, supply is controlled if resources and production are restricted. In addition, gas exports are regulated by a bilateral agreement, making it difficult to reduce exports in proportion to any decrease in production, even if production declines. Consequently, if production does not increase, domestic consumption is it is inevitably likely to be restricted.

As shown in Figure 6.1.1-4, gas production has tended to decrease in recent years; due to the decline in production as existing production facilities have become decrepit. Conversely, sufficient exploration and development of gas fields to compensate for such reduction have not been initially implemented[2]. Uzbekistan ranks the energy sector as a key part of major industry and increased gas production in particular is adopted as a priority policy item. Though utilization of foreign investment was expected due to technological and financial restrictions in the country, an environment conducive to direct foreign investment was not adequately established in the past. Accordingly, the main activities involved implementing a production-sharing agreement (PSA) with Russia, since long ago and establishing a joint venture between state-owned companies based on a bilateral energy agreement with Chine and South Korea, etc., targeting overseas expansion. Uzbekistan has started to devote effort to encouraging large-scale foreign investment in recent years, but considerable time is required to achieve good results. There is also the need to continue lasting positive invitation of foreign investment.

As stated above, although gas production is declining, gas consumption is considered unlikely to decrease unless a positive energy saving policy is implemented, due to the difficulty in adopting measures to restrict consumption that lead to the national economy stagnating. Conversely, though promoting gas exports is one of the mainstays of Uzbek energy policy, the situation is such that restrictions on exports are inevitable to some extent to transfer a certain amount of gas to meet domestic demand. In conclusion, the overall supply and demand situation of gas in Uzbekistan is considered tight at present and set to remain that way in the near future.

(3) Natural gas resources

According to Uzbekistan Energy and Power Sector Issues Note (World Bank), the proven gas reserves as of 2010 were estimated at 1,841 bcm (billion cubic m) and undiscovered possible reserves were 4,000 bcm. Conversely, according to BP, the proven reserves as of 2012 were estimated considerably lower as 1,120 bcm. Since data on reserves are also treated as confidential, it is not known how Uzbekistan evaluates reserves. Accordingly, resources were evaluated from the perspective of a stable natural gas supply, using data announced by energy research organizations hereinafter.

The ratio of reserves (R) to production (P) or R/P is defined as reserves in a certain year divided by production the same year. This is an indicator showing how many years production can be continued when production is performed every year with an amount equivalent to that in the year in question. Although the reserves used with the indicator are generally proven (or recoverable) reserves, such reserves will increase following any new discovery of gas and decrease with increased

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[2] It is said that the Government initially prioritized focusing on natural gas production from existing fields to meet domestic demand, rather than investing in new reserves (Country Analysis Note – EIA).

production. In addition, there is also the scope for reserves to increase with any rise in price and improvement in exploration and development technology. Accordingly, the value of R/P does not necessarily mean expired life of resources. However, in case of larger R/P, there is a room for production increase but in case of smaller R/P, production increase cannot be possible. Judging from a long history of petroleum industry in USA, it is said that when R/P decreases below 10 years production increase becomes impossible and production heads toward reduction[3].

As mentioned above, when the reserves of gas as of 2010 were 1,841bcm, R/P is calculated at 30.6 years as the production was 60.1 bcm in that year. Accordingly, if there is no increase in reserves natural gas will be exhausted in around year 2040, even if production continued at the same level as 2010. However, both proven reserves and production change year after year.

According to Business Monitoring International (BMI), the following outlook for reserves is presented; ”Some discoveries and exploration activity would keep gas reserves stagnant at about 1,800 bcm through to 2018, though Uzbekistan would need to speed up the rate of exploration and discovery should it wish to prevent a fall in gas reserves to about 1,700 bcm by 2023[4]. According to the forecast temporally made by the JICA Study Team[5], gas production was estimated at 66.1 bcm in 2018 and 70.2 bcm in 2023. Based on these forecast figures, R/P in 2018 and 2023 are calculated at 27.0 and 24.2 years, respectively, which means that R/P would decrease by 2.8 years during 5 years from 2018 to 2023. If R/P continues to reduce at the same rate after 2023, it is possible to determine how many years it takes before R/P becomes 10 years, namely 26.0 years, which means R/P becomes 10 years in 2049.

As mentioned above, although it is considered impossible to increase production when R/P drops to 10 years, at the same time it means production can be continued for a further decade, hence production is considered to continue until around 2060 at least. If the serviceable life of TashTETs-2 is 30 years, TashTETs-2 will complete its operation in around 2050 and therefore it might be concluded that there is no problem in terms of natural gas resources according to the simple calculation as above.

Uzbekneftegas presented an annual increase in natural gas reserves in a seminar held in Tokyo in 2009 as shown in Figure 6.1.1-7. There is no explanation as to whether reserves are proven or possible undiscovered. If those are proven reserves, the annual increase in proven reserves during the period 2000 to 2013 results in an average 108 bcm. However, as production during that period is some 50 to 60 bcm, proven reserves are set to increase in this case, even if there is some increase in production. Since the reserves are estimated for 2009 when the presentation was made and after and the data before 2008 are from actual records, if the annual average increase in reserves is

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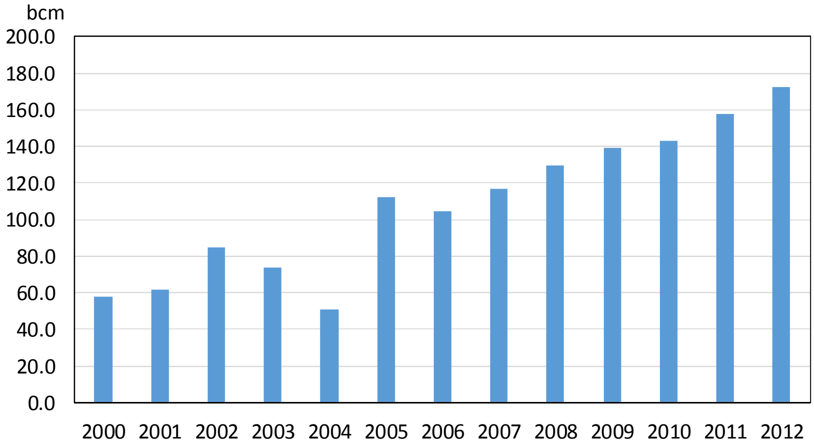
[3] Oil/gas terminology dictionary、JOGMEC (Japan Oil, Gas and Minerals National Corporation)

[4] Oil and Gas: Uzbekistan Oil and Gas Report Q3 2014, BMI Research, June 4, 2014

[5] Details of the forecast will be described on the Master Plan report.

calculated using the actual record during the period 2000 to 2008, the end result is 88 bcm, which means that proven reserves continue to increase.



Source: Footnote [6]

Figure 6.1.1-7 Annual increase in natural gas reserves

Conversely, according to BP's statistical data, proven reserves during the period 2000 to 2012 underwent little change, namely, the increase in reserves is almost equal to production. As mentioned above, reserve data are treated as confidential, making it impossible to clarify whether or not it is true, given a lack of available confidential data.

Improvement of energy conservation and the accelerated development of renewable energy have been declared as part of the major energy policy in Uzbekistan. Accordingly, it is not necessary to increase natural gas production drastically, if there is no specific aim to increase exports. Proven reserves are likely to increase if exploration and development actions are accelerated. Accordingly, as a decrease in R/P can be mitigated at least depending on energy policy, it is considered that gas resources will not raise concerns during the TashTETs-2 operation period.

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[6] Sharkat Majitov, Uzbekistan's oil and gas potential and its contemporary development, Uzbekneftegas, 31 August, 2009

6.1.2 Present Situation and Outlook on Gas Supply to Tashkent City

(1) Infrastructure for gas supply

Gas is supplied to Tashkent city exclusively by Tashkentshahargas, namely, it supplies gas to all customers in Tashkent city, including for industrial, residential and heat and power generation uses. Uztransgas delivers gas to Tashkentshahargs, which is an affiliated company of Uztransgas.

According to Uzbekneftegas, Uztransgas delivers natural gas produced and processed by Uzbekneftegas, the parent company of Uztransgas, to Tashkent city via three trunk pipelines shown in Figure 6.1.2-1. Those pipelines are:

1. Djarkak－Bukhara－Samarkand－Tashkent (DBST) pipeline
2. Pakharol－Yangier－Tashkent (PYT) pipeline
3. Yangier－TashGRES pipeline[7].

Of those pipelines, the DBST pipeline is extended to Shymkent in Kazakhstan through Tashkent city, but the PYT pipeline terminates at the Vostochnaya-2 gas distribution station located in the outskirts of Tashkent city. The gas distribution station (GDS) refers to the connecting point between the trunk pipeline for gas transportation and main supply pipeline for gas distribution and is generally called a “city gate”.

According to Uzbekneftegas, the total annual transportation capacity is 29 bcm and the volume actually transported was 17.3 bcm in 2014. If these two figures are compared, it seems that the pipelines might have sufficient allowance but it is necessary to confirm their allowance in winter, when gas consumption rises. Namely, the actual transportation volume in winter, particularly January and February, must be clarified by obtaining data on the monthly transportation volume in 2014.

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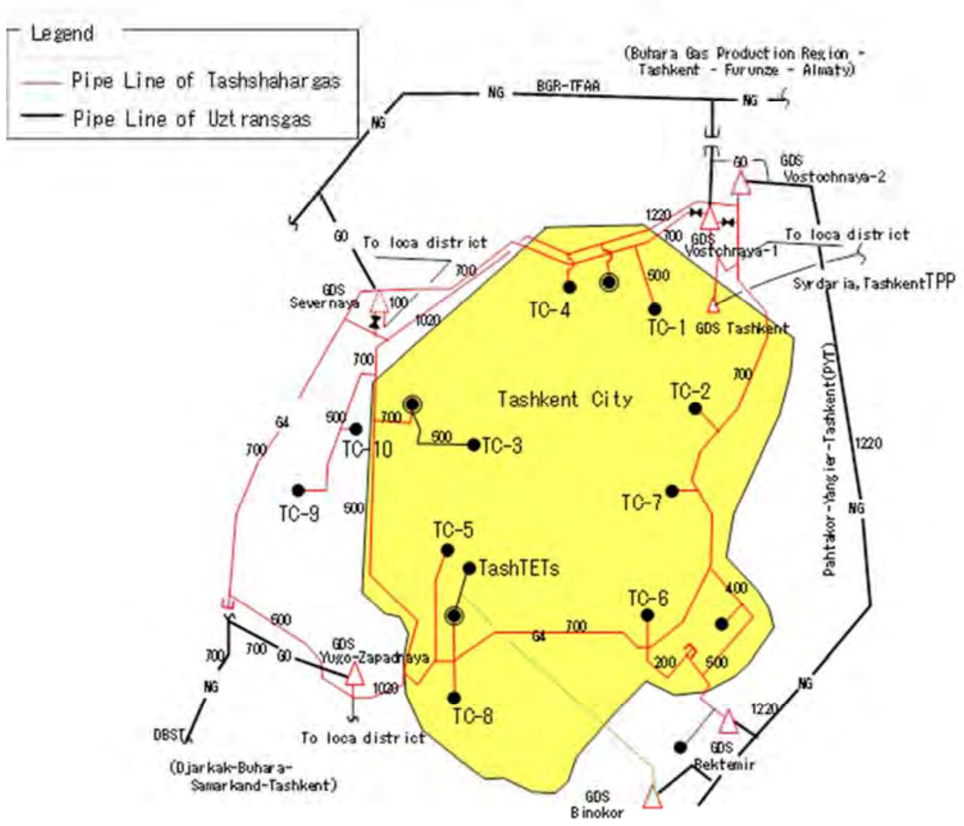
[7] The Yangier－TashGRES pipeline is to deliver gas to Tashkent city through a gas distribution station called “Severnaya”. However according to Tashkentshahargas, since the Severnaya gas distribution station is not currently in service, it is considered that delivery of gas is not implemented through this pipeline. Tashkentshahargas has clearly stated that gas is delivered to Tashkent city via the DBST and PYT pipelines.

Source: footnote [6]

Figure 6.1.2-1 Natural gas pipeline route in Uzbekistan, including pipelines supplying gas to Tashkent city

Natural gas transported through the above trunk pipelines are delivered to four GDS, namely Yugo-Zapadnaya, Vostochnaya-2, Bektemir and Binokor (a newly built GDS about 10 km upstream from Bektemir GDS for the exclusive use of TashTETs). Gas passed through 3 GDS, except Binokor, is supplied to customers in Tashkent city via a ring-shaped main high pressure supply pipeline as shown in Figure 6.1.2-2.



Source: Tashkentshahargas

Figure 6.1.2-2 Main high pressure supply pipeline in Tashkent city

Table 6.1.2-1 represents the supply capacity of the above-mentioned four GDS. The total supply capacity on an annual basis is some 19 bcm/y but the gas supply to Tashkent city is only some 4.2 bcm, as mentioned later.

Table 6.1.2-1 Supply capacity of gas distribution stations

Gas supply station	Supply capacity（m^3/h）
Yugo-Zapadnaya	600,000
Vostochnaya-2	890,000
Bektemir	300,000
Binokor	145,300
Total	1,935,300

Source: Tashkentshahargas

Binokor GDS was built to avoid gas shortages due to a decrease in incoming pressure in winter at TashTETs, where the cogeneration facility was installed as NEDO's model project. Gas is supplied to construction material manufacturing companies, piping fabrication companies, etc. as well as TashTETs from this GDS and the installation of a gas supply pipeline to these customers was undertaken by Uztransgas. The length of the pipeline to TashTETs is some 15 km. The pipeline with some 10 km length of 15 km is newly installed and an existing pipeline 5 km long was used for the remaining part. This supply system was built based on a credit guarantee jointly issued by Uztransgas and Uzbekenergo JSC and specified ensuring sufficient inlet pressure (i.e. amount of gas) at gas booster facilities at TashTETs to respond to the requirement by the Japan side, which wished to eliminate concerns over gas supply shortages.

Natural gas to all the heat supply stations such as TC-1 to TC-10 (TC-2 is exclusive) operated by TashTeploCentral and TC-2 operated by TashTeploEnergo was supplied through the service pipelines installed from the branch points which were provided on the ring-shaped main supply pipeline. The total length of gas supply pipelines operated by Tashkentshahargas was 5,507.173 km as of 31 December, 2014 including the service pipelines as above. Table 6.1.2-2 represents a breakdown of these pipelines.

Table 6.1.2-2 Tashkentshahargas's gas supply pipeline

Pipeline	Pressure	Installed length
High pressure pipeline	3 ～6 kg/cm^{2}G or 1～3 kg/cm^{2}G	188.04 km
Medium pressure pipeline	0.5～1 kg/cm^{2}G	1,031.253 km
Low pressure pipeline	Below 0.5 kg/cm^{2}G	4,287.88 km
Total		5,507.173 km

Source: Tashkentshahargas

Furthermore, there are also 2,232 gas distribution substations (called gas distribution point - GDP. See section 6.2.3), including:

High pressure －104 GDPs
Medium pressure －2,128 GDPs.

All four of the above-mentioned GDSs operate in winter when gas demand is high, but only Yugo-Zapadnaya and Binokor GDSs operate in summer when gas demand is low and other GDSs suspend operations. However, Vostochnaya-2 GDS is on standby in case of accidents involving Yugo-Zapadnaya GDS.

(2) Current gas supply situation

In Tashkent city, while all households can access the gas supply infrastructure of Tashkentshahargas, around 2 percent of households utilized electricity as a heating source as of the end of 2014. 577,711 households (including 1,608,788 residents) enjoy gas supply, including 163,052 private homes and 414,659 apartment blocks.

Wholesale consumers comprise 1,022 industrial enterprises, 9 heat supply stations of TashTeploCentral, a heat and power supply station operated by TashTETs, 164 local heating thermal plants of TashTeploEnergo, 32 Compressed Natural Gas Filling Stations (CNGFS) of JSC “AvtoGaz”; 7,493 of public utility facilities and 2,328 facilities for self-employment and 34 branches to Tashkent province.

Table 6.1.2-3 represents the gas supply to the above-mentioned customers during the period 2004 to 2014. Though the gas supply to Tashkent city increased from 3,507.38 to 3,957.4 million m^3, this increase is as small as 1.1% in terms of annual rate.

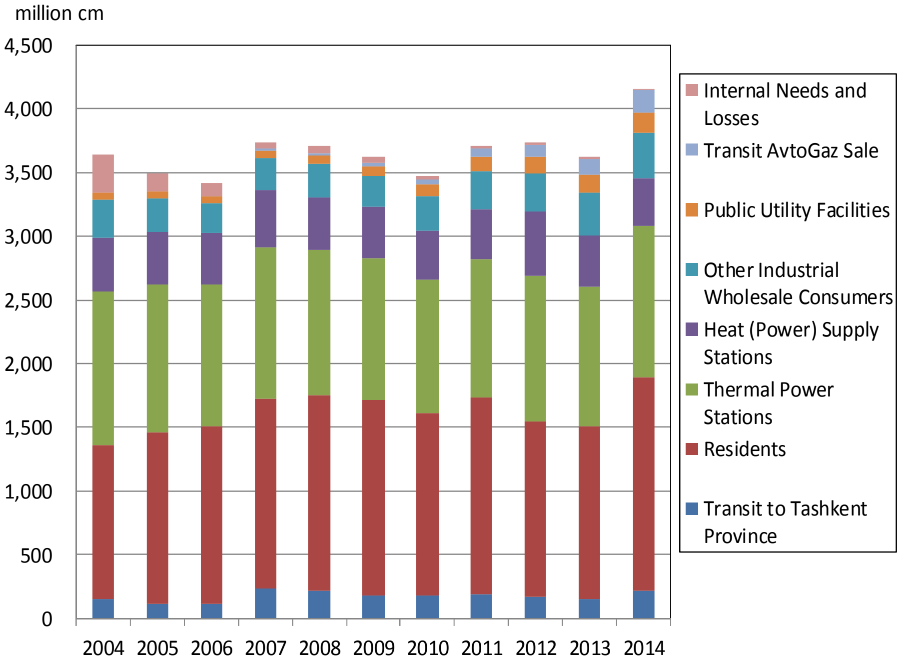
Table 6.1.2-3 Gas supply to the customers of Tahskentshahargas in 2004 to 2014

(1,000 m^3)

Year	Supply by Uztransgas	Transit to Tashkent province	Supply to Tashkent city	Total sold	including		including						Transit AvtoGaz sale	Internal needs and losses	Unconfirmed	Gas remaining in pipes
					Residents	Wholesale consumers	TashTeplo Cental	TashTETs	TashTeplo Energo	Other industrial wholesale consumers	Public utility facilities	Facilities for self-employment				
2004	3,655,846	148,463	3,507,383	3,204,742	1,212,326	1,992,416	1,208,736	273,008	142,775	296,497	60,321	11,079	0	302,640	0	0
2005	3,503,382	113,012	3,390,370	3,248,723	1,348,295	1,900,428	1,161,166	260,895	151,369	263,134	50,285	13,578	0	141,647	0	0
2006	3,427,119	118,444	3,308,675	3,206,173	1,386,432	1,819,741	1,120,992	251,374	146,518	237,545	51,046	12,266	772	101,730	0	0
2007	3,750,953	239,817	3,511,136	3,448,297	1,484,964	1,963,333	1,186,895	268,902	176,952	252,640	61,392	16,552	13,835	47,651	0	1,354
2008	3,723,329	219,304	3,504,025	3,432,113	1,529,388	1,902,725	1,146,417	245,337	168,056	254,341	72,311	16,263	17,392	53,554	0	2,320
2009	3,636,075	182,726	3,453,349	3,386,807	1,532,063	1,854,743	1,109,290	253,244	150,085	244,745	80,747	16,632	27,002	41,319	0	541
2010	3,490,962	184,240	3,306,721	3,241,058	1,427,829	1,813,229	1,047,735	240,636	144,765	269,381	92,059	18,653	35,892	29,901	0	412
2011	3,724,853	186,567	3,538,286	3,191,937	1,286,714	1,905,223	1,087,716	245,690	146,529	294,337	112,481	18,469	62,195	19,023	262,358	3,186
2012	3,755,253	171,173	3,584,080	3,410,495	1,313,194	2,097,302	1,138,719	350,805	155,576	305,528	128,274	18,401	92,015	20,474	61,309	2,973
2013	3,641,447	150,584	3,490,863	3,195,650	1,211,354	1,984,295	1,093,081	260,787	140,628	333,719	137,113	18,967	125,072	19,618	150,986	2,510
2014	4,175,090	217,692	3,957,398	3,095,013	1,002,123	2,092,890	1,188,576	221,674	148,392	351,806	162,953	19,489	176,201	10,005	676,346	2,343

Source: Tashkentshahargas

Figure 6.1.2-3 represents the gas supply structure of Tashkentshahargas during the period 2004 to 2014, in which "Not specified" in Table 6.1.2-3 is added to "Residents". According to Figure 6.1.2-3, though the total supply remained unchanged from 2004 to 2013, it increased rapidly in 2014. The rapid increase in gas volume for "Not specified" in 2014 contributed to the total gas supply as well as the relatively warmer winter of 2013 compared that of a usual year and the unusually cold climate[8] in February 2014.



Source: Tashkentshahargas

Figure 6.1.2-3 Gas supply structure of Tashkentshahargas

There are no significant changes overall in terms of the gas supply structure year by year, except for the fact that the supply for residents increased gradually, although fluctuating over the year. However, it is noted that demand in terms of compressed natural gas for vehicles is steadily increasing, although its share remains relatively small. It is considered that the role of compressed natural gas will become increasingly significant as an alternative fuel for gasoline and diesel oil together with GTL (gas to liquid), due to the restrictions on petroleum resources in Uzbekistan.

Table 6.1.2-4 represents the wholesale price of natural gas since 2010, where the gas price is revised every half year. The price was set separately for each of three groups into which customers were divided pending the price revision on 1 October, 2012. In particular, heat supply companies have enjoyed the most preferential treatment in terms of price setting for one year since the price revision in April 2012. However, such price categories have been integrated since the revision on 1st April, 2013.

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[8] The monthly average temperature was 0.12 degrees C in January 2012, 4.36 degrees C in January 2013, 2.79 degrees C in January 2014 and -2.40 degrees C in February 2014.

Table 6.1.2-4 Natural gas price for wholesale customers

（Sums / 1,000 m^3）

Categories	Wholesale price								
	1 Oct ‘14	1 Apr ‘14	1 Oct ‘13	1 Apr ‘13	1 Oct ‘12	1 Apr ‘12	1 Oct ‘11	1 Apr ‘11	1 Oct ‘10
Natural gas delivered to wholesale consumers	181,620	165,240	151,740	139,800	128,000	161,100	108,000	99,600	91,800
Natural gas delivered to heat supply companies					122,850	107,700	94,500	82,800	72,000
Natural gas delivered to construction material manufacturing companies					128,000	116,100	51,000	51,000	51,000

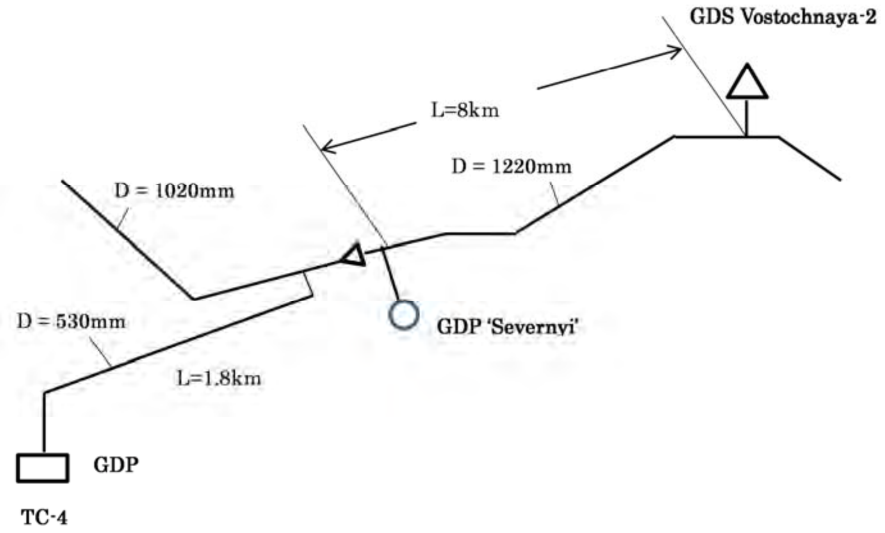
Source: Ministry of Finance of the Republic of Uzbekistan

Tashkentshahargas receives all the natural gas that is supplied to the customers in Tashkent city from Uztransgas. However, there is no purchase contract between Tashkentshahargas and Uztransgas. Tashkentshahargas delivers gas sales to Uztransgas on a back-to-back basis. Accordingly, Uztransgas pays back certain money from gas sales delivered to Uztransgas to Tashkentshahargas based on an amount determined by the Ministry of Finance. However, under current circumstances, Tashkentshahargas inevitably achieves fewer sales than the actual gas volume supplied due to many households not paying gas charges. In Uzbekistan, the gas supply would not be stopped in the residential sector, even if payment for gas charges is not made. However, the gas supply may be stopped in the industrial sector as shown in Table 6.1.2-7.

Though the main concern is the tight gas supply and demand situation in winter when gas demand increases from the perspective of fuel supply planning for the project, the relevant staff from Tashkentshahargas and Uztransgas do not recognize any gas shortage, despite acknowledging the tight supply and demand situation in winter. This is because no gas shortage is deemed to occur in Uzbekistan if the gas is supplied monthly to the planned amount determined in previous year, as mentioned above. However, it seems that some gas shortage may occur depending on the areas or consumers concerned. One example is specified based on the current situation on gas supply to TC-4 hereinafter.

(3) Current situation on gas supply to TC-4

TC-4 is located adjacent to the premises in which TashTETs-2 is planned to be constructed, where 10 gas-fired boilers supply heat to the neighboring area. The gas supply to TC-4 is conducted through a service pipeline 530 mm in diameter branched off from the pipeline of diameter 1,020 mm (the diameter of the main supply pipeline reduces from 1,220 to 1,020 mm just upstream from the branch point) that comprises a ring-shaped high pressure main supply pipeline. Figure 6.1.2-4 shows the service pipeline to TC-4.



Source: Tashkentshahargas

Figure 6.1.2-4 Service pipeline to TC-4

The pipeline of diameter 1,020 mm was installed together with that of diameter 1,220 mm and replaces the pipeline 700 mm in diameter installed in 1968 (the service pipeline was originally connected to this old pipeline). Conversely, the service pipeline now utilized is an old one that was installed in 1968 and is around 1.8 km long. The pipeline of 700 mm in diameter is still used as a branch pipeline to supply natural gas to 34 provinces in the suburbs of Tashkent.

Table 6.1.2-5 represents the monthly gas supply to TC-4 by Tashkentshahargas over the four years from 2011 to 2014. The monthly gas supply sometimes exceeds 45 million m^3 in winter and goes below 12 million m^3, meaning the gas supply varies considerably depending on the season. According to Table 6.1.2-5, the monthly maximum gas supply (consumption for TC-4) was recorded in January 2012 at about 50 million m^3 and the minimum occurred in September 2012 at about 9.9 million m^3. A significant gap in the gas supply between winter and summer seasons is due to the higher supply volume of hot water as well as the higher supply temperature (70 to 75 degrees C) in winter but a lower supply volume as well as lower temperature (around 60 degrees C).

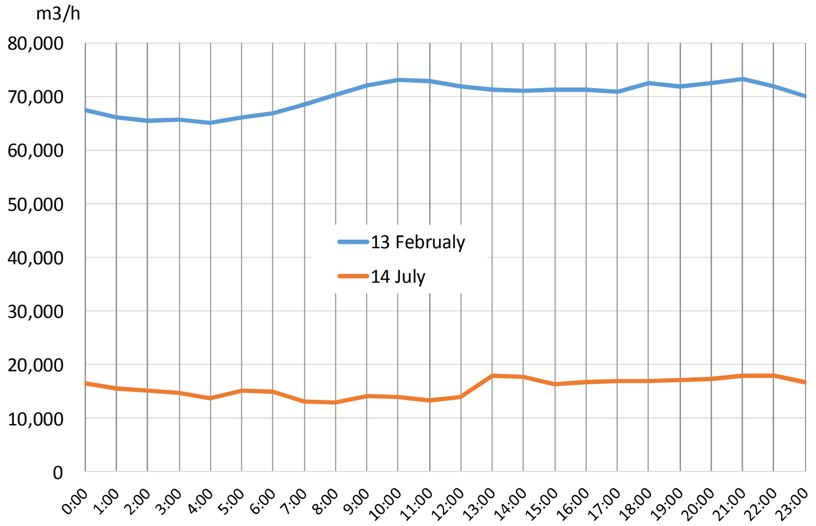
Table 6.1.2-5 Monthly gas supply to TC-4

(1,000m^3/month)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	43,308	38,120	34,577	14,014	15,219	11,593	11,567	10,975	11,148	12,803	39,410	47,369	290,103
2012	50,163	47,086	40,173	13,342	14,621	11,664	11,864	11,308	9,888	13,132	33,724	47,381	304,346
2013	48,337	40,552	37,403	15,643	15,185	14,509	14,535	13230	11,038	16,118	31,25	40,338	298,141
2014	44,817	43,719	38,315	15,091	16,102	14,184	12,721	13,923	11,904	19,635	35,948	45,438	311,797
Average	46,656	42,369	37,617	14,523	15,282	12,988	12,672	12,359	10,995	15,422	35,084	45,132	301,097

Source: Tashkentshahargas

According to TC-4, hourly gas consumption peaked in 2014 on 13 February and reached a minimum on 14 July. Figure 6.1.2-5 represents the change in hourly gas consumption on those days.



Source: TC-4

Figure 6.1.2-5 Hourly gas supply to TC-4 on a typical day

From the perspective of changes during the day in winter, when consumption is higher, two peaks in consumption were recognized between 8 to 10 and 18 to 22, but the shape of the peak is gentle and changes throughout the day are small. However, since gas consumption is relatively low in the early morning, when the ambient temperature is lowest, it is considered that any gas supply restriction should be imposed at this time of day, when the highest gas supply is required. In summer, the gas supply is relatively high in the afternoon but changes throughout the day are small.

At TC-4 there are occasions where fuel oil is used as a spare fuel, though it is very rare. Table 6.1.2-6 shows the monthly fuel oil consumption in winter at TC-4 for the past four years.

Table 6.1.2-6 Monthly fuel oil consumption at TC-4

(tons)

	2011	2012	2013	2014
January	-	-	-	
February	99.32	389.40	-	440.00
March	318.01	-	-	-
April	-	-	-	-
Total	417.33	389.40	-	440.00

Source: TC-4

When the share of fuel oil is compared with natural gas in terms of calories, it is as little as 0.3% in February 2012 and 1% in other months when fuel oil was used. Accordingly, the gas shortage to date is considered minimal. However, fuel oil consumption will increase if the gas supply and demand situation becomes tighter in future. Assuming that fuel oil covers 10 percent of the fuel required for heat supply, fuel oil consumption of one percent in terms of calories is equivalent to combined combustion for 72 hours per month (30 days times 24 hours times 1% divided by 10%).

TC-4 receives gas from Tashkentshahargas based on Purchase Contract No. 10002, which TashTeploCentral concluded in 2012. The amount of gas to be purchased every month for the forthcoming year is determined every year. TC-4 also includes a mechanism via which TC-4 can receive gas beyond the upper limit stipulated in the contract by issuing a “Notification letter” in preparation for the requirement of rising supply temperature of heated water on consecutive extremely cold days. However, this mechanism has not been used to date, because an extra payment is required if gas is consumed beyond the upper limit under this mechanism.

Table 6.1.2-7 represents the major contents of Purchase Contract No. 10002. The following are particularly relevant items to note:

- ✓ The supplier supplies natural gas, provided that the consumer installs a gas flowmeter at his/her expense.
- ✓ The contract prescribes the gas supply for each year, quarter and month.
- ✓ The consumer can change the gas quantity for the forthcoming month. Such change is accepted subject to an advance payment of 15 percent of the monthly supplied gas in case of government investment entities[9] (30 percent in case of other entities, organizations).
- ✓ The standard condition is 20 degrees C and 760 mmHg.
- ✓ The supplier supplies gas with a uniform daily breakdown of monthly amount prescribed on the contract.
- ✓ The consumer submits the application form describing the planned gas consumption for the forthcoming year by 15 July of the previous year.
- ✓ In case of a gas shortage and an operational accident affecting the gas supply infrastructure, the supplier shall impose supply restrictions under predetermined procedures. If this applies, the consumer is to use standby fuel (fuel oil in case of TC-4).
- ✓ In case the consumer consumes more gas than prescribed in the contract without previous agreement, the supplies shall collect twice as much charge for the entire supplied amount, including any excess.

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[9] GOSCOMIMUSHESTOVO (national investment organization) owns 99% of TashteploCentral’s capital.

Table 6.1.2-7 Major contents of natural gas Purchase Contract No. 10002

Clause	Items	Major contents
-	Parties to the contract	Consumer: TashteploCentral Supplier: Tashkentshahagas
I.	Object of the contract	✓ The supplier assumes liability on gas supply to the consumer according to the application agreed. ✓ The supplier supplies natural gas, provided that the consumer installs a gas flowmeter at his/her expense. ✓ The contract prescribes the gas supply for one year, quarter and month. ✓ If the consumer wishes to change the amounts of gas for the forthcoming month, the consumer must inform the supplier no later than 10 days prior to the change. Such change is accepted subject to an advance payment of 15 percent of the monthly supplied gas in case of the government investment entities (30 percent in case of other entities and organizations).
II.	Obligations and rights of the parties	✓ The amount of delivered gas is calculated under standard conditions, i.e. 20 degrees C and 760 mmHg. ✓ The supplier supplies gas with a uniform daily breakdown of the monthly amount prescribed on Clause I of the contract. ✓ The consumer is obliged to maintain gas-consuming equipment, gas receiving facility and gas flowmeter under normal conditions and is responsible for ensuring the accuracy of the flowmeter is in accordance with the national standard by calibrating periodically. ✓ In case of inaccuracy, failure and expiration of the national inspection certificate of flowmeter, calculation of delivered gas is made assuming that gas is supplied at the maximum rated flow of gas-consuming equipment for 24 hours per day. ✓ Once the settlement month for the calculation has elapsed, the consumer shall submit the measured data and calibration data of the gas flowmeter to the supplier. ✓ The consumer shall input the correction data based on gas properties into the flowmeter every month. ✓ The requirement for the gas flowmeter --- omitted. ✓ The supplier has the right to access the consumer’s gas-consuming equipment, gas receiving facility and gas flowmeter at any time. ✓ If installing additional gas-consuming equipment, improving existing gas-consuming equipment or repairing the equipment, the Consumer shall receive technical specification on such installations, improvements, etc. from the supplier, if the above-stated work

Clause	Items	Major contents
		involves any change in gas consumption. The consumer shall also submit permission issued by the natural inspection organization (the state inspectorate for safety), whereupon the contract shall be revised. ✓ In case of gas shortage in winter, the supplier shall not guarantee a stable gas supply to consumers except those listed by the Tashkent municipal office or in the resolutions of the Cabinet of Ministers.
III.	Price of natural gas and procedure of payment	✓ Payments are performed via the following procedure: 1) The Consumer is to make an advance payment of 15 percent of the monthly amount of gas prescribed in the contract, no later than five days prior to the beginning of the settlement month 2) The amount of delivered gas in the settlement month is fixed based on the gas flowmeter reading and proved by the supply receipt certificate between the consumer and supplier. The payment shall be completed by the 10th of the following month by bank transfer. 3) In case the above payment is not made, the supplier requests payment through the supplier's bank with a deduction of the advance payment amount. 4) In case of any failure of the required payment within three banking days due to the consumer's fault, gas supply to the consumer is stopped. 5) In case of a consumer registered in the resolution of the Cabinet of Ministers, payment is to be completed within 30 days of the settlement month having elapsed. 6) In case of failure of required payment specified in Clause 3) above within three banking days, the supplier delivers the minimum amount of gas required to secure facilities and safety of life. A complete stoppage is subject to a court decision. 7) In case of a government-financed organization, payment is made according to Clause 5) above. In case of failure of required payment within three banking days, the suppliers stop gas supply to the consumer, except for hospitals and schools. ✓ The price of natural gas is determined by the Ministry of Finance based on existing law.
IV.	Procedure for purchase of natural gas	✓ The consumer submits an application describing the planned gas consumption for the forthcoming year by 15 July of the current year.

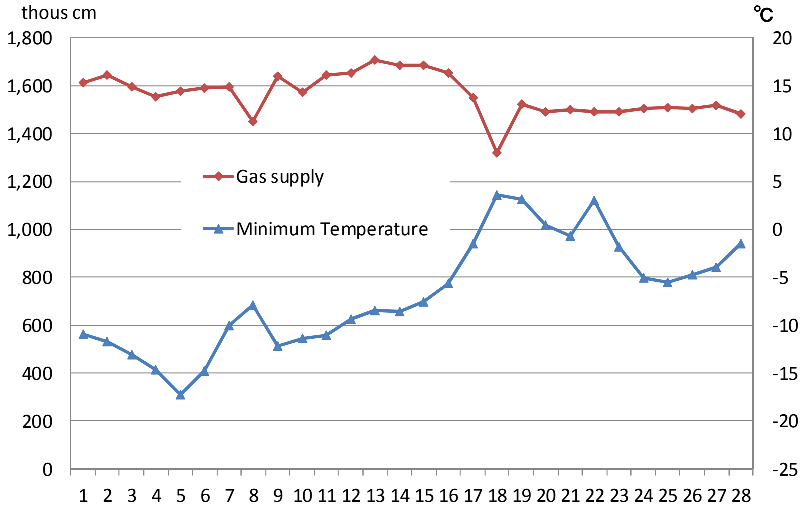
Clause	Items	Major contents
		✓ The amount of gas specified on the application may be changed until 1 September. ✓ The consumer has the right to withdraw an application or change the duration of an application. The consumer shall inform the supplier of any such change no later than 10 days prior to the settlement month. ✓ If there is any change in the gas supply conditions, the supplier shall inform the consumer by phone. ✓ If the supplier imposes any restrictions on gas supply, the supplier shall notify the consumer in writing no later than six hours prior to the restriction, except where emergency circumstances affect the gas supply network. In case of emergencies, the supplier shall impose a restriction of gas supply immediately after notification. ✓ In winter and in case of any interference with the operation of the gas supply network, the supplier shall impose restrictions on gas supply through an established procedure. The consumer uses standby fuel.
V.	Procedure for gas supply suspension and shutdown of gas connection	✓ The supplier shall stop gas supply to the consumer under the following circumstances: ✓ The consumer consumes more gas than prescribed in the contract ✓ The supplier must prevent failure in gas supply to the population and socially significant consumers ✓ The consumer connects additional gas-consuming equipment to the gas supply network without permission ✓ In the event of unpaid receivables ✓ In the event of significant violation of gas usage rules ✓ In the event of nonfulfillment of advance payments ✓ Shutdown from the gas supply network and reconnection is implemented at the supplier's cost ✓ In case of gas supply to consumers registered in the resolution of the Cabinet of Ministers, the supplier delivers the minimum amount of gas required to secure facilities and safety of life. A complete stoppage is subject to a court decision.
VI.	Physical liability of the parties	✓ The supplier shall compensate to the consumer, in accordance with established procedure, for any practical damage and lost profit due to failure to deliver or delivery shortage except in the event of any violation as specified in Chapter V above. ✓ If any unauthorized connection to the gas supply network or dishonest manipulation of the gas flowmeter for the purpose of altering the flowmeter indication is detected, an administrative liability is imposed

Clause	Items	Major contents
		on the customer. In case of repeated violations within a year, criminal liability is imposed. ✓ In case of a gas supply less than prescribed in the contract, a supplier penalty is imposed except in the following cases: ✓ Emergency situation or inevitability ✓ Emergency situation of trunk pipeline and regional supply network ✓ Contractual violation on the operation of the consumer's gas-consuming equipment ✓ In case the quality of delivered gas does not meet contractual requirements, the consumer has a right to refuse the receipt of gas and payment as well as claiming a penalty payment equivalent to 20 percent of the amount of defective gas against the supplier. ✓ In case the consumer uses more gas than prescribed in the contract without prior agreement, the supplier levies twice the price for the delivered gas, including excess, upon the consumer. ✓ In case of dishonest manipulation the supplier levies twice the price of the amount of gas used by the customer uses since the most recent visit of the supplier to the consumer.
VII.	Procedure for the dispute resolution	Omitted
VIII.	Force majeure circumstances	✓ In case of natural disasters, incidental accidents affecting the trunk gas pipeline and regional gas supply network, the parties have the right to stop supplying or receiving gas or reducing of receipt of gas. ✓ If force majeure circumstances apply, the parties shall inform each other via all possible means of communication.
IX.	Validity	✓ For state-financed organizations, the contract becomes effective from the date of registration by the Department of Treasury. ✓ The contract is valid for five years. The contract shall be extended for a further year unless any of the parties request cancelation or revision of the contract after expiration. ✓ For state-financed organizations, the contract is constituted every year. The contract is extended for a further one year unless cancelation of revision is made after expiration.
X.	Final provisions	Omitted
XI.	Bank details and addresses of the parties	In addition to information on bank details and addresses of the parties, space is provided for juridical counsellor to describe conclusions

Source: The agreement on supply of the natural gas No. 10002 dated January 2, 2012

Since the gas supply is determined considering the balance with gas resources by the Ministry of Economy, this purchase contract is drafted assuming that gas supply does not exceed a certain amount, even if there is an increase in gas demand. Therefore gas is supplied to the supplier with a uniform daily breakdown of the monthly supply prescribed in the contract. In addition, restrictions on gas supply and the usage of standby fuel in winter are prescribed in the contact.

Figure 6.1.2-6 represents the gas supply to TC-4 per day and the minimum ambient temperature in February 2014. This month was the coldest in terms of ambient temperature through recent years. Though gas consumption should be higher on a day when the minimum temperature is relatively low, there is no clear correlation between gas supply and the minimum temperature in reality. In particular, as the amount of gas consumed by consumers other than TC-4 increases on colder days, it is evident TC-4 suffers a certain supply restriction affected by such increase. The usage of fuel oil in this month as shown in Table 6.1.2-6 is evidence of the same.



Source: Prepared by JICA study team based on Tashkentshahargas's data, etc.

Figure 6.1.2-6 Daily gas supply to TC-4 and the minimum temperature (February 2014)

(4) Outlook for gas supply

As mentioned above, TC-4, which engages in a heat supply business closely related to the lives of residents, has suffered restrictions of gas supply. If gas production increases slowly and gas consumption increases considerably at the same time, the supply and demand situation will become increasingly tight.

A shortage in gas supply is likely to occur in case of insufficient transportation capacity, even if gas production increases satisfactorily. The Uzbekneftegas staff concerned do not accept any restriction on gas supply taking place in winter, although they accept gas supply shortages a few times each winter due to accidents affecting the gas transportation system, such as failure of gas compressor facilities and an instantaneous increase in gas consumption. It is unclear which factor, the amount of gas production or transportation capacity, leads to short-term gas shortages in winter, owing to the barrier in obtaining confidential information. However, any supply shortage, even in the short term, means that supply and demand are already tight. As mentioned above, terms such as "gas shortage", “supply restriction” and “standby fuel” are prescribed in the purchase contract as evidence of supply shortages. Under the circumstances, it is difficult to obtain conclusive evidence of any bright outlook for gas supply.

Accordingly, it is desirable to implement all possible measures to relieve the tight supply and demand situation by controlling any increase in domestic demand for natural gas by conserving energy and developing and encouraging the utilization of alternative energy as well as striving to increase production by exploring and developing gas resources. In addition, it should be noted that enhancement of gas transportation and gas supply infrastructure are also crucial.

6.2 Outlook for Gas Supply for the Project

As mentioned above, it is considered that gas production will not end before 2050s or in the first half of the 2060s when TashTETs-2 is expected to complete its service life from the perspective of gas reserves. From the perspective of a stable gas supply, however, it remains unclear whether or not the trunk pipelines of Uztransgas have sufficient transportation capacity, though the capacity is considered to suffice on average through the year. At TC-4 there are months in winter when standby fuel is used to counter gas supply shortages. This is an issue also likely to occur when the gas booster facilities of TashTET-2 are connected to the existing gas supply infrastructure operated by Tashkentshahargas.

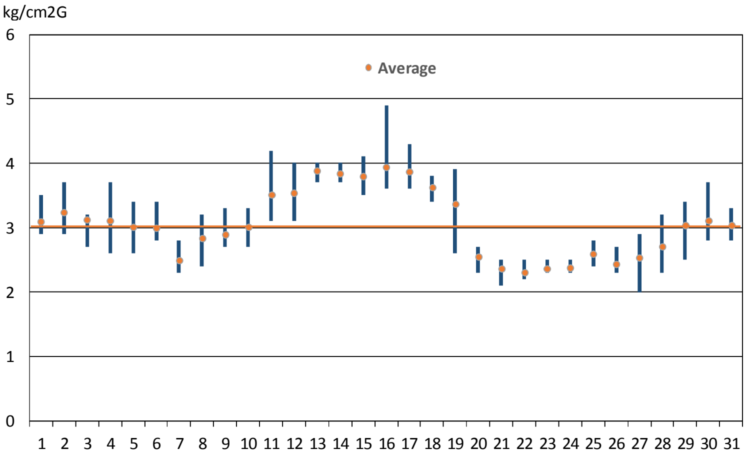
Conversely, there are circumstances where the incoming gas pressure at the existing TC-4 facilities drop below 3 kg/cm^{2}G, which is the allowable minimum pressure at interface (inlet of gas booster facilities) of TashTET-2, in winter and any decrease in incoming gas pressure is a similar or more important problem than that of gas supply shortage. Gas supply issues were approached from the perspective of any decrease in incoming gas pressure as the initial priority.

6.2.1 Supply Pressure of Natural Gas

The basic fuel system design for TashTETs-2 has been implemented, assuming a minimum pressure at the facility interface of 3 kg/cm^{2}G. As mentioned above, however, it was envisaged that it would be impossible to secure this pressure if the facility were connected to the existing gas supply infrastructure of Tashkentshahargas. Accordingly, an analysis was undertaken by obtaining operation data sheets on the gas distribution station and heat (and power) supply stations for January in 2012 to 2014 from Tashkentshahargas. On these data sheets, gas pressure, gas flow, etc. are specified with a timespan of around every two hours from 7 p.m. to 2 a.m. The daily maximum, minimum and average pressures were organized based on these data.

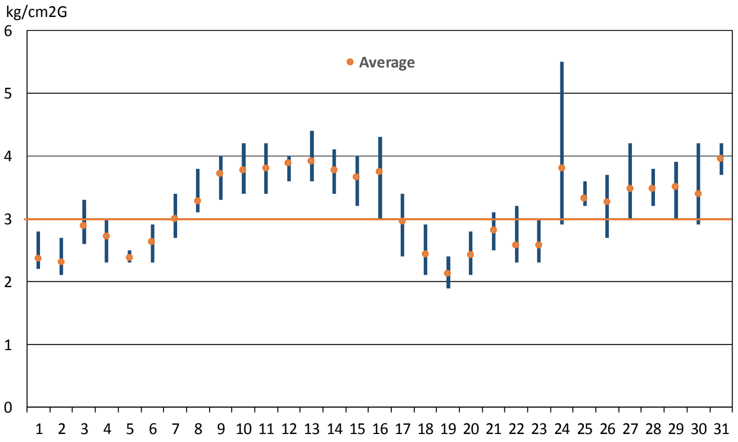
(1) Incoming pressure at TC-4

Figures 6.2.1-1 to 6.2.1-3 represent the daily changes in maximum, minimum and average figures in terms of incoming pressure at the existing TC-4 facility.



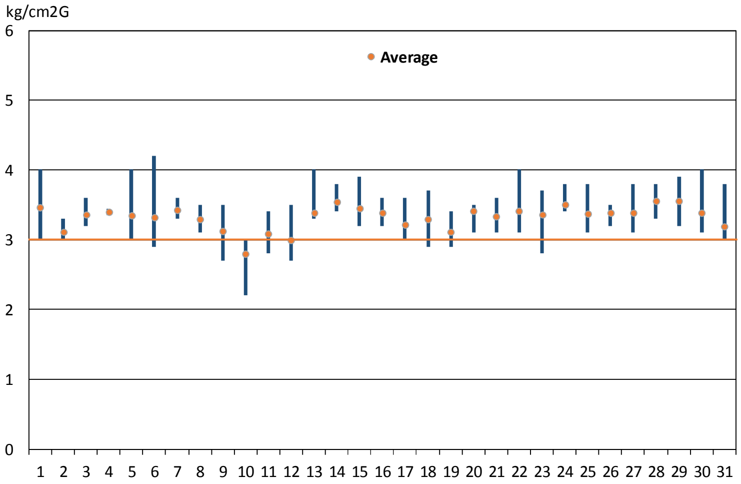
Source: Tashkentshahargas

Figure 6.2.1-1 Incoming gas pressure at TC-4 (January 2012)



Source: Tashkentshahargas

Figure 6.2.1-2 Incoming gas pressure at TC-4 (January 2013)

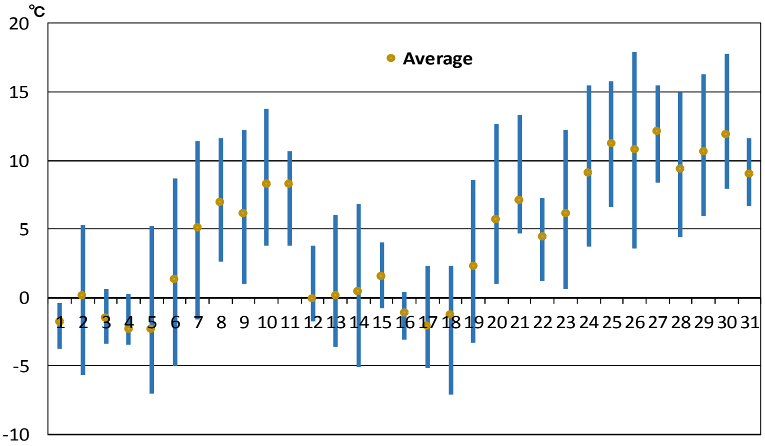


Source: Tashkentshahargas

Figure 6.2.1-3 Incoming gas pressure at TC-4 (January 2014)

According to these figures, the number of days when the minimum incoming pressure drops below 3 kg/cm^{2}G was 22 in January 2012, 17 in January 2013 and 8 in January 2014. Namely, the number of days when the minimum incoming pressure drops below 3 kg/cm^{2}G accounts for an average of half the month for three years. In addition, the number of days when even the maximum incoming pressure is below 3 kg/cm^{2}G was nine in January 2012 and 7 in January 2013.

As shown by these figures, the incoming gas pressure at TC-4 varies daily, with periodic changes. Figure 3.2.2-4 represents changes in ambient temperature in Tashkent city in January 2013. When compared with Figure 6.2.1-2, it is clear that trends of increase and decrease, particularly the period of change, coincide.



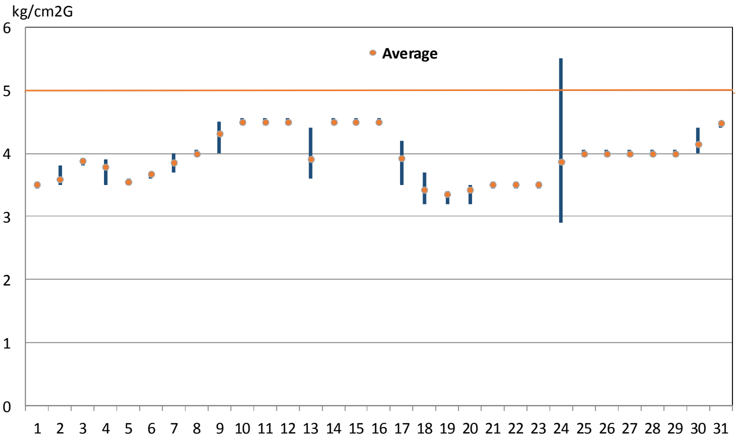
Source: http://www.pogodaiklimat.ru/monitor.phd?id=38457&month=1&year

Figure 6.2.1-4 Change in ambient temperature in Tashkent city (January 2013)

(2) Outgoing and incoming gas pressures at the Vostochnaya-2 gas distribution station

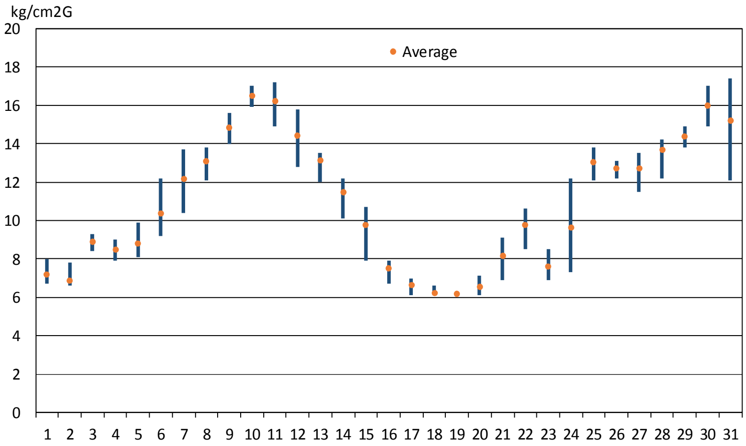
Figures 6.2.1-5 and 6.2.1-6 represent outgoing and incoming gas pressures at the Vostochnaya-2 gas distribution station in January 2013. Tashkentshahargas required an outgoing gas pressure of 5 kg/cm^{2}G, i.e. the gas pressure at which gas is delivered to the gas supply pipeline of Tashkentshahargas at the Vostochnaya-2 gas distribution station to secure above 3 kg/ cm^{2}G as incoming gas pressure at TashTETs-2 (refer to the technical specification shown in Table 6.2.3-1).

According to Figure 6.2.1-5, however, it is clear that even the maximum gas pressure was below 5 kg/cm^{2}G except for 24 January, when it is considered that an uncertain accident affected the gas supply infrastructure. Conversely, when reviewing Figure 6.2.1-6, the incoming gas pressure at the Vostochnaya-2 gas distribution station exceeded 10 kg/cm^{2}G during the period 10 to 12 January, when the outgoing gas pressure remained at 4.5 kg/cm^{2}G throughout the day as shown in Figure 6.2.1-5 and it is considered feasible to increase outgoing gas pressure up to 5 kg/cm^{2}G with such significant differences in pressure (according to Uztransgas pressure losses at the gas distribution station are around 2 to 2.5 kg/cm^2) . It is presumed that the outgoing gas pressure is maintained at 4.5 kg/cm^{2}G because any increase in outgoing gas pressure up to 5 kg/ cm^{2}G leads to an excess gas supply to Tashkentshahargas beyond predetermined amount. Thus, it is understood as impossible to achieve an outgoing gas pressure of 5 kg/ cm^{2}G at the Vostochnaya-2 gas distribution station, if the gas to TashTETs-2 is supplied via the existing gas supply infrastructure of Tashkentshahargas.



Source: Tashkentshahargas

Figure 6.2.1-5 Outgoing gas pressure at the Vostochnaya-2 gas distribution station (January 2013)



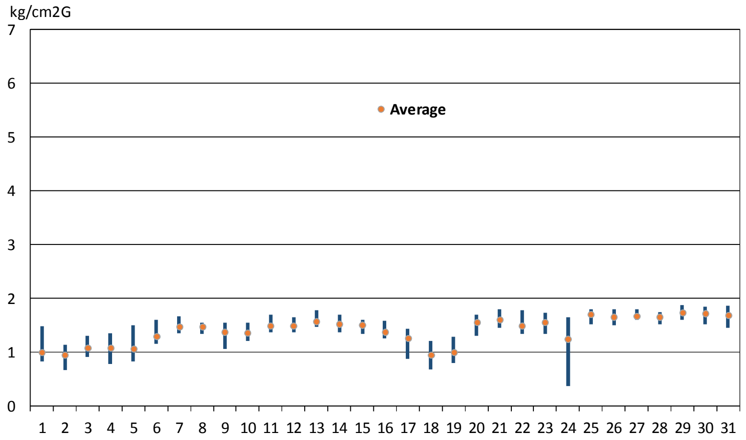
Source: Tashkentshahargas

Figure 6 .2.1-6 Incoming gas pressure at the Vostochnaya-2 gas distribution station (January 2013)

(3) Incoming gas pressure at TashTETs

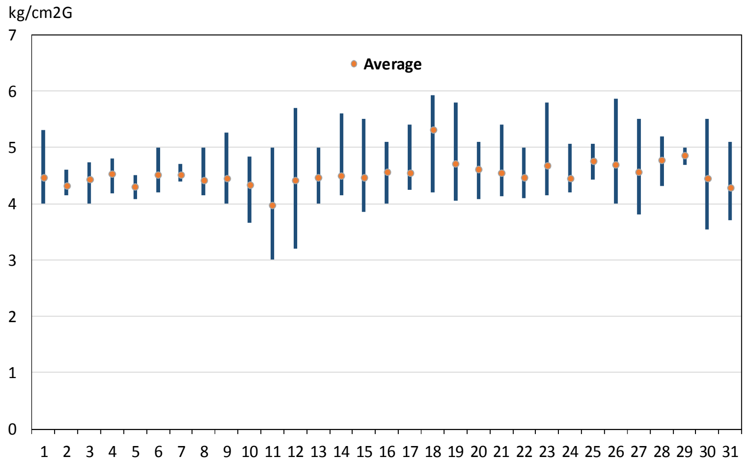
Figures 6.2.1-7 and 6.2.1-8 represent the incoming gas pressure at TashTETs where the gas turbine cogeneration facilities were built as a model project by NEDO before installing a new gas distribution station and an exclusive supply pipeline (January 2013) and after (January 2014) .

It is reported that demonstration operation inevitably involved reduced power for more than 85 percent of all running hours, though a base load operation was originally planned for the period of demonstration operation of the facilities which started in Autumn 2013. This was due to a reduction in incoming gas pressure and a shortage of gas supply as well as frequent blockages of the fuel filter due to insufficient removal of foreign objects in gas (presumably due to rust, etc. inside the pipeline). Subsequently, as mentioned above, the Binokor gas distribution station (GDS) and exclusive supply pipeline were built.



Source: Tashkentshahargas

Figure 6.2.1-7 Incoming gas pressure at TashTETs before building the Binokor GDS, etc. (January 2013)



Source: Tashkentshahargas

Figure 6.2.1-8 Incoming gas pressure at TashTETs after building the Binokor GDS, etc. (January 2014)

As shown by these figures, the incoming gas pressure in winter was usually below 3kg/cm^{2}G before building the Binokor GDS and an exclusive supply pipeline but an incoming gas pressure of 3kg/cm^{2}G was constantly secured after building. It is clear that the fact as above should provide an effective reference when investigating the gas supply system for TashTETs-2.

6.2.2 Transportation Capacity of the Trunk Gas Pipeline to Tashkent City

According to Uzbekneftegas, the annual volume of gas transported through three trunk pipelines of Uztransgas was 17.3 billion cubic meters (bcm) in 2014 and the transportation capacity was 29 bcm as mentioned above. However, given the significant differences between winter and summer seasons in terms of transported volume, it is necessary to clarify whether or not the actual transported volume in winter still includes a margin for further transportation compared with the transportation capacity. Since data on monthly transported volume have not been available, a simple trial calculation was made using data on monthly gas supply in 2014 provided by Tashkentshahargas (equivalent to the volume of transported gas by Uztransgas). Namely, the monthly transported volume by Uztransgas and the volume converted into a yearly basis were calculated assuming that the monthly deviation pattern of gas supply by Tashkentshahargas was equal to that of transported volume by Uztransgas. The calculation results are shown in Table 6.2.2-1.

Table 6.2.2-1 Assumption of transported volume of three trunk pipelines of Uztransgas

(million m^3)

	Gas supply by Tashkentshahargas	Transported volume of three trunk pipelines	Transported volume converted into an annual figure
January	623.93	2,585.3	30,440
February	613.45	2,541.9	33,136
March	498.31	2,064.8	24,311
April	263.95	1,093.7	12,877
May	171.61	711.1	8,372
June	152.87	633.4	7,707
July	145.28	602.0	7,088
August	146.44	606.8	7,144
September	152.08	630.1	7,667
October	275.27	1,140.6	13,430
November	511.10	2,117.8	25,767
December	620.82	2,572.4	30,288

Source: Prepared by the JICA Study Team based on Tashkentshahargas's data

As shown by Table 6.2.2-1, the transported volumes converted into an annual figure in January, February and December end up exceeding the transportation capacity of 29 bcm. As the monthly deviation pattern between gas supply by Tashkentshahargas and the transported volume by Uztransgas is not considered the same, the above result does not necessarily trigger actual restrictions on transportation capacity, but it can be remarked that this would be cause for concern from the perspective of stable gas supply.

When investigating the transportation capacity of gas, the transportation pressure has a key influence. If the transportation pressure of gas doubles, for instance, the transportation capacity follows suit. Since there are some restrictions on the pressure resistance of pipeline and the capacity of gas compressor facilities installed in-between pipelines, it is impossible to increase the pressure beyond the rated level, whereupon the transportation capacity is automatically determined.

Conversely, when the transported volume of gas increases, the gas flow velocity in the pipeline would increase and likewise the pressure losses in the pipeline (the losses increase in proportion to the density of gas and the square of the flow velocity approximately). As the gas pressure in the pipeline drops with increasing pressure losses, the velocity of gas flow increases due to an increase in specific volume without any change in gas flow (in weight), resulting in a vicious spiral, where increased pressure losses trigger a further decrease in transportation pressure (though the degree of pressure loss is mitigated through reduced gas density due to pressure drop). Slight differences in the volume of transported gas between colder and warmer days are considered amplified through the above vicious spiral when gas is transported for long distances and lead to significant differences in incoming pressure from one day to the next. However, since the volume of gas supplied to Tashkent city is part of the total volume transported (as mentioned above, the annual gas supply to Tashkent city in 2014 was 4.18 bcm while the volume of gas annually transported through trunk pipelines was 17.3 bcm), it would be impossible to quantitatively prove such differences in incoming pressure solely with the data on gas supply to Tashkent city.

According to Tashkentshahargas, total gas supply through the four gas distribution stations shown in Table 6.1.2-1 was 23.06 million cubic meters (mcm) per day on 13 February, 2014 when gas consumption at TC-4 peaked for the year, equivalent to 0.96 mcm per hour. As shown in Table 6.1.2-1, since the total supply capacity of these four gas distribution stations is about 1.94 mcm, the above-mentioned gas supply comprises about 50 percent of total gas supply capacity. Thus, as far as the gas supply capacity of the gas distribution stations is concerned, there is sufficient room for increased demand in future.

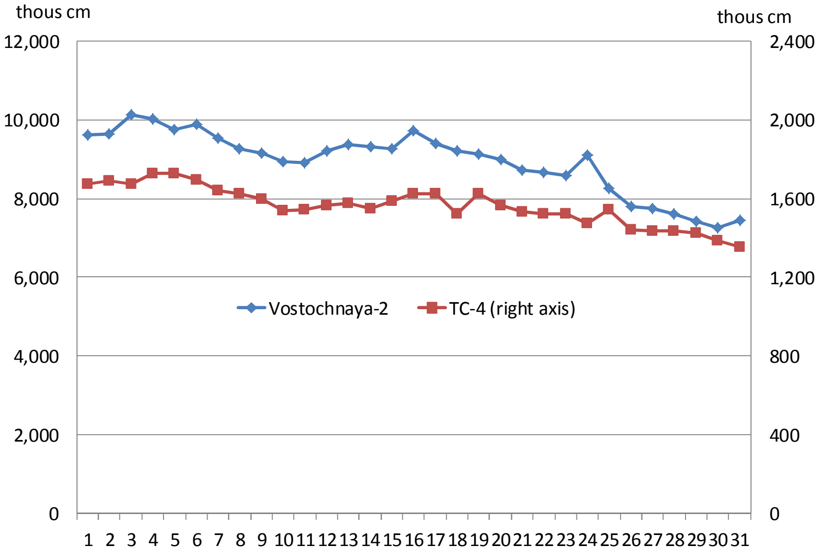
6.2.3 Outlook for Gas Supply to TashTETs-2

(1) Outlook for gas supply and proposal for stable gas supply

Consideration was made concerning the outlook for gas supply to TashTETs-2 that will be operated until around 2060s in the longest case, based on the above-mentioned analysis and examination as well as the proposal for stable gas supply.

Firstly, as specified in Section 6.1.1, it is considered that there would be no problem until the operation period of TashTETs-2 terminates as far as gas reserves are concerned. However, as specified in Section 6.1.2, from the perspective of gas supply to Tashkent city, since current circumstances dictate the usage of fuel oil as standby fuel owing to gas supply shortages in winter at TC-4, although in small quantities, the problem of stable gas supply would arise if gas were delivered through the existing gas supply infrastructure of Tashkentshahargas.

Figure 6.2.3-1 represents the transit gas flow through the Vostochnaya-2 gas distribution station and the gas supply to TC-4. As shown by Figure 6.2.3-1, both amounts of gas change with almost equivalent tendency. This means that the gas supply to TC-4 would be approximately proportional to the transit gas flow through the Vostochnaya-2 gas distribution station. Accordingly, when transit gas flow decreases, it is virtually impossible to increase the gas supply to TC-4, irrespective of such decrease.



Source: Tashkentshahargas

Figure 6.2.3-1 Transit gas flow at the Vostochnaya-2 GDS and gas supply to TC-4 (January 2013)

Under the current circumstances on incoming gas pressure at TC-4, the key issue is an inability to keep the incoming gas pressure above 3 kg/cm^{2}G at TashTETs-2 in case gas is delivered through the existing gas supply infrastructure of Tashkentshahargas. In addition, a more serious existing problem is the inability to maintain incoming gas pressure above 3 kg/cm^{2}G at TashTETs-2, due to a drop in outgoing gas pressure at the Vostochnaya-2 gas distribution station.

Conversely, incoming gas pressure at the Vostochnaya-2 gas distribution station is constantly above 5 kg/cm^{2}G. It is inevitable to transport gas so that the incoming gas pressure might drop as low as possible to keep the constantly incoming gas pressure above 3 kg/cm^{2}G at TashTETs-2. For that purpose, a branch point for gas supply to TashTETs-2 must be located at the receiving side of gas from Uztransgas's pipeline, namely, the most practical and effective solution is to construct a gas distribution point[10] upstream of the built-in equipment such as a pressure regulating valve and flowmeter composing gas distribution station and install an exclusive supply pipeline starting from the gas distribution point to connect directly to gas booster facilities at TashTETs-2. The validity of this solution has been already proved through operational experiences at TashTETs, for which the Binokor gas distribution station and exclusive supply pipeline were installed.

In case this measure is adopted, installation of a gas supply system for TashTETs-2 is no longer in the hands of Tashkentshahargas and it is presumed that Uztransgas will undertake the construction of the gas distribution point and install an exclusive supply pipeline through the Cabinet of Ministers' Decree or Presidential Decree. Namely, Uztransgas is expected to undertake all the construction work, including the pipeline connection to TahTETs-2 at its interface. However it is

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[10] Gas distribution point refers to a smaller-scale gas distribution station in Uzbekistan

Tashkentshahargas that carries out the actual gas supply and also oversees the maintenance work. This is completely identical with the case of TashTETs.

According to Tashkentshahargas, a new exclusive pipeline is likely to be installed along the existing main gas supply pipeline 1220 mm in diameter and now operated by Tashkentshahargas. In reality, the route of the new gas pipeline shall be determined by the relevant design organization and the Main Department of Architecture and Construction of Tashkent city, after the Technical Specifications have been issued by Uztransgas or Tashkentshahargas. The cost of constructing the new gas pipeline shall also be calculated by the relevant design organization. The period for constructing the new gas pipeline shall be determined by the Cabinet of Ministers' Decree or Presidential Decree.

The distance from TashTETs-2 to the Vostochnaya-2 gas distribution station is about 10 km. If the exclusive gas pipeline is installed with the same diameter of 530 mm as that of the existing supply pipeline for TC-4, the cost of the linear pipe per meter with diameter of 530 mm and thickness of 8 mm is 556.2 thousand sums and the cost per km of installing the underground pipeline is 1,250 million sums. In addition, the cost of constructing a gas distribution point with capacity of 50,000 m^3/h is 4 billion sums. Accordingly, the total construction cost is estimated at about 22 billion sums. Though the organization that bears construction cost shall be determined by the Cabinet of Ministers' Decree or Presidential Decree, it is likely to be Uzbekenergo JSC.

The above-mentioned technical specification is issued by a supplier like Tashkentshahargas, after an application has been submitted by a consumer to receive gas from a supplier and an attached document describing the location of the gas-consuming equipment, leading particulars of the equipment, planned gas consumption, etc. has been submitted. The specification ranks as basic material for starting facility design work. Table 6.2.3-1 represents a sample of the technical specification prepared for the pre-feasibility study. On this specification, a branch point for the gas supply to cogeneration facilities to be provided inside the site, provided that an outgoing gas pressure of 5 kg/cm^2G is secured at gas distribution stations. However, as mentioned above, it is clear that this condition setting is unrealistic.

At moment, the Vostochnaya-2 gas distribution station is basically not in service in summer and gas is supplied through another gas distribution station. However, according to Tashkentshahargas, the Vostochnaya-2 gas distribution station is under standby condition in case of any accident affecting the gas distribution station in service, it is also to be operated in summer following the installation of the exclusive pipeline.

Table 6.2.3-1 Sample of technical specification

Tashkentshahargas

23 July 2013

The Technical Specification No. 29458

Additional gas-using facilities at TC-4 located at 6, Yunusabahd

1. Connection is possible from the existing underground high pressure gas pipeline at TC-4 site to the high pressure distribution point
2. Connection point : Site of cogeneration facilities
3. Diameter of gas pipeline: 530 mm
4. Pressure at connection point: 3.0－3.2 kg/cm^2 (Outgoing gas pressure at each of Uztransgas's gas distribution stations, «Yugo-Zapadneya», «Vostochnaya-2», «Bektemir» in winter season should be more than 5.0 kg/cm^2G)
5. Calorific value of gas: 8,200 $kcal/m^3$
6. Specific weight of gas is 0.7 kg/cm^3 at 20 degree C and 760 mmHg
7. Composition of gas：Methane CH_4、Ethane C_2H_6、Propane C_3H_8、Carbon monooxide CO、Hydrogen H_2 and residue：Nitrogen N_2、Carbon dioxide CO_2, etc.
8. Gas flow－34,300 Nm^3/h (Annual gas flow is 296.35 million m^3）
9. Equipment installed：4 gas turbines of ”Hitachi, H-25/H-15, Japan“
10. The project is to be implemented subject to an examination and approval by the State inspection organizations »Sanoatgeokontexnazorat», «Uzdavneftgazinspeksii».
11. The specification is valid for two years from the date of the issuance.
12. Design and estimate documents are to be submitted to Tashkentshahargas for approval
13. Note
    - a) Modern electronic measurement system is to be equipped for measuring gas flow, etc.

Chief engineer Signed Zufarov M.M.

Engineer Signed Tojiev Sh. T

Stamp 「TOSHKENTSHSHARGAS」

Source: Tashkentshahargas

In case an exclusive gas supply pipeline system is adopted, it is considered possible to secure an incoming gas pressure of 3 kg/cm^2G at TashTETs-2 for the time being because securing incoming gas pressure of 5 kg/cm^2G at the Vostochnaya-2 gas distribution station would be achievable as any growth in gas demand in total Tashkent city is likely to be mild. Though it is necessary to examine the feasibility of securing an incoming gas pressure of 5 kg/cm^2G in the event of a sharp increase in gas demand in future, it is inevitable to analyze the present situation on transportation capacity by obtaining data on the monthly transported gas volume through the trunk gas pipeline of Uztransgas at least for the examination. Through analyzing the present situation, it is possible to estimate that securing incoming gas pressure of 5 kg/cm^{2}G may be difficult, based on the extent to which gas demand increases in future.

It is obvious that there would be some risk concerning stable gas supply to TashTETs-2 through the analysis mentioned above, hence guarantees of stable gas supply should be provided by the Republic of Uzbekistan. However, it should be noted that such guarantees will become useless if the transported gas volume increases to the extent where securing incoming gas pressure of 5 kg/cm^{2}G at the Vostochnaya-2 is impossible due to increased pressure losses in the trunk pipelines under the worst case scenario. If the gas supply to Tashkent city through Tashkentshahargas has to be decreased at the Vostochnaya-2 gas distribution station, incoming gas pressure would increase physically owing to the reduction in flow velocity inside the trunk pipeline of Uztransgas. However this is a problem of selection and decision-making as to whether the to gas supply to TashTETs-2 or Tashkent city is prioritized. There is a need to enhance the capacity of gas compression facilities integrated into the pipeline as well as increase gas production so that the gas supply to TashTETs-2 or Tashkent city may go together. In addition, there is also a need to control gas demand by actively promoting energy conservation. These are considerably big issues related to the production, transportation and distribution and supply and demand of gas for the entire Uzbekistan rather than stable gas supply to TashTETs-2 and thus not issues which can easily be solved.

As mentioned above, though it is an essential condition whereby a stable gas supply should be guaranteed by the Republic of Uzbekistan for TashTETs-2 to receive gas stably all the time, there is no sufficient background against which such guarantee is secured. Accordingly, though the cogeneration facilities at TashTETs-2 are designed to accommodate more than 3 kg/cm^{2}G in terms of incoming gas pressure, as much margin as possible must be provided concerning the minimum allowable gas pressure at the interface of the facilities to prepare for pressure decrease in future.

(2) Examination of an alternative plan

Finally, an alternative plan that has been investigated by the Uzbek side, in which gas is to be supplied at a pressure of 2 kg/cm^{2}G at the interface of the facilities at TashTETs-2 by providing a branch point on the gas supply service pipeline for TC-4 and installing a supply pipeline to TashTETs-2 from there was examined in terms of feasibility. However, the impact of pressure reduction at the interface from 3 to 2 kg/cm^{2}G on gas booster facilities was excluded from the subject of examination.

The concrete contents of the examination are as follows, namely for the Base case based on actual operational data on gas supply infrastructure of Tashkentshahargas.

- ✓ Gas flow on the existing service pipeline for TC-4 increases owing to the construction of TashTETs-2 and how incoming pressure would be decreased at the branch point provided on the service pipeline for TC-4 (referred to as Case 1)

- ✓ In addition to Case 1, when the gas flow on the main gas supply pipeline of Tashkentshahargas increases due to the increased gas demand of neighboring users, how incoming pressure would be decreased at the branch point provided on the service pipeline for TC-4 (referred to as Case 2)

In the Base case, it is desirable to use a series of data where the incoming gas pressure at TC-4 is 2 kg/cm^{2}G but there is no data with said pressure among the data of January 2012 to 2014. Therefore the data of 19 January, 2013 with pressure of 1.9 kg/cm^{2}G was referred as that for the base case. The related figures of said date except the above incoming pressure are as follows:

✓ Outgoing pressure at the Vostochnaya-2	3.2 kg/cm^{2}G
✓ Amount of gas supply through Vostochnaya-2	9.133 million m^3/day
✓ Amount of gas supply amount to TC-4	1.548 million m^3/d (48 million m^3/month)

In Case 1 gas supply through service pipeline (530 mm in diameter) from the branch point provided for gas supply to TC-4 on the main supply pipeline of Tashkentshahargas (referred to as branch point 1) to the branch point provided for that to TashTETs-2 at TC-4 (referred to as branch point 2) increases to 57 million m^3/m from 48 million m^3/m by constructing TashTETs-2. The amount of gas supply through the main supply pipeline (1,220 mm in diameter) between Vostochnaya-2 and branch point 1 (pipeline between Vostochnaya-2 and branch point 1 is referred to as Route 1 and the service pipeline between branch points 1 and 2 is referred to as Route 2) increases by the amount of difference between 48 million m^3/m and 57 million m^3/m). As the increase in gas flow in both routes leads to an increased flow velocity inside the pipe, the pressure losses increase due to an increase in pipe friction, whereupon the incoming pressure at branch points 1 and 2 decreases. The length between Vostochnaya-2 and TC-4 is about 10 km and it is assumed that the length between Vostochnaya-2 and branch point 1 comprises 80 % and that between branch points 1 and 2 comprises 20%. It is also assumed that the pressure drop inside the pipe is proportional to the above ratio of length.

In Case 2, despite no change in the flow amount in Route 2, it is assumed that the amount of flow increases by 10% from the gas supply of 9.133 million m^3/d. The incoming pressure at branch point 1 decreases due to the above-mentioned increase and incoming pressure at TC-4 (branch point 2) decreases even further.

The pressure loss inside the pipe (the differential pressure between the starting and terminal points – in Route 1 between Vostochnaya-2 and branch point 1) is approximately proportional to 'density x square of flow velocity'. As change in mean pipe pressure (average between outgoing and incoming pressures) trigger changes in the specific gas volume, even if the weight of gas flow is unchanged, the pipe velocity also changes. Accordingly, the value of 'density x square of flow velocity/differential pressure' is firstly calculated for Routes 1 and 2 in the Base case and this value is assumed to be constant regardless of any change in amount of gas flow. Next, the flow velocity is calculated assuming the mean pipe pressure whereupon differential pressure is calculated using the relation that 'density x square of flow velocity/differential pressure' is constant. Increased flow leads to an increase in differential pressure through these calculations. Consequently incoming pressure decreases, resulting in a decline in mean pipe pressure. An iterative calculation is carried out until decreased mean pipe pressure becomes identical to the assumed value. Table 6.2.3-2 represents the calculation result (final values only are shown both in Cases 1 and 2 by omitting the interim calculation).

Table 6.2.3-2 Calculation result of incoming pressure at TC-4

Items	Unit	Base case	Case1	Case 2
Outgoing pressure (Vostochnaya-2 － GDS)	kg/cm^{2}G	3.2	3.2	3.2
Incoming pressure (TC-4)	kg/cm^{2}G	1.9	1.73	1.37
Differential press(Vostochnaya-2－TC-4)	kg/cm^2	1.3	1.46	1.83
Ditto (Vostochnaya-2－branch point 1)	kg/cm^2	1.04	1.12	1.40
Incoming pressure (branch point 1)	kg/cm^{2}G	2.16	2.08	1.80
Mean pipe pressure (Vostochnaya-2－branch point 1)	kg/cm^{2}G	2.68	2.64	2.50
Amount of gas flow (20 degrees C, 760 mmHg)	thous m^3/d	9133		
Ditto (20 degrees C, 760 mmHg)	thous m^3/h	380.5	392.64	430.69
Ditto (20 degrees C,760 mmHg)	m^3/s	105.7	109.1	119.6
Density(20 degrees C, 760 mmHg)	kg/m^3	0.726	0.726	0.726
Ditto (20 degrees C, mean pipe pressure)	kg/m^3	2.672	2.643	2.541
Pipe diameter	mm	1220	1220	1220
Cross area of pipe	m^2	1.169	1.169	1.169
Velocity of flow (20 degrees C, mean pipe pressure)	m/s	24.57	25.63	29.79
Density x (flow velocity)^2 /differential press		580.57	1551.09	1551.09
Differential pressure (branch point 1－TC-4)	kg/cm^2	0.26	0.35	0.43
Mean pipe press (branch point 1－TC-4)	kg/cm^{2}G	2.03	1.908	1.548
Amount of gas flow (20 degrees C, 760 mmHg)	thous m^3/m	48000	57000	57000
Ditto (20 degrees C, 760 mmHg)	thous m^3/h	64.52	76.61	76.61
Ditto (20 degrees C,760 mmHg)	m^3/s	17.92	21.28	21.28
Density(20 degrees C, 760 mmHg)	kg/m^3	0.726	0.726	0.726
Ditto (20 degrees C, mean pipe pressure)	kg/m^3	2.20	2.111	1.876
Pipe diameter	mm	530	530	530
Cross area of pipe	m^2	0.221	0.221	0.221
Velocity of flow(20 degrees C, mean pipe pressure)	m/s	26.81	33.17	37.33
Density x (flow velocity)^2 /differential press		6080.93	6080.93	6080.93

Source: Prepared by the JICA Study Team based on Tashkentshahargas's data

According to Table 6.2.3-2 there are increases in differential pressure by 0.08 kg/cm^2 in Route 1 and by 0.09 kg/cm^2 in Route 2 in Case 1, which are equivalent to the decrease in incoming pressure at branch points 1 and 2 respectively. Consequently incoming pressure at TC-4 is to decrease to 1.74

kg/cm^{2}G. Accordingly, in this alternative plan it is impossible to achieve incoming pressure of 2 kg/cm^{2}G without ensuring the pressure of some 2.2 kg/cm^{2}G instead of 2 kg/cm^{2}G.

In Case 2, the increase in overall differential pressure comes to 0.53 kg/cm^2 (in Table 6.2.3-2, 1.9 minus 1.37 kg/cm^2) compared with 0.17 kg/cm^2 (ditto, 1.9 minus 1.73) in Case 1. Namely, if the incoming pressure at TC-4 is 2 kg/cm^{2}G, it would decrease to some 1.5 kg/cm^{2}G or lower in Case 2. It is necessary to maintain an incoming pressure exceeding 2.5 kg/cm^{2}G to ensure 2 kg/cm^{2}G. In Case 1 it is sufficient to maintain an incoming pressure of some 2.2 kg/cm^{2}G to ensure 2 kg/cm^{2}G. However, no one would be able to guarantee no increase in gas flow throughout Route 1 in future.

Furthermore, since an increased flow in Route 1 will lead to an increased flow in the trunk pipeline, there is a possibility of incoming and outgoing pressures decreasing at the Vostochnaya-2, whereupon the incoming pressure at TC-4 would drop even further.

As shown by the above examination, the alternative plan is not technically feasible taking increased gas demand into account in future.

(3) The settlement agreed through discussion with the Uzbek side

Originally, the Uzbek side requested a design change to the Japan side so that the inlet pressure at gas booster facilities at TashTETs-2 might be set at 2.0 kg/cm^{2}G, since it is extremely difficult to determine an installation route for the new gas supply pipeline and pressure losses and economic performance have been taken into consideration owing to the longer distance of the new pipeline.

However, the Japan side requested that the Uzbek side re-investigate whether 3.0 kg/cm^{2}G might be achievable at the inlet to the gas booster facilities because fears about stable gas supply cannot be eradicated, as mentioned in Clause 6.2.3 (2) when utilizing an existing gas supply pipeline. In conclusion, the Uzbek side proposed a plan in which installations of an exclusive gas supply pipeline and separate gas booster facilities in the vicinity of but outside the TashTETs-2 site are to be undertaken by the Uzbek side to ensure gas pressure of 3.0 kg/cm^{2}G in the distant future.

Receiving the proposal as above, the Japan side required the submission of a written guarantee, in which inlet gas pressure of 3.0 kg/cm^{2}G at the inlet of gas booster facilities should be ensured over 30 years for this project, by showing a credit guarantee issued at the time of implementing NEDO's model project as a previous instance, because the proposed countermeasure is a prerequisite for successful project implementation (as the project income and expenditure were estimated assuming base load operation the TashTETS-2 facilities in the feasibility study, repayment of yen loan would be affected if it were impossible to operate TashTETs-2 as planned due to fuel supply problem).

Finally, agreement was reached for the Uzbek side to commission a design institute to inspect whether it is feasible to ensure inlet pressure of 3.0 kg/cm^{2}G for 30 years through the countermeasure proposed by Uzbek side this time and a written guarantee concerning the inlet gas pressure is to be issued for the Japan side after getting conclusive evidence.

Chapter 8 Environmental and Social Considerations

Chapter 8 Environmental and Social Considerations

The environmental and social considerations under the project have been studied to confirm the project’s effectivity and validity with the following points illustrated in this chapter taken into consideration:

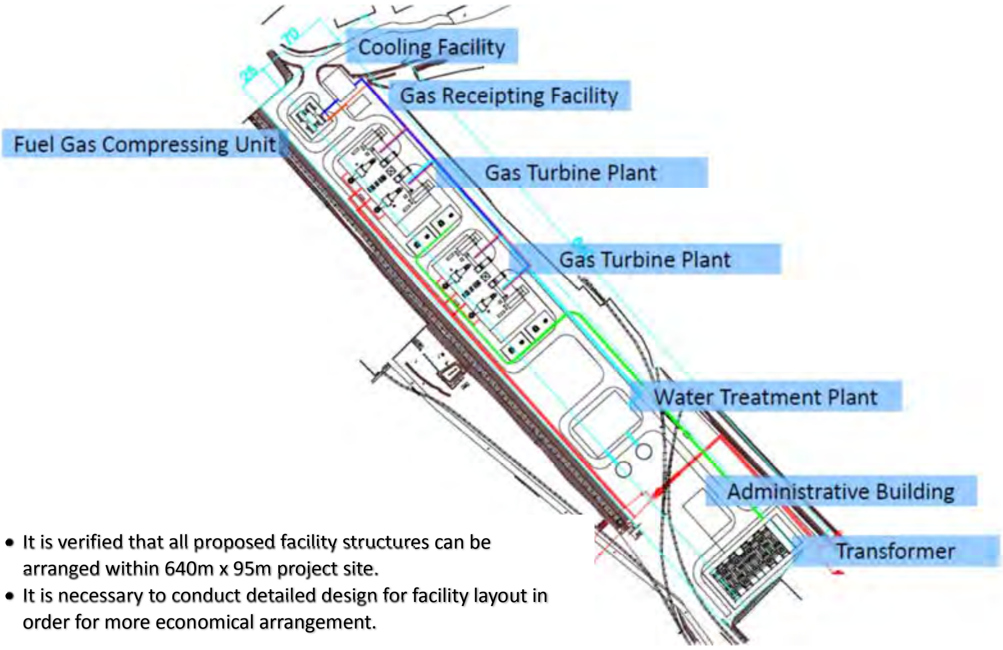
- Review of the existing Pre - Feasibility Study Report and EIA Report prepared by Tashkent city,
- Verification of project background appropriateness through the site survey, interviews with the project proponents, etc.,
- Reassessment both quantitatively and qualitatively to ensure compliance with Uzbek law and regulations concerning social, natural and environmental aspects in consistency with JICA’s “Guidelines for Environmental and Social Considerations” (hereinafter referred to as “JICA Guidelines”) and Safeguard Policy (ies) of IFC/WB.

8.1 Project Components Which May Impact on the Environment and Society

8.1.1 Summary of JICA-financed Portion

The project facility of TashTETs-2 (Tashkent Heat and Power Supply Station-2) comprises the following components:

- Four (4) cogeneration gas-turbine units, each of 30MW and 40Gcal/h (total of 120MW+160Gcal/h);
- Transformer substation;
- HRG and Heat Exchanger;
- Associated facilities (water treatment plant, treated water reservoir, water tank, gas receiving facility, cooling facility, switch facility and administrative building)



- It is verified that all proposed facility structures can be arranged within 640m x 95m project site.
- It is necessary to conduct detailed design for facility layout in order for more economical arrangement.

Source: JICA Study Team

Figure 8.1.1-1 General Building Layout of the Project Facility

8.1.2 Summary of the Land

The building complex is arranged on the south-west side of the territory of the existing TC-4. The configuration section is rectangular, measuring approximately 6ha in area and with a longitudinal length of 640m. The west side of the project site is sealed off by existing railway tracks and site access should be secured by a road linking to the northern end of the land. Since the proposed land is uninhabited, no land acquisition and resettlement will take place.

Canal (channel) between TC-4 and Proposed Site (Project site is behind the long wall)

Project Site View at the Center of the Land looking toward South

Source: JICA Study Team

Figure 8.1.2-1 View of the Proposed Construction Site

8.1.3 Summary of the Related Facility

The following facilities will be provided by the Uzbek side, as they are not included in the JICA Project scope:

(1) 110kV Power Transmission Line

The new power transmission line from TashTETs-2 will run approximately 3km to the existing Severna transformer station located south-west of TashTETs-2 utilizing underground installation. However, the route has yet to be finalized.

(2) New Gas Pipeline to TashTETs-2

A new gas supply line of 1.6 km-long facility, from the East-2 distribution station to TashTETs-2 and parallel to Uztransgas' existing pipeline, will be developed in relation to the project development by the Uzbek side work as planned. The actual detail of the route and the implementation body will be decided by the Uzbek side later. The line will be branched at the intersection of Qoraqamish and Nurmakon streets running under the public right of way, eliminating any need to acquire new land. The route map is shown in Figure 8.1.3-1.

The projected TashTETs-2 can be connected to an existing high-pressure gas pipeline within TC-4 in accordance with specification No. 329458 of "Toshkent Shahar Gas." The connection point has been selected taking into account the feasibility of managing the construction and installation works and ensuring safety during gas fitting works. The specification of the fuel gas to be used is as follows:

Calorific value is 8,200 kcal/m^3.

Specific gravity of gas under 20^{o}C and 760 mm Hg is 0.7 kg/m^3.

Note: The yellow line illustrates the proposed pipeline location.
Source: JICA Study Team with Google Map

Figure 8.1.3-1 Layout of the new Gas Pipeline

8.2 Project Components Subject to Environmental and Social Consideration

The main task under the environmental and social consideration in this study is to identify all potential impacts on the environment and society (positive and negative) through the project implementation to minimize any negative effects by taking appropriate countermeasures. Besides, there is also a need to provide all project-related information to the relevant stakeholders to ensure all issues of concern are taken into account through the reporting.

An environmental impact assessment will be performed by Uzbekenergo JSC as a project core proponent for implementation. The main components subject to environmental and social consideration are:

- Identifying issues of the development plan conflicting with current legislation regarding environmental and social considerations and EIA.
- Studying the current state of the environment and social conditions, components of which may be affected during the project implementation.
- Determining the project implementation components and their impact on the environment and society.
- Studying alternative project implementation options.
- Preparing measures to mitigate any negative effects caused by the project.
- Holding two stakeholder meetings to discuss information on project implementation, including possible consequences and their mitigation measures.
- Public opinion polling in terms of concern over project implementation.
- Taking into account the opinions and concerns of the interested parties identified during the meetings, to improve the project implementation plan.

8.3 Current Status of Environment and Society As a Basis of the Project Development

8.3.1 Land Use

The project site is located in the Abad Younus Tashkent city, on the south-western boundary of the current TC-4 territory. The lot size is approximately 4.7 hectares. The project area comprises unused land, which is a spot for unauthorized landfill garbage. The site also includes railways, ramps, power lines and a water-supply piping system (m-1), which will have to be dismantled and relocated to facilitate construction. The nearest residential area (4-storey house 6 quarter Yunus- Abad) is 200 m northeast of the project site, shown in Figure 8.3.1-1. The white rectangular structures around the proposed site are old apartment structures, which are also spread over the northern part of the project site. There is also a stretch of Karakamysh Canal (partly closed culvert box) about 3m wide from the east to south side of the project site.

Note: The blue line in the image illustrates the location of Karakamysh Canal. The white rectangular structures in the yellow dotted line are the apartment structures, which are spread over the northern part of the project site.
Source: JICA Study Team with Google Map

Figure 8.3.1-1 Aerial Image of the Project Site and Surrounding Development

8.3.2 Natural Environment

8.3.2.1 Topographical and Geological Project Site Features

The project site of TashTETs-2 construction is located in Yunus- Abad District of Tashkent city, 7 km to the north of the city center. The site is rectangular and the longitudinal side runs from the south-east to the north-west. The altitude of the site is 445.7-447.2 m. The terrain slopes to the north-east. The project site is located on the surface of the fourth terrace above the flood plain of the Chirchik river, which comprises loam and sand-gravel sediments of the Tashkent geological complex. The layer includes muddy sediments of Karakamysh Canal, which belong to the Mirzachol Steppe geological complex.

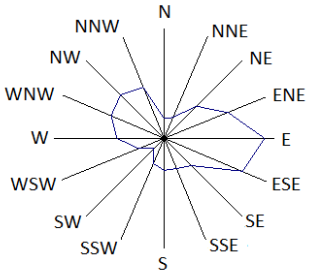
8.3.2.2 Analysis of Seismic Activity

The seismicity of the TashTETs-2 construction site is eight (8) on the Richter scale according to the seismic risk zoning map of the territory of the Republic of Uzbekistan (on a 12-point scale, Attachment 2 to KMK 2.01.03-96). The area of Tashkent and adjacent areas are located in the piedmont elevation area of the Southern Tian Shan. Here and in adjacent areas, ancient *orogenic processes* have taken place, as well as the movement of earth's crust in modern times, which exists in present time. The current terrain of Tashkent formed as a result of complex modern tectonic activity.

8.3.2.3 Climate and Meteorology

Tashkent is located in a wide plain of the Western Tian Shan, in the middle part of the Chirchik river valley, which is the climate-forming factor. For Tashkent, as well as the whole Central Asia region, the air temperature varies considerably from winter to summer and it varies greatly during twenty-four hours in summer, which is just one of the features of extreme continental climate.

In Tashkent, the annual average wind speed over the past five-year observation period was 1.23 m/s and weak winds (0-1 m/s) are common, with a repetition rate of 81.14% per year. Such winds exacerbate the accumulation of pollutants in ambient air for low fugitive sources (generally vehicles). The frequency of wind with a speed of 2-3 m/s is far lower, at 18.11%. Maximum wind speed reached in separate months is 16-17 mph, but such strong winds are rare and short-lived.



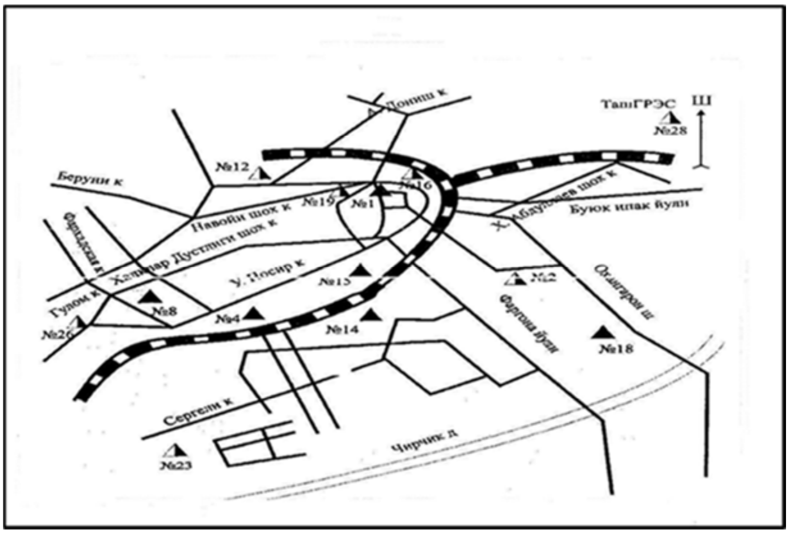
Source: JICA Project Team

Figure 8.3.2.3-1 Wind Rose of Tashkent

8.3.2.4 Air Quality

The main sources of atmospheric impact in Tashkent are the boiler plants of "Tashteplocentral" and household boiler facilities, the Tashkent Heat Supply Plant (TC-4) and the Tashkent Thermal Power Plant motor vehicles. There are a total of 13 air quality monitoring stations in the city (three in residential areas, eight in industrial areas and two along city roads) for monitoring. The locations of the monitoring stations are shown in Figure 8.3.2.4-1 and air quality indicators are specified in Table 8.3.2.4-1. The nearest monitoring station to the project site is station No. 12.

According to the data indicated, the annual condensation of pollutants in the atmosphere in Tashkent city generally complies with environmental standards (MPC: Maximum Permissible Concentration). However, there are a few cases where the 24 hour figure exceeds MPC: CO is 0 to 9.5% and NO_2 is 0.7 to 33.7% with the 30 minutes' maximum exceeding the standard and these particular excesses are deemed attributable to the automobile exhaust.



Source: Report on ambient air pollution and emissions of hazardous substances in the area monitored by Uzgydromet within towns, Tashkent, 2013

Figure 8.3.2.4-1 Air Quality Monitoring Station Map

Table 8.3.2.4-1 Ambient Air Quality Indicators of Tashkent

Impurities	Station	q_{ave}^{*}	G	q_m	q	q_i	n
Dust	2	0.1	0.06	2.0	0	0	849
	4	0.1	0.10	0.9	0.7	0	855
	6	0.1	0.14	2.2	0.4	0	849
	15	0.1	0.06	0.4	0	0	761
Sulfur dioxide	1	0.003	0.005	0.059	0	0	1047
	2	0.003	0.004	0.032	0	0	849
	4	0.004	0.005	0.047	0	0	856
	6	0.003	0.003	0.022	0	0	849
	8	0.003	0.003	0.028	0	0	846
	12	0.003	0.003	0.020	0	0	867
	14	0.004	0.005	0.048	0	0	849
	15	0.003	0.004	0.033	0	0	914
	18	0.004	0.004	0.024	0	0	846
	19	0.003	0.004	0.040	0	0	1165
	23	0.004	0.004	0.027	0	0	876
	26	0.004	0.005	0.058	0	0	849
	28	0.003	0.004	0.037	0	0	843
Carbon monoxide	1	1	0.5	2	0	0	1116
	2	2	1.5	11	4.4	0	566
	4	1	0.9	7	0.5	0	570
	6	3	1.9	9	9.5	0	566
	8	2	1.4	10	2.7	0	564
	12	2	1.3	9	1.9	0	578
	14	2	1.3	9	3.0	0	566
	15	4	1.5	8	9.0	0	610
	18	1	0.8	4	0	0	564
	19	1	0.9	4	0	0	989
	23	2	1.1	8	1.0	0	584
	26	2	1.4	8	3.0	0	566
	28	2	1.5	9	2.8	0	843
Nitrogen dioxide	1	0.02	0.021	0.10	0.7	0	1041
	2	0.07	0.05	0.17	33.3	0	849
	4	0.04	0.032	0.17	9.2	0	856
	6	0.07	0.041	0.18	33.7	0	849
	8	0.06	0.04	0.22	19.5	0	846
	12	0.04	0.025	0.16	4.2	0	867
	14	0.07	0.036	0.17	29.2	0	849
	15	0.04	0.027	0.16	6.1	0	914
	18	0.04	0.014	0.10	1.7	0	846

Impurities	Station	q_{ave}^{*}	G	q_m	q	q_i	n
	19	0.05	0.030	0.17	11.7	0	1165
	23	0.05	0.026	0.18	7.5	0	876
	26	0.06	0.037	0.17	19.9	0	849
	28	0.07	0.036	0.17	26.7	0	843
Nitrogen oxide	4	0.02	0.018	0.10	0	0	856
Ozone	1	0.026	0.016	0.065	0	0	282
Phenol	1	0.001	0.001	0.006	0	0	1041
	4	0.002	0.002	0.014	0.5	0	856
	6	0.002	0.002	0.041	0.6	0	849
	8	0.002	0.002	0.016	0.7	0	846
	14	0.003	0.003	0.019	2.5	0	849
	15	0.001	0.001	0.009	0	0	914
	19	0.001	0.001	0.019	0.2	0	1165
	23	0.001	0.001	0.011	0.1	0	876
	26	0.002	0.002	0.015	0.5	0	849
Hydrogen fluoride	14	0.004	0.004	0.018	0	0	849
	15	0.003	0.004	0.018	0	0	913
	23	0.003	0.003	0.017	0	0	876
Ammonia	1	0	0.006	0.04	0	0	1041
	2	0.01	0.016	0.10	0	0	849
	8	0.01	0.016	0.13	0	0	846
	18	0.01	0.013	0.09	0	0	846
	23	0.01	0.012	0.08	0	0	876
	26	0.01	0.015	0.09	0	0	849
Formaldehyde, mg/m^3	23	0.020	0.011	0.054	8.2	0	876
Benzpyrene, mg/m^3*10^{-6}	2	0.003		0.006			9
	4	0.002		0.002			4
Metals, mg/m^3	6	0.00		0.00			12
Cadmium	15	0.00		0.00			10
Copper	6	0.04		0.08			12
	15	0.00		0.01			10
Lead	6	0.09		0.14			12
	15	0.02		0.04			10
Zinc	6	0.14		0.20			12
	15	0.09		0.17			10

$^{*}q_{ave}$ – average impurity concentration in the air, mg/m^3;
q_m – maximum impurity concentration in the air, mg/m^3;
q – occurrence of air impurity concentrations, which exceed the maximum permissible concentration (MPC), %;
G- standard deviation;
q_i– occurrence of air impurity concentrations, which exceed 5 MPCs, %;
n – number of observations.

Air pollution index (5) = 3.63.

Dust concentrations.

The average annual dust concentration did not exceed MPC and constituted 0.1 mg/m^3. The maximum single-time concentration exceeded MPC by 4.4 times at station No. 1 in June and constituted 2.2 mg/m^3.

Air pollution index = 0.61.

Sulfur dioxide concentrations.

The average annual concentration and maximum single-time concentration did not exceed MPC and constituted 0.0003 mg/m^3 and 0.059 mg/m^3, respectively.

Air pollution index = 0.7.

Carbon monoxide concentrations.

The average annual concentration constituted 2 mg/m^3, which is less than MPC. The maximum single-time concentration constituted 2.2 MPCs (11 mg/m^3) and was registered at station No. 2 in December.

Air pollution index = 0.64.

Nitrogen dioxide / nitrogen oxide concentrations.

The nitrogen dioxide air pollution remains elevated throughout the year, with average concentration of 0.05 mg/m^3 (1.3 MPCs). In comparison with all monitored substances, in the case of nitrogen dioxide, the most significant MPC excess in analyzed samples was registered at almost all stations. At station No. 6 the nitrogen dioxide concentration exceeded MPC by 33.7%. The maximum single-time concentration was registered at station No. 8 in August and constituted 0.22 mg/m^3 (2.6 MPCs).

Air pollution index = 1.37.

The average annual nitrogen oxide concentration in Tashkent did not exceed MPC and constituted 0.02 mg/m^3. Single-time concentration did not exceed the maximum permissible single-time concentration and constituted 0.10 mg/m^3.

Air pollution index = 0.35.

Source: Observation data of the Main Department for Hydrometeorology of the Republic of Uzbekistan (Glavgydromet)

Comparison data between the air quality of station No. 12 and the international standard is shown in Table 8.3.2.4-2. The recorded annual pollutant concentration in the atmosphere mostly complies with the standard MPC at the No. 12 station, except for the 30-minute NO_2 value, which exceeds MPC at 1.88 times. However, it should be noted that the 30-minute MPC standard in Uzbekistan is stricter than other international standards.

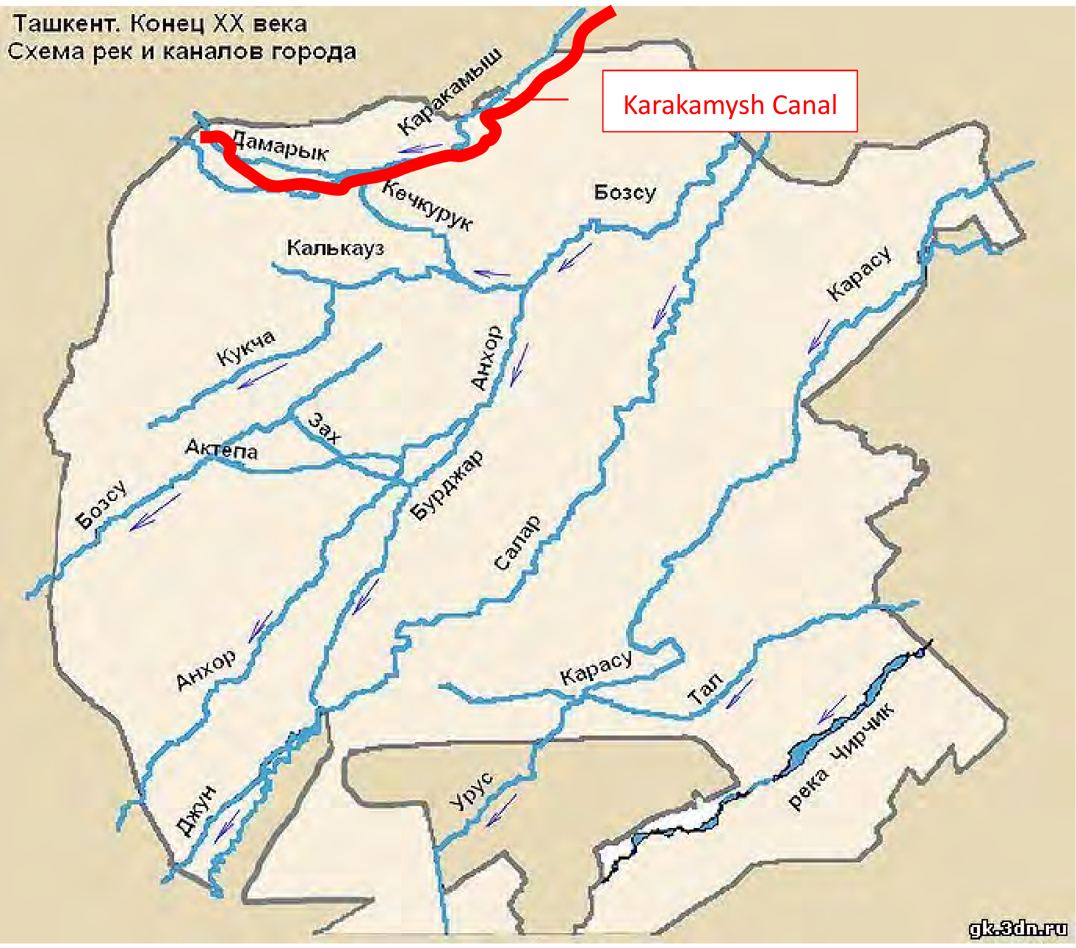
Table 8.3.2.4-2 Air Quality in Tashkent (mg/m³)

Pollutant	Current value			Maximum Permissible Concentration (MPC) in Uzbekistan			IFC/WB EHS Guidelines
	Average concentration	Maximum (30-minute value)	Number of samples	30-minute maximum single-time concentration	24-hour daily average	Working area	
NO_2	0.04	0.16	867	0.085	0.06	5.0	0.2 (1 hour) 0.04 (1 year)
SO_2	0.003	0.02	854	0.5	0.20	10.0	0.5 (10 minutes) 0.125 (24 hours)
CO	1.3	9.0	867	5.0	4.0	20.0	-
Dust	-	-	-	0.15	0.1	-	0.15 (24 hours) 0.07 (1 year)

Source: Observation data of station No. 12, Main Department for Hydrometeorology (Glavgydromet)

8.3.2.5 Hydrology

Channel Karakamysh closest to the TashTETs-2 surface watercourse and the intended receiver of the waste water from the surrounding area of the canal. The canal runs toward the west in the north Tashkent area, merges into the Bozsu canal, then merges again with the Syrdarya river 70km downstream. The Karakamysh channel is a collector with a concrete lining at TC-4 and a large stretch of the canal is under a closed culvert about 3m wide. The water level in the canal during the year varies from 0.5 to 1.5 m and the channel is 3 m wide. The water flow rate at the minimum occupancy rate of the channel varies from 1.39 to 2.08 m³/s. The canal network was originally built as part of an irrigation network (pre-fifth century) and the network today is used to collect waste water from industrial activities and facilities along the canal system functioning as an urban canal. There are no related activities identified, including fishing and recreation (swimming, for instance), worthy of particular mention.



Source: JICA Study Team based on the map referred to in the website "http://gk.3dn.ru/publ/8-1-0-8"

Figure 8.3.2.5-1 Rivers and Canals in Tashkent City

8.3.2.6 Geology

According to the findings of engineering-geological conditions of the construction site of the district heating plant "Severnaya" performed by TashGIITI in 1980, geomorphological research is dedicated to the surface area of the fourth plain over the flood plain terraces of Chirchik River, folded clay loams and sandy-gravel deposits of the complex.

8.3.2.7 Hydrogeology

The hydrogeological conditions of the construction site are characterized by the presence of ground water in clay soils to a depth of 1.2 -3.2 m from the ground surface.

8.3.2.8 Soil

The soil of the TashTETs-2 project site is gray- OASIS loamy soil with pH of 8.1 to 8.6, equating to alkaline content. The typical profile of gray desert soils was disturbed following intensive urban development in Tashkent. According to methodological guidance on environmental-hygienic zoning of territories of the Republic of Uzbekistan to determine the degree of risk to the health of the society, the level of soil contamination in the area can be classified as "moderate", which is a risk equivalent to that indicated in industrial areas of the city.

8.3.2.9 Protected Area

The proposed land for both TashTETs-2 and transmission line facility installation and surrounding areas does not include any protected land. The nearest national park, Ugam- Chatcal National Park, is approximately 50km from the project site.

8.3.2.10 Flora

Near the TashTETs-2 construction site, there are no natural forests and protected areas, as the area is developed urban land. Vegetation in the TashTETs-2 construction is limited to mainly small wood-shrub type plants and no protected plant species as defined by law have been observed in the area.

8.3.2.11 Fauna

According to the Science Academy of the Republic of Uzbekistan, the Republic’s fauna includes 97 mammal species, 424 birds, 58 species of reptiles and 83 species of fish.

Rare and endangered species of animals, according to the IUCN (International Union for conservation of nature and natural resources) and the Red Book of Uzbekistan, have not been observed in and around the project site.

Wildlife near the TashTETs-2 construction site is typical of the man-made landscape. The mammals found here include the house mouse (Mus musculus), rat (Rathis norvegicus), earthen rat (Nesokia indica), rarely long-eared Hedgehog (Hemiechinus auritus), along the Karakamysh channel-ondatra (Ondatra zhibetica), several species of bats (Chiroptera).

8.4 Surrounding Area of the Project Target Site

The west side of the proposed construction site is occupied by the railway tracks operated today and the vibration of trains is one concern for the new heat and power supply station development. Another concern is the unsanctioned garbage dump yard, which lies in the middle of the project site. The topographical condition of the area is flat in general, except for railway tracks at higher elevation and the lower garbage dump yard for the required landfill (garbage must first be removed). During the construction, waste must be cleared from the project site and the transfer site and means of transport used shall be effectively studied to minimize impact on the environment and society.

Unsanctioned garbage dump at the center area of the construction site (elevated railway tracks are seen beyond)

Proposed construction site looking southward (left side: TC-4)

Source: JICA Study Team

Figure 8.4-1 Projected Construction Site for the Thermal Power Plant

8.5 Socioeconomic Conditions

Tashkent is the capital of the Republic of Uzbekistan and one of the largest cities in Uzbekistan and Central Asia. The area of the city in January 2014 was 334 km^2. Tashkent is the cultural, economic, scientific and political center of the country and accounts for 20% of products in Tashkent city. The main production industry (over 12 factories) in the city is mechanical engineering and there are about a dozen large factories that produce thousands of different products from airplane parts to tractor parts. There are electronic devices, automated control systems and communications as well as petrochemical, construction, food, chemical and pharmaceutical industries.

Since demand for electricity in the capital is growing, one important issue is to guarantee a reliable and stable power supply, which is one of the project objectives. Table 8.5-1 describes the socioeconomic condition of Tashkent city, while Table 8.5-2 illustrates the condition of the living environment and the population in the Yunus- Abad district nearest the project site.

Table 8.5-1 List of Social Conditions of Tashkent City[*]

Name of the indicator		Tashkent
1	Population, thousand people	2352.9
2	Ethnic group,%:	
	Ethnic Uzbeks	73
	Russians	18
	Other nationality	9
3	Population density, population per 1 km^2	7044.6
4	Average age, years	32.4
5	Age group,% of total:	
	Below working age (0-16 years)	24.8
	Working age (men 16-59, women 16-54)	61.3
	Older than working age (men over 59, women- over 54)	13.9
6	Population by sex:	
	Men, thousand	1145.8
	Women, thousand	1207.1
7	* Religion * (main)	Muslims
8	Fertility rate per 1000 population	17.7
9	The death rate, at 1000 population	6.9
10	Number of labor force, thousand. in the year	1537.0
11	Average size of monthly pension, 000 Sums	415.3
12	Industrial products (at current prices, billion. Sums	14312.3
13	Industrial production growth rate in%	115.8
14	Provision of housing, m² per person	19.5
15	Security of centralized water supply,%	99.7
16	Provision of sanitation,%	92.5
17	Security of electricity supply,%	100
18	Security of natural gas supply	98%
19	Transportation of passengers by motor transport, million people	1482.2
20	Carriage of goods by road, Mt	146.6
21	Number of hospitals	76
22	Number of outpatient medical establishments	789
23	Number of physicians, thousand. man	11.2
24	Population per doctor	210
23	Morbidity of population by 100000 population	60751.9
24	Number of educational institutions	320
25	Number of colleges and academic lyceums	121
26	Number of higher education institutions	34
27	Number of parks of culture and rest	15
28	Area landscaping of public spaces, HA	1243

Source: Statistical Yearbook of the Republic of Uzbekistan, Tashkent, 2014

* Data for January 1, 2014

** Also operate in Tashkent: Russian Orthodox Church, Church, Church, synagogue, etc. Are generally tolerant of other religions.

Table 8.5-2 Population and Residential Conditions of Yunus- Abad district (around the Project Site)

Name of the indicator		Tashkent
1	Total number of residential buildings:	164
	Private houses	119
	4-storey houses	45
2.	Buildings closest to the TC-4 (10 m from the border):	
	Private houses	No
	4-storey houses	16
3.	Number of apartments per building	54-60
4	Number of inhabitants including:	6694
	Men	2909
	Women	3785
5	Number of families	1984
6	Number of children up to 7 years	370
7	Number of people up to 30 years	4163
8	Number of residents at working age from 30 years	1241
9	Retired Persons:	920

Source: JICA Study Team

8.6 Environmental and Social Consideration and its Legal Framework and Organization

8.6.1 Relevant Organizations

The following public officials and institutions play a major role regarding environmental management in the Republic of Uzbekistan:

(1) Goskompriroda (State Committee of the Republic of Uzbekistan for Nature Protection)

In Uzbekistan in 1989, the State System of Nature Protection was created, controlled by the State Committee for Nature Protection (Goskompriroda), which is specifically authorized as a superior departmental and coordinating body responsible for control and inter-sectoral management of nature protection as well as the use and reproduction of natural resources on a national, inter-regional or inter-state level and functions as the main EIA authority for permission. Local Nature Protection Committees (Regional Goskompriroda) oversee state level and large city functions, including the Republic of Karakalpakstan and other large cities and should monitor the condition of air and water discharge and quality as well as the soil condition of the facilities within their jurisdiction.

(2) Uzhydromet (Center of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan)

It is under the Cabinet of Ministers and monitors the water, air and soil environment in the wider regional environment.

(3) Goskomzemgeodezkadastr (State Committee of the Republic of Uzbekistan on Land Resource, Geodesy, Cartography and State Cadaster)

This is to control and manage land in Uzbekistan.

(4) Ministry of Health

It is to monitor the environment based on health and sanitary perspectives, such as soil and noise.

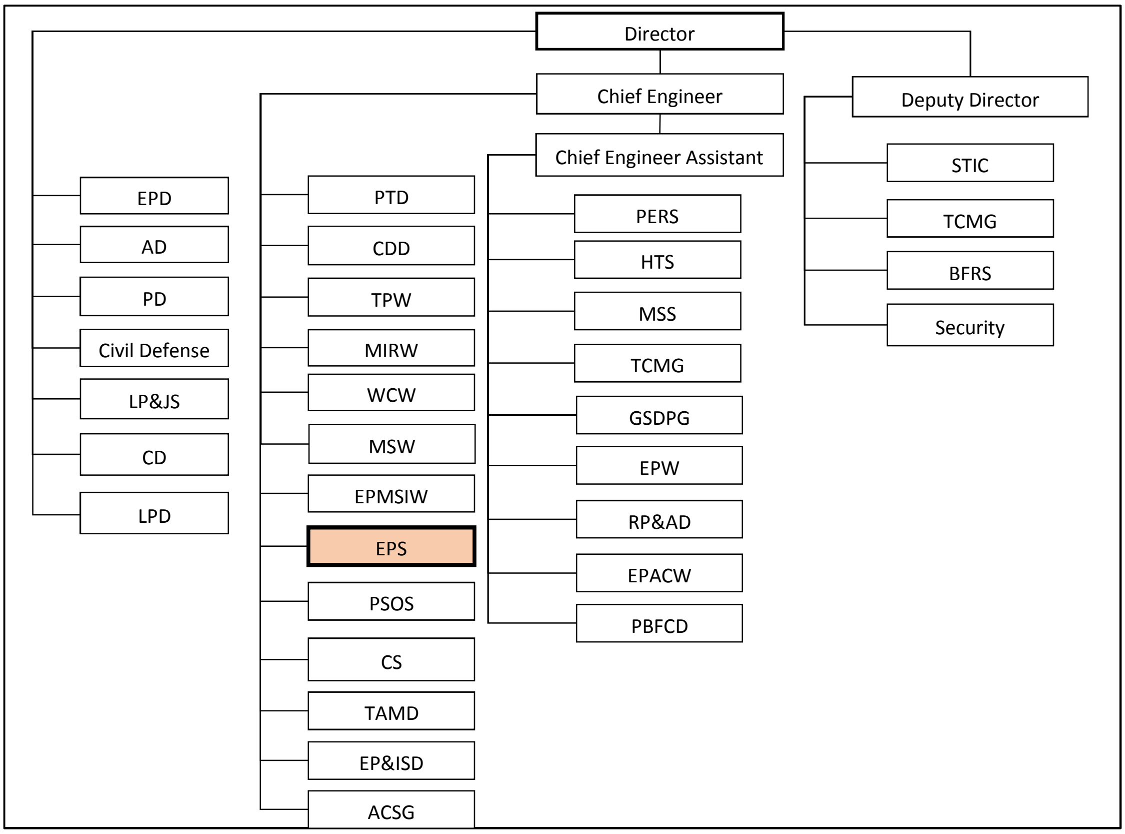
(5) Ministry of Agriculture and Water Resource

It is to monitor the quality of water for irrigation, canals and rivers nationwide.

(6) Ministry of Internal Affairs

This organization is to monitor environmental activities nationwide. If illegal activities or violation are identified, they will investigate, further monitor and instruct the concerned parties and check and improve the procedural activities.

Counterpart organization of Uzbekenergo JSC, including EPS for the environmental sector, is illustrated in the figure below.



Source: Uzbekenergo JSC

Figure 8.6.1-1 Organizational Structure of Uzbekenergo JSC

Table 8.6.1-1 Administration List (corresponding to the above organization structure)

CD	Correspondence department	TPW	Thermal power workshop
AD	Accounting department	TAMD	Thermal automatics and measurements department
PD	Personnel department	MSW	Metal and steam pipe workshop
Civil Defense	Civil defense department	WCW	Water chemistry workshop
PTD	Production and technical department	MIRW	Metrology and instrument repair workshop
EPD	Economic planning department	EPMSIW	Electric power metering systems and instruments workshop
LPD	Logistics and procurement department	EPACW	Electrical process automatic control workshop
LP&JS	Labor protection and job safety department	RP&AD	Relay protection and automation department
ACSG	Automatic control system group	GSDPG	General system documentation preparation group
PBFCD	Production buildings and facilities control department	PSOS	Power station operation service
EP&ISD	Environmental protection and industrial sanitation department	PERS	Power equipment repair service
BFRS	Buildings and facilities repair section	HTS	Hydrotechnical service
STIC	Scientific and technical information center “Uzinformenergo”	MSS	Metrology and standardization service
CDD	Chief Designer Department	EPS*	Environmental protection service
CS	Cadastral service	TCMG	Technical conditions modernization group
EPW	Electric power workshop		

Source: Uzbekenergo JSC

8.6.2 Legal Framework

The legislation of the Republic of Uzbekistan in the field of the protection and use of natural resources and environmental protection comprises laws, Presidential Decrees, decisions of the Government, departmental normative legal acts and also local acts of local authorities.

The Constitution of the Republic of Uzbekistan establishes principles of environmental legislation. It is reflected in Article 55, defining that the earth, its subsoil, waters, flora and fauna and other natural resources are national wealth and shall be rationally used and protected by the state; Articles 47&48 define the responsibilities of citizens to observe the Constitution and law; Article 50, establishes an obligation for citizens to use the surrounding environment sparingly; Article 51 obliges citizens to pay statutory taxes and outlines other constitutional provisions defining powers of state authorities, including in the field of regulating environmental relations.

The legislation system in the regulatory area of nature management and environmental protection relations comprises the following areas of environmental legislation: land, water, mining, legislation on flora and fauna, as well as environmental protection.

The main act regulating environmental relations is the Law from December 9, 1992 "On Environmental Protection." The following are basic but important laws in the field of environmental protection:

- The Law of the Republic of Uzbekistan "On environmental protection" (December 9, 1992, No. 754- XII)
- The Law of the Republic of Uzbekistan "On water and water use" (May 6, 1993, No. 837- XII)
- The Law of the Republic of Uzbekistan "On protection of atmospheric air" (December 27, 1996, No. 353- I)
- The Law of the Republic of Uzbekistan "On protection and use of flora" (December 26, 1997, No. 543- I)
- The Law of the Republic of Uzbekistan "On protection and use of fauna" (December 26, 1997, No. 545- I)
- Land Code of the Republic of Uzbekistan (April 30 1998, No. 599- I)
- The Law of the Republic of Uzbekistan "On forest" (April 15, 1999, No. 770- I)
- The Law of the Republic of Uzbekistan "On protection of the population and territories against emergency situations of natural and technogenic nature" (August 20, 1999, No. 824- I)
- The Law of the Republic of Uzbekistan "On ecological expertise" (May 25, 2000, No. 73- II)
- The Law of the Republic of Uzbekistan "On radiation safety" (August 31, 2000, No. 120- II)
- The Law of the Republic of Uzbekistan "On protection of agricultural plants against pests, diseases and weeds" (August 31, 2000, No. 116- II)
- The Law of the Republic of Uzbekistan "On waste" (April 5, 2002, No. 362- II)
- The Law of the Republic of Uzbekistan "On subsoil" (New edition), (December 13, 2002, No. 444- II)
- The Law of the Republic of Uzbekistan "On protected natural territories" (December 3, 2004, No. 710- II)
- The Law of the Republic of Uzbekistan "About ratification of Amendments to the Montreal protocol on the substances that deplete the ozone layer" (September 7, 2006, No. ZRU-44, 45)

8.6.2.1 Environmental Impact Assessment (EIA)

8.6.2.1.1 Outline of the EIA in Uzbekistan

On May 25, 2000 Oliy Majlis (Parliament) of the Republic of Uzbekistan enacted the law of the Republic of Uzbekistan "On Ecological Expertise," which, along with the Law "On Environmental Protection" underpins the environmental impact assessment materials. The specially authorized state body for State Ecological Expertise is the State Committee for Nature Protection of the Republic of Uzbekistan (Article 12).

According to Annex 2 of Resolution No. 491 dated December 31, 2001 "Regulations on the State Ecological Expertise in the Republic of Uzbekistan," the Tashkent TashTETs-2 is categorized as category II in terms of environmental impact (medium risk) (Paragraph 47 of the Annex: Thermal power stations and other combustion installations with heat output from 100 to 300 MW). All economic activities in Uzbekistan are divided into four categories (I- IV), depending on the degree of potential impact. Categories I and II should be under the control of Goskompriroda, while III and IV should be under the Regional Goskompriroda for the approval process.

The related projects of power transmission lines and gas pipeline developments are also under category II and require EIA preparation. Besides, any projects considered in protected/vulnerable lands or inter-regional development shall be considered category I, but there is no size or scale-based definition between categories.

The plan for the EIA procedure difference by category is shown in Table 8.6.2.1.1-1.

Table 8.6.2.1.1-1 EIA procedure difference by category

Point	Category I	Category Ⅱ	Category Ⅲ	Category Ⅳ
Preparation of pre-project and project documentation Before commissioning of the object.	Stage I. EIA Draft Stage II EIA* Stage III Statement of environmental effects (SEE)	Stage I. EIA Draft Stage II EIA* Stage III SEE	Stage I. EIA Draft Stage II SEE	EIA Draft
Considering authorities	Goskompriroda	Goskompriroda	Regional Goskompriroda	Regional Goskompriroda
Fee for of petition to conduct expertise of the application	Minimum salary of 25 people	Minimum salary of 15 people	Minimum salary of 7.5 people	Minimum salary of one person
Period of ecological expertise	30 days (By the decision of Goskompriroda on complicated objects period may be extended, but not more than 2 months)	30 days (By the decision of Goskompriroda on complicated objects period may be extended, but not beyond 2 months)	20 days	10 days

*Developed only on demand of Goskompriroda by results of consideration of the EIA Draft, in case of any lack of data to establish the impact on the environment.

Source: Goskompriroda

8.6.2.1.2 EIA Procedure

As defined in Regulations No. 491, the development of EIA materials comprises three stages, which are implemented in the following sequence: Draft EIA during the planning stage; EIA, on demand of Goskompriroda in case of the need for further research; and the development of the Statement of environmental effects (SEE) of an object on the environment before commissioning.

【Planning stage】

I. Preparation of the EIA Draft

The EIA Draft should be prepared at the project planning stage and submitted to the State Committee for Nature Protection. The validity of conclusions of Goskompriroda is three (3) years. In case the validity of a conclusion expires or changes during the design process, the EIA Draft must be resubmitted for state geological scrutiny.

II. EIA

When considering the EIA Draft, in case any lack of data and/or the survey results are identified, Goskompriroda decides on EIA redevelopment.

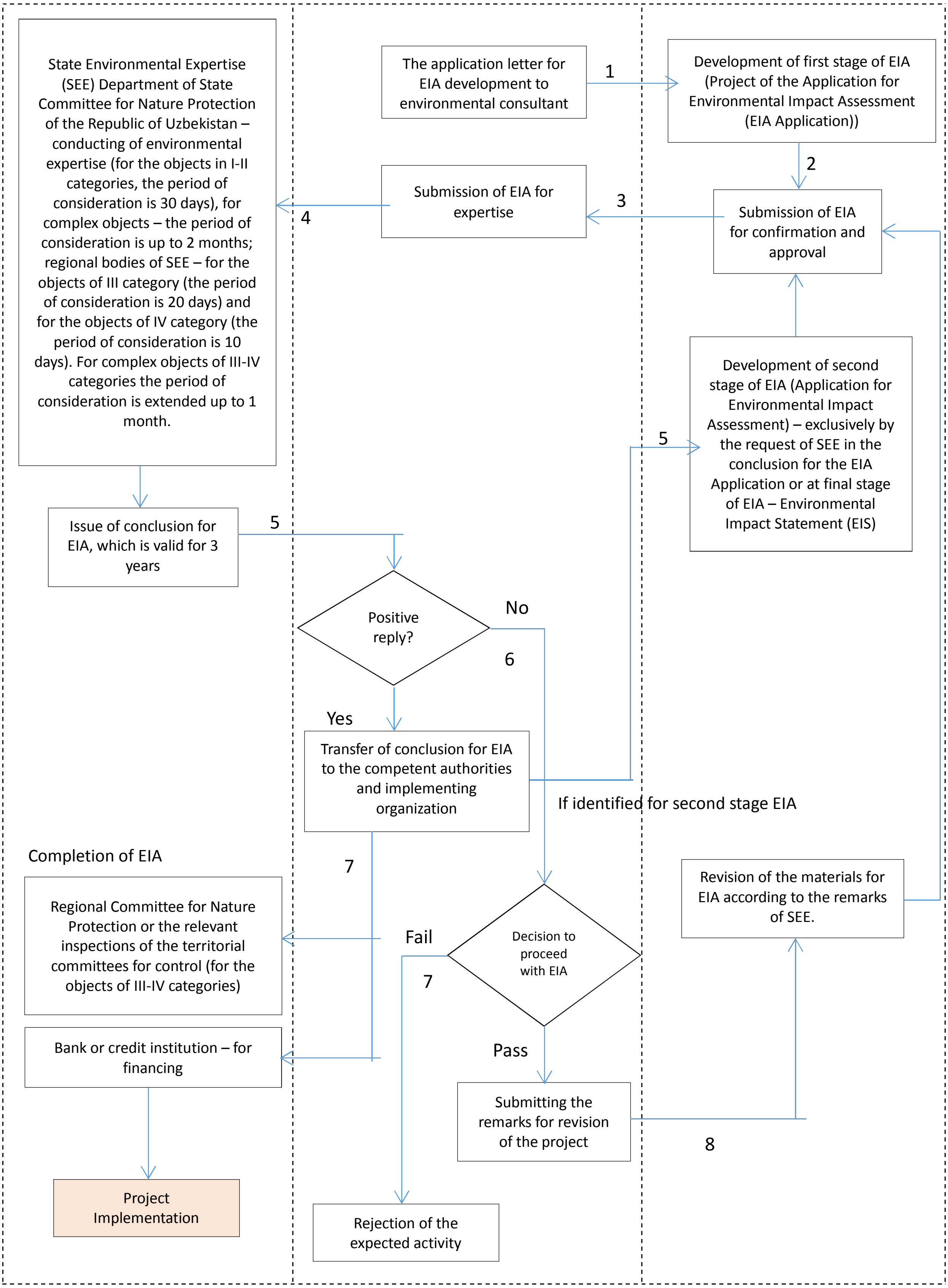
【Preparation stage for object commissioning】

The statement of environmental effects (environmental regulations for the enterprise) marks the final stage of the EIA procedure and must be prepared and submitted to Goskompriroda before commercial exploitation of the projected object.

Commissioning of the facility is not permitted without a positive conclusion of Goskompriroda of Uzbekistan, in which environmental standards for emissions, discharges and waste, for which the company makes payments, as well as action plans to reduce the impact on air, water and waste management are approved.

This procedure resembles the approval procedure of the application for the pre- Commissioning stage in Japan.

The following Figure 8.6.2.1.2-1 illustrates the typical procedure of the EIA activities.



Source: JICA Study Team

Figure 8.6.2.1.2-1 Procedure of EIA in Uzbekistan

8.6.2.1.3 Environmental Impact Assessment (EIA) for the Project

According to a Resolution of the Cabinet of Ministers No. 491 (Dec. 31, 2001: Regulations for Environmental Impact of Uzbekistan), TshTETs-2 is under category II (thermal power station with capacity of between 100 and 300 MW) and requires an EIA. Tashkent city, with its TC-4 expansion project, already obtained Goskompriroda's approval in October 2013. However, a new EIA must be prepared as the implementation agency has changed to Uzbekenergo JSC from the city and the facility capacity has changed. The EIA category, incidentally, varies according to the plant capacity: over 300 MW as category I and less than 100 MW as category III.

Uzbekenergo JSC has planned its EIA preparation program from July 2015 and is expected to submit an EIA report to Goskompriroda in September, with approval scheduled for the end of October 2015. After EIA approval, a more detailed emission and discharge plan (Normative Document) based on the detailed facility design should be prepared for review, but the process may be less critical since the design and emission plan should be approved through the EIA process before preparing the Normative Document.

8.6.2.1.4 Environmental Impact Assessment (EIA) for Related Facilities

(1) 110kV Power Transmission Line

In accordance with the Decree of Cabinet of Ministers, Republic of Uzbekistan, No. 491 (Dec. 31, 2001), the power transmission line is also under category II. Accordingly, the EIA preparation and procedure shall be made along with the TashTETs-2 procedure. Uzbekenergo JSC plans to implement the EIA when the power line routing is finalized.

(2) Gas Pipeline to TashTETs-2

A gas pipeline installation is also required for category II EIA and the implementation agency of the gas pipeline installation shall prepare an EIA in accordance with Decree No. 491.

8.6.2.2 Rights for Land Use

According to the law of the Republic of Uzbekistan No. 598- I dated 30 April, 1998 and amended under Section XIX of the Legislation Act of the Republic of Uzbekistan dated 30 August, 2003, all land (both above ground and underground) is owned by the state government and registered to the central government. The general public and other people can use national land with a land use permit issued by the government.

The land in Tashkent city is all managed by the city government under state government land ownership. The rights of way of roads and railways are also held by the city (or the city authorized agency). Any part of the state land used by the project or land user(s) should be identified and Tashkent city should determine a permit for the method of land use of the particular land in accordance with the Decree and the land user and its right should be clearly marked on the cadaster map prepared by the city.

The project site for TashTETs-2 and its land is managed by Tashkent city and the land use right should be transferred to Uzbekenergo JSC in accordance with the Decree of Cabinet of Ministers No. 110-f (March 2, 2015). However, the official document of land use rights shall not be obtained during processing for security control reasons.

8.6.3 Public Consultations

In Uzbekistan, public meetings as part of the EIS are not particularly regulated in the Resolution of the Cabinet of Ministers No. 491. Article 11 of the aforementioned Resolution states that the results of public consultation should be described, as required, when developing Stage II of the EIA – Environmental Impact Statement. As shown by the practice of EIA material development, Goskompriroda of Uzbekistan necessarily requires public hearings in problematic areas of the projected objects (without breaks with residential buildings, or non- Compliance with the size of the sanitary protection zone or in predicting an increase in noise and air emissions) for the level of concern among people to decline and giving the opportunity to explain the presence of actions to reduce the impact on standard level. For power generation projects in Uzbekistan, a public meeting is usually held by the company as instructed that produces electric power within the environmental impact assessment, in case the project is located in close proximity of residential areas.

8.6.4 Regulations and Standards

8.6.4.1 Atmosphere

The maximum permissible concentration (MPC) to protect human health is set to ambient air of populated and work areas in Uzbekistan. Table 8.6.4.1-1 illustrates MPC and hazard categories of main pollutants produced by thermal power plant emissions. The 30 min MPC value for NO_2 in Uzbekistan is very strict compared to the one-hour average value of common fundamental principles of IFC / WB EHS and environmental standards of the EU.

Table 8.6.4.1-1 Regulation of Hazard Contents of the Main Pollutants Generated by Thermal Power Plants (MPC)

Pollutant	Maximum Permissible Concentration (MPC)** (mg/m^3)			Hazard category*	IFC / WB EHS Guideline Fundamental principles (mg/m^3 (2007))	EU Environmental standard (mg/m^3)
	30 min	Daily average	Work zone			
Nitrogen dioxide (NO_2)	0.085	0.06	2.0	2	0.2 (on the average 1 hour) 0.04 (annual average)	0.2 (on the average 1 hour) 0.04 (annual average)
Nitrogen oxide (NO)	0.6	0.25	-	3	—	—
Sulfur dioxide (SO_2)	0.5	0.2	10.0	3	0.5(10 min) 0.125 (daily average)	0.35 (on the average 1 hour) 0.125 (daily average) 0.02 (annual average)
Carbon monoxide (CO)	5.0	4.0	20.0	4	—	—
Suspended particles (Dust)	0.15	0.1	-	3	0.15 (daily average) 0.07 (annual average)	0.05 (daily average) 0.04 (annual average)

Note: *Hazard categories are classified as follows according to the Russian standard:
1. Polluting substance of extreme danger
2. Polluting substance of high danger
3. Polluting substance of medium danger
4. Polluting substance of low danger

Source: ** The sanitary norms, rules and hygienic standards of the Republic of Uzbekistan (San PiN No. 0179-04, Hygienic standards), the list of maximum permissible concentration (MPC) of pollutants in the ambient air of populated areas on the territory of the Republic of Uzbekistan")

※ Because Uzbekistan was previously part of the Soviet Union, the government utilizes any Russian regulations where no referring codes and regulations as permitted by the Uzbekistan government apply.

8.6.4.2 Emissions

In the Republic of Uzbekistan, pollutants in the exhaust gas emitted by power plants are regulated by the concentration of air pollutants in the surface layer of the atmosphere created by the release from each exhaust pipe or chimney instead of the exhaust air quality at the emission point, such as stack.

The standard values of maximum pollutant concentration are calculated and should not exceed the MPC value shown in Table 8.6.4.2-1. The surface layer MPC calculation should be made based on the guideline[1] and the result will be compared with the 30 minute MPC to set the permissible amount of exhaust air. The implementation agency, after EIA approval is obtained, must prepare a Normative Document illustrating the actual design and the calculated air distribution for approval by Goskompriroda, since the EIA reported figure is only an assumption. According to the Approval on the Normative Document by Goskompriroda, the final MPC figure for air emission and quality to be complied with by the implementation agency shall be set.

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[1] Ministry of Justice, Reg. No. 1553 from 03.01.2006 "Guidelines for the inventory of pollution sources and regulation of pollutants emission into the atmosphere for the enterprises of the Republic of Uzbekistan" , Tashkent, 2006

Table 8.6.4.2-1 Quotas on Polluting Substances emitted in atmosphere by enterprises

Location of	Quota shares of MPC based on the class of risk of emitted substances			
	1	2	3	4
Regions: Tashkent, Fergana, Andijan, Namangan City: Navoi, Samarkand, Bukhara	0.17	0.20	0.25	0.33
Areas: Bukhara, Djizak, Kashkadarya, Navoi, Samarkand, Surkhandarya, Syrdarya	0.20	0.25	0.33	0.50
The Republic of Karakalpakstan, the Khorezm province	0.25	0.33	0.50	1.00

Source: Instruction on the inventory of sources of pollution and regulation of emissions into the atmosphere for enterprises of the Republic of Uzbekistan, the Ministry of Justice of the EGR. No. 1553, Tashkent, 2006. Categories 1, 2, 3 and 4 refer to the hazard categories applied in Table 4.6.4.1-1.

Based on the values illustrated in Tables 8.6.4.1-1 and 8.6.4.2-1, the concentration of air pollutants in the surface layer of the atmosphere that will apply for the project is calculated and shown in Table 8.6.4.2-2. Since the NO_2 concentration level in the surrounding area before implementing the project development already exceeds MPC, this MPC norm will most likely be rejected by Goskompriroda.

Table 8.6.4.2-2 Maximum Concentration of Air Pollutants in the Surface Layer at the TeahTETs-2

Pollutants	MPC (30 min)	Regional coefficient	MPC default Value	Hazard category
Nitrogen dioxide (NO_2)	0.085	0.2	0.017	2
Nitrogen oxide (NO)	0.6	0.25	0.15	3
Sulfur dioxide (SO_2)	0.5	0.25	0.125	3
Carbon monoxide (CO)	5.0	0.33	1.65	4
Suspended particles (Dust)	0.15	0.25	0.0375	3

Source: Instruction on the inventory of sources of pollution and regulation of emissions into the atmosphere for the enterprises of the Republic of Uzbekistan, the Ministry of Justice of the EGR. No. 1553, Tashkent, 2006. Category 1, 2, 3 and 4 refers to the hazard category applied in the table 4.6.4.1-1.

The concentration of NOx should refer to the Russian Standard (GOST 29328-92), shown in Table 8.6.4.2-3 in this project, as there are no particular rules concerning concentrations of pollutants in exhaust gases in Uzbekistan.

Table 8.6.4.2-3 Standard on Concentration of Pollutants in Emissions

The Polluter	GOST 29328-92*	Basic principle OOSMFK/WB for thermal power plant (2008)
Nitrogen oxides (NOx)	50 mg/Nm³ (25 mg/m³)	50 mg/Nm³ (25 mg/m³)

* GOST 29328-92: the plant turbine to drive the turbo generator

Note: the dry gas, O_2 = 15%

Source: Ministry of Justice of the EGR

8.6.4.3 Water Quality

Environmental Standard

The discharged water should also comply with regulations for surface water protection (San PiN RUz No. 0172-04) as shown in Table 8.6.4.3-1 and the permissible increase in water temperature is a maximum of three (3) degrees Celsius.

Table 8.6.4.3-1 Environmental Standard for Surface Water Protection

Indicators	Water use category	
	I (drinking water supply)	**II (recreational use)**
1. Suspended solids*	During effluent discharge, producing of works on water bodies and coastal zone content of suspended solids in the water control point should not increase in comparison with natural conditions by more than:	
	0.25 mg/L	0.75 mg/L
	For water bodies containing more than 30 mg/L of natural suspended solids in low water, the permissible increase in content in water within 5%	
	Discharge of suspended matter with a settling rate exceeding 0.4 mm/s for flowing water reservoir and 0.2 mm/s for water reservoirs is prohibited	
2. Floating impurities	On the water surface, no films of oil products, oil, grease and accumulation of other impurities should be found	
3. Coloring	Should not be detected in the column:	
	20 cm	10 cm
4. Odor	Water should not acquire an odor intensity exceeding two points, which are detected:	
	Directly or upon subsequent chlorination	Directly
5. Temperature	Summer water temperatures as a result of wastewater discharges should not rise by more than 3°C in comparison with the monthly average water temperature for the hottest month of the year for the last decade.	
6. pH value	Should not exceed 6.5 - 8.5	
7. Water salinity	Not exceeding 1000 mg/L, including chlorides: 350; sulfates: 500 mg/L	
8. Dissolved oxygen	Should be a minimum of 4 mg /L at any time of year, in samples collected before 12 pm	
9. Biochemical oxygen demand (BOD)	At a temperature of 20 °C should not exceed:	
	2 mg O_2/L	4 mg O_2/L
10. Chemical oxygen demand(bichromateoxidability) (COD)	Should not exceed:	
	15 mg O_2/L	30 mg O_2/L
11. Chemical matters	Should not be contained in water bodies in concentrations exceeding the maximum permissible concentration or approximate permissible level	
12. Causative agents of enteric infections	Water should not contain causative agents of enteric infections	
13. Viable helminth eggs (ascarids, whipworm, toxocara, fasciola and others), armed tapeworm and viable cysts of pathogenic intestinal protozoa	Should not be contained in 25 liters of water	
14. Thermotolerant coliform bacteria **	Not exceeding:	
	100 CFU /100 ml**	100 CFU /100 ml
15. Total coliform bacteria **	Not exceeding:	
	1000 CFU /100 ml**	500 CFU /100ml
16. Coliphage **	Not exceeding:	
	10 PFU/100 ml**	10 PFU/100 ml
17. Total volumetric activity of radionuclides at compresence***	$\sum(\frac{A_i}{VB_i}) \leq 1$	

Notes:

* - Content of suspended solids in the water of neprirodnogo origin (flakes of metal hydroxides, resulting from the treatment of wastewater, particles of asbestos, glass fibers, basalt, kapron, lavsan, etc.) is not allowed;
** - For the centralized water supply, when decontaminating necentralizovannom from the water supply;
*** - When exceeding the levels of radioactive contamination of the water, additional control of radionuclide contamination applies in accordance with regulations on radiation safety. 1 -specific activity i-equipment of the radionuclide in the water. VB1 -appropriate level of intervention for the i-equipment of the radionuclide.
Source: San PiN No. 0172-04. “Hygienic requirements to protect surface waters in the territory of the Republic of Uzbekistan”).

The maximum permissible concentration (MPC) of pollutants in surface water is illustrated in Table 8.6.4.3-2. MPC is divided into four categories, the most relevant of which is under Fisheries. According to Goskompriroda, water will be discharged into Karakamysh Canal under the Fishery MPC category respectively, but there are no monitoring activities conducted in Karakamysh Canal. There are also some pollutant materials such as SS overlapping with the environmental standard, whereupon the environmental standard is superseded.

Table 8.6.4.3-2 Maximum Permissible Concentration (MPC) of Pollutants in Surface Water

Parameters	Fishery	Culture-household	Household-drinking	Irrigation*
COD	15	40	30	40
BOD20, mgO/L	3	3-6	3-7	10
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Suspended matters	15	30	30	50
Salinity	1000	1000	1000-1500	1000
Including: sulfates	100	500	400-500	
Chlorides	300	350	250-350	
Ca	190			
Mg	40			
Ammonium nitrogen (ammonium salt) (NH_4^+)	0.5	2	0.5	1.5
Nitrite nitrogen (NO_2^-)	0.02	0.5	3	0.5
Nitrate nitrogen (NO_3^-)	9.1	25	45	25
Nitrites	0.08	3.3	3	
Nitrates	40	45	45	
Phosphates (PO_4^{3-})	0.3	1	3.5	1
Ether-solubles	0.05	0.8	0.8	0.8
Oil products	0.05	0.3	0.1	0.3
Synthetic Surface Active Agents`	0.1	0.5	0.5	0.5
Phenol	0.001	0.001	0.001-0.1	0.001
Fluorine (F)	0.05	1.5	0.7	1
Arsenic (As)	0.05	0.05	0.05	0.1
Iron (Fe)	0.05	0.5	0.3-3	5
Chrome (Cr^{6-})	0.001	0.1	0.05	0.1
Copper (Cu)	0.001	1	1	1
Zinc (Zn)	0.01	1	3	5
Cyanides	0.05	0.1		
Lead (Pb)	0.03	0.1	0.03	0.2
Nickel (Ni)	0.01	0.1	0.1	
Cadmium (Cd)	0.005	0.01		
Cobalt (Co)	0.1	1		
Molybdenum (Mo)	0.0012	0.5	0.25	
Strontium (Sr_2^+)		2	7	
Selenium (Se)	0.001		0.01	
Thiocyanates	0.1			
Mercury (Hg)		0.005	0.0005	

Source: San PiN No. 0172-04. “Hygienic requirements to protect surface waters in the territory of the Republic of Uzbekistan”).

Standard waste water discharge

Discharge of waste water from the Tashkent TashTETs-2 should be performed such as to ensure that the discharge water, surface watercourse and sink waste water meets the quality standard based on the requirements of the Decree of the Cabinet of Ministers No. 14, January 21, 2014. The estimated concentrations of wastewater discharge from the TashTETs-2 unit are listed in Table 8.6.4.3-3.

Table 8.6.4.3-3 Quality Standard of Wastewater Discharge to the Tashkent TashTETs-2

Indicator composition of wastewater*	Unit	Standard	Guide to CCA WB/IFC OST
pH	-	6.5 -8.5	6.5 -8.9
Suspended solids	mg/l	15	50
Dry residue	mg/l	1000	-
Petroleum Products	mg/l	0.5	10
Nitrite	mg/l	0.02	-
Nitrates	mg/l	9.1	-
Sulfate	mg/l	100	-
Chloride	mg/l	300	-
Ammonium-nitrogen	mg/l	0.5	-
Phosphate	mg/l	0.3	-
Iron	mg/l	0.05	1.0
Copper	mg/l	0.001	0.5
Zinc	mg/l	0.01	0.5
BOD	mg/l	3.0	0.5

*List of pollutants subject to regulation, defines application 13 to the provisions on project development procedure and harmonization of environmental standards (Source: Decree of the Cabinet of Ministers No. 14 from Jan. 21, 2014)

After EIA approval has been obtained, a Normative Document with detailed water discharge and MPC must be prepared for Goskompriroda approval, as for exhaust air quality and the final MPC will be sent for compliance.

8.6.4.4 Noise and Vibration

The standard for noise and sound pressure level and the environmental standard for areas directly adjacent to homes are shown in Tables 8.6.4.4-1 and 8.6.4.4-2.

The noise level should not exceed 45 decibels at night and 55 decibels in daytime in accordance with KMC 2.01.08-96 “Protection against noise” (The State Committee of the Republic of Uzbekistan for architecture and construction, Tashkent, 1996). Noise is equivalent to the value of the standard Guide to CCA OST IFC/World Bank.

Permissible vibration levels (up to 50 DB) in houses are standardized under the hygienic standards of the Sanitary Standard of the Republic of Uzbekistan No. 04-0146 “Sanitary Rules and Norms in Design of Houses in the Climatic Conditions of Uzbekistan.”

Table 8.6.4.4-1 Environmental standard for noise (residential area)

Category	Standard, Uzbekistan		Guide to CCA WB/IFC OST (2007)	
	Day time	Night time	Day time	Night time
Residential area	55dB (A)	45dB (A)	55dB (A)	45dB (A)
Working area	80 dB (A)			

Source: KMK 2.01.08-96 “Protection against noise. (The State Committee of the Republic of Uzbekistan for architecture and construction, Tashkent, 1996); Sanitary code No. 0175-04” health standards for noise levels in the workplace.

There is also a rule on noise caused by equipment companies regulated under sanitary code No. 0175-04 “Sanitary norms of noise at work, under which the company’s noise level must not exceed 80 DB.

Determination of Daytime and Night Time: Day Time 7:00 AM to 23:00 PM, Night Time 23:00 PM to 7:00 AM.

Table 8.6.4.4-2 DB sound pressure levels in octave bands with frequency in Hz

Premises and territory	Sound level, DB(a)	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Living rooms apartments, dormitories in preschool institutions	30	72	55	44	35	29	25	22	20	18
Territory, directly adjacent to the houses (within two meters of walls, platforms vacations neighborhoods and inside residential houses, a nursery, school sites	45	84	67	57	49	44	40	37	35	33

Source: KMK 2.01.08-96 “Protection against noise.” (The State Committee of the Republic of Uzbekistan for architecture and construction, Tashkent, 1996).

8.6.4.5 Waste

Regulations of waste production are implemented in accordance with the technological features of the main and auxiliary production (education and public nature of waste disposal is not standardized). Waste regulations are defined in units of mass (volume) in relation to the quantity of used raw materials, or the number of products. Limit values for mass, area and duration of the temporary placement of waste generated in primary and secondary production processes within the territory of the enterprise, determine the limits of waste disposal.

Waste disposal limits do not apply to:

- Objects of long-term storage of waste (over one year);
- Objects of permanent placement of waste (tailings, landfills, dumps, etc.);
- Waste disposal in the subsoil;
- Radioactive waste.

To improve the reception of waste and reduce human and environmental exposure, as well as address issues of their further processing and utilization, environmental protection measures are developed. The procedure for development projects of environmental regulations for waste disposal is governed by the resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 14, 21.01.2014. The hazard class of waste to the environment when developing environmental standards is in accordance with the catalog of waste. All the waste generated should be separated and disposed of in accordance with applicable laws and regulations. Waste recycling, reuse and reproduction of solid waste can only be performed by companies with permission. All waste is divided into the following five classes:

(I)	Highly dangerous
(II)	Dangerous
(III)	Moderately hazardous
(IV)	Slightly dangerous
(V)	Almost harmless

Source: Regulations on developing and coordinating project environmental regulations (Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. 14, Jan. 21, 2014.

8.6.4.6 Establishing Sanitary (Sanitary- Protective Zone: SPZ)

SPZ is set according to the sanitary norms, rules and regulations of the Republic of Uzbekistan hygienic sanitary code of the Republic of Uzbekistan No. 0246-08 “Sanitary norms and rules on the protection of atmospheric air of localities of the Republic of Uzbekistan.” SPZ has been established based on the Russian regulation and defines a specific area around any industrial development concerned of pollution, such as emissions of pollutant gas or contents, with residential areas or zones in the vicinity. This is a kind of buffer zone to protect residential areas and their livelihoods. Any developments of schools, hospitals, recreational park and related others are restricted in SP and SPZ is categorized in 5 levels according to the scale of facilities. The project land based on the project nature should be category IV (SPZ at 100m), but since the nearest residential areas are 200m from the land, SPZ will no longer apply.

8.7 JICA Guidelines for Environmental and Social Considerations

The purpose of the guidelines is to encourage the project proponent, Uzbekenergo JSC, to ensure appropriate consideration of environmental and social impacts, as well as ensuring that JICA’s support for and examination of environmental and social considerations are conducted accordingly. Organizations concerned with project implementation are responsible for taking environmental protection and social environment protection measures within the project framework. These measures are regulated by JICA Guidelines.

The JICA Environmental Guideline should be applied to the TashTETs-2 project and power transmission line facilities and the new 1.6km gas supply line to be constructed by the Uzbek side (with reference to “8.1.3 Summary of the related facility”) are considered as “associated necessary facilities[2].” According to the applicable local EIA regulation, these projects are under category II and EIA is necessary for both confirmed by Goskompriroda. The gas pipeline route is already finalized without any land acquisition necessary. However, the transmission line route remains unconfirmed. Accordingly, it is important for Uzbekenergo JSC to prioritize JICA Environmental Guidelines to a greater extent and apply them when implementing related facility development required.

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[2] Associated facilities, which are facilities that are not funded as part of the JICA project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.

8.8 Examination of Development Alternatives

8.8.1 Heat and Power Supply Station

8.8.1.1 “Do Nothing” Case

In case of project cancelation, the following tasks will not be solved:

- Partial covering of demand for heat and electricity among consumers in Tashkent with optimal use of fuel;
    - Providing additional power generation with total capacity of 120 MW at minimum fuel consumption;
    - Increased fuel efficiency by transferring to combined electricity and heat production with the use of high-technology gas turbines substituting for underperforming heating plants;
    - Increased efficiency of power generation from 33% (current average of power system) to 85% (advanced world experience);
    - Production of additional heat energy by exhaust gases with the capacity of 160 Gcal/h;
    - Release of electrical power of Uzbekenergo JSC to cover own needs of heating plant, about 67,000-71,000 MW per year;
    - Natural gas savings amounting to approximately 108 million Nm^3 per year;
- Creation of additional workplaces in the Yunus- Abod district of Tashkent, with about 50 workers during the operational phase;
- Reducing the environmental load on Tashkent;
    - Reduction in CO_2 emissions by approximately 206,000 tons per year;
    - Reduction in air pollution by 65%;
    - Reduction in nitrogen oxide concentration in exhaust gases in comparison with TC-4 through advanced combustion technologies to 1/3 of the original amount or less (concentration of nitrogen oxides in exhaust gases of gas turbines is 50 mg/m^3, in comparison with existing boilers which is 160 mg/m^3);
    - Reduction of noise and vibration impact on residential areas and buildings via a number of noise reduction measures on new gas-turbine equipment (noise reduction enclosure, silencers on chimneys, resilient base) and space-planning measures (larger distance from residential areas in comparison with existing TC -4 equipment).

Thus, “Do Nothing” option is not a recommendable alternative.

8.8.1.2 Examination of an Alternative Project Site

Initially, the city planned to implement the project within the existing TC-4 plant land. However, preliminary analysis shows the space of TC-4 is limited for installing new cogeneration plant equipment.

It has been decided to install 4 GTCS units in a site adjacent to the south-west boundary of TC-4. There is sufficient space to install the necessary GTCS equipment in this location. Moreover, there are also access roads and railroad tracks and existing infrastructure, including water treatment equipment and TC-4 utilities, is also operational. Considering the infrastructure requirements, such as fuel supply system, potential for materials and equipment transportation, economic efficiency in terms of construction, the proposed project site is the most appropriate alternative. The issues of the project site are as follows:

- Existing railroad tracks and approach ramp;
- Existing transmission line;
- Existing hot-water supply pipeline (M1 system).

Solving these issues will be decided on and reflected in the detailed design by Uzbekenergo JSC through coordination with other related organizations, such as railway company (UTY), before construction is implemented.

As the following Table 8.8.1-1 illustrates, the new TashTETs-2 facility west of the existing TC-4 land is considered the most preferable option, according to overall analysis of environmental, social and economic perspectives.

Table 8.8.1.2-1 TashTETs-2 Facility Development Plan Alternatives Comparison

	Do Nothing	South- West Site of TC-4 （Proposed Plan）	Within TC-4Property （TC-4 Land）
Environmental Aspects	CO_2 emission will not be reduced	• Reduce air pollution to 65% of current value • 206,000 tons of CO_2 will be reduced per year • Based on the newly introduced technology and systems, noise and vibration distributed to the surrounding area will be effectively reduced.	• Reduce air pollution to 65% of current value • 206,000 tons of CO_2 will be reduced per year • Based on the newly introduced technology and systems, noise and vibration distributed to the surrounding area will be effectively reduced.
Evaluation	C	A	A
Social Aspects	・No land acquisition and involuntary resettlement necessary ・No local employment can be expected.	• No land acquisition and involuntary resettlement necessary • Local employment can be expected.	• Land acquisition and involuntary resettlement will be necessary due to the lack of sufficient land in TC-4 • Local employment can be expected.
Evaluation	C	A	C
Economic Aspects	No construction cost necessary	Possible to generate 120 MW of electricity with minimum fuel cost	• Cost of resettlement should apply. • Possible to generate 120 MW of electricity with minimum fuel cost.
Evaluation	A	B	C
Technical Aspects	Low efficiency of electricity generation	・33% of power generation efficiency can be increased by 85%.	・33% of power generation efficiency can be increased by 85%.
Evaluation	C	A	A
Overall Evaluation	C	A	B

A: Best option B: Better than the other options C: Worse than the other options
Source: JICA Study Team

8.8.1.3 Consideration of Possible Technological Options of the Project

Three possible alternatives have been considered, each of which propose different sets of equipment, differing by specification and base-load operation (reference to 5.2):

1. Installation of 2 GTCS[3] (gas-turbine cogeneration units).
   Specification: 60 MW gas-turbine generator + 80 Gcal/h heat-recovery boiler.
   Base-load operation: (2) two main GTCS

2. Installation of three GTCS (gas-turbine cogeneration units).
   Specification: 40 MW gas-turbine generator + 53.3 Gcal/h heat-recovery boiler.
   Base-load operation: (3) three main GTCS

3. Installation of 4 GTCS (gas-turbine cogeneration units).
   Specification: 30 MW gas-turbine generator + 40 Gcal/h heat-recovery boiler.
   Base-load operation: (4) four main GTCS

According to the demand analysis performed in the project, the proposed site with system package 3 is the most preferable, with the existing electric power and heat generation needs and to minimize the impact on the environment.

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[3] GTCS：Gas-Turbine Cogeneration System

8.9 Scoping Environmental and Social Consideration

The project development should only be implemented by Uzbekenergo JSC within land for which Tashkent city owns the usage right so that the impact of the development is only expected within the project land. Accordingly, the project study was conducted at the IEE level with environmental and social considerations under the JICA Environmental Guidelines. Draft scoping of the project associated with TashTETs-2 is described in Table 8.9-1, according to the Guidelines, the reference on the EIA report and the results of the Pre- F/S made by Tashkent City.

Table 8.9-1 Scoping for TashTETs-2

No.	Item	Assessment				Reasons for assessment
		Construc-tion phase		Operation phase		
		Positive	Negative	Positive	Negative	
【Pollution】						
1	Air pollution	N	B	N	B	Construction phase: Dust formation during excavation and other construction works is expected. Formation of air pollutants (SOx, NOx, etc.) is assumed from the operation of heavy machinery and trucks, but the effects are local and will be limited to the vicinity. Operational phase: NOx might be generated during the operation of cogeneration thermal power plants.
2	Water pollution	N	B	N	B	Construction phase: Turbid water formed by dredging and land preparation. Waste water containing oil will be generated during the construction phase, but the effects may be limited to the vicinity. Operational phase: Wastewater generated during the operation of the cogeneration plant, including heating, blowdown and boiler water is discharged into the Karakamysh Canal. This wastewater is expected to be relatively clean and free of pollutants. There are plans to discharge domestic wastewater into the public sewage system.
3	Waste	N	B	N	B	Construction phase: Consumer waste and hazardous waste will be generated as a result of construction work. Illegally dumped waste has to be removed before starting land reclamation. Operational phase: Consumer waste, waste of production and consumption, including hazardous waste will be generated. Proper waste management in compliance with the regulations is necessary.
4	Soil pollution	N	B	N	B	Construction phase: The possibility of soil contamination caused by leakage of fuel and lubricants from construction machinery and vehicles is expected. Operational phase: The possibility of soil contamination caused by leakage of fuel and lubricants is expected during the operation of the cogeneration plant.
5	Noise and vibration	N	B	N	B	Construction phase: The impact of noise and vibration caused by the operation of heavy machinery and trucks will occur, but limited only in the vicinity. The effect of high noise, such as pile-driving, can be significant, but only for a short time. Operational phase: The noise and vibration by the operation of the cogeneration thermal power plant will be expected.
6	Ground Subsidence	N	N	N	N	Construction/Operation: Groundwater is not used.
7	Offensive odor	N	B	N	B	Construction phase: Waste rotting process in personal service rooms for workers and their disposal to landfill causes an objectionable odor of rotting waste. Operational phase: Removal and transport of waste containers to landfill will cause an objectionable odor.
8	Bottom sediment	N	B	N	B	Construction/Operation: Discharge of untreated wastewater may contaminate the Karakamysh Canal sediment.

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
【Natural environment】						
1	River water	N	N	N	B	Construction/Operation: River water is not used for any water use in the project. During operation, wastewater including hot water will be discharged into Karakamysh Canal. Accordingly, the flow volume, water quality and temperature may be impacted.
2	Ground water	N	N	N	N	Construction/Operation: Extraction of groundwater is not performed during the construction and operational phases.
3	Protected area	N	N	N	N	The project site is not located in a protected area and there are no protected areas located around the project site.
4	Terrestrial ecosystem and precious species	N	N	N	N	Construction/Operation: No impact is envisaged on vegetation and precious species of flora / fauna.
5	Marine ecosystem and precious species	N	N	N	N	Construction/Operation: The project does not apply with this section.
6	River ecosystem	N	N	N	N	Construction/Operation: Few aquatic organisms exist in Karakamysh Canal. Adverse effects on the ecosystem are negligible.
7	Marine condition	N	N	N	N	Construction/Operation: The project does not apply with this section.
8	Geographical features	N	N	N	N	Construction/Operation: The project site is located in the industrial zone of the city, without sudden changes in altitude in the territory; geographical features will remain unchanged.
【Social environment】						
1	Involuntary resettlement Land acquisition	N	N	N	N	The project site relates to state-owned land and no involuntary resettlement or land acquisition is foreseen under the development plan.
2	Poor People	N	N	N	N	There are hardly any poor people living in the projected land or around the site.
3	Minorities and Indigenous Peoples	N	N	N	N	There are no groups of minorities or indigenous peoples living around the project site.
4	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	B	N	B	N	Construction phase: There is the potential to provide job opportunities to local residents for construction work and construction materials and equipment may be purchased from local trade organizations. Operational phase: New workplaces may be created during the operation of TashTETs-2.
5	Land Use and Utilization of Local Resources	N	N	N	N	Construction/Operation: The project site is located on state-owned land and no land use change around the site will be expected.
6	Water use	N	N	N	N	Construction phase: Turbid water may be generated temporarily by violating the technology of construction work, but the amount of water involved will be limited. Fishing is not performed in the Karakamysh Canal, so no impact on water use is expected. Operational phase: The project will utilize tap water, so there are no impacts on water use in the vicinity.
7	Existing Social Infrastructure and Services	N	B	N	N	Construction phase: Construction staff for TashTETs-2 will be involved among the residents of Tashkent, so no houses for workers and their families are provided within the project scope. There is no need to improve infrastructure (houses, schools, hospitals, water-supply systems, sewage and gas pipelines in residential areas). The ride to and from work of construction workers will increase traffic on adjacent roads and the surrounding road network. Some congestion may be observed due to rearranging traffic in the surrounding areas,. Operational phase: Operating personnel for TashTETs-2 may be involved among the residents of Tashkent, so no houses for workers and their families are provided within the project. There is no need to improve infrastructure (houses, schools, hospitals, water-supply systems, sewage and gas pipelines in residential areas).

No.	Item	Assessment				Reasons for assessment
		Construction phase		Operation phase		
		Positive	Negative	Positive	Negative	
8	Social Institutions such as Social Capital and Local Decision-making Institutions	N	N	N	N	The project is not expected to have an impact on any social institutions because it utilizes the land which the city has the official right to use.
9	Misdistribution of Benefits and Loss	N	C	N	C	Construction/Operation: There might be inequality in local employment and contract, which will lead to a misdistribution of profits.
10	Local Conflicts of Interest	N	N	N	N	No local conflicts of interest are expected because of the absence of resettlement or land acquisition.
11	Cultural heritage	N	N	N	N	There are no historical, cultural, religious and archeological sites or heritage sites around the project site.
12	Landscape	N	N	N	N	There is no scenic area around the project site to be considered. The project will utilize four tall stacks, but the site is in an industrial area and there are other stacks in the surrounding area. Accordingly, no landscape issues are expected.
13	Gender	N	N	N	N	Construction/Operation: No specific impact on gender is expected in the project.
14	Children’s Rights	N	N	N	N	Construction/Operation: No specific impact on children’s rights is expected in the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	Construction phase: A temporary influx of migrants during the construction period may increase the risk of infectious diseases. Accordingly, periodic medical examinations are required. Operational phase: only limited personnel will access the facility and property. Accordingly, no high risk of infections is envisaged.
16	Labor Environment (Including Work Safety)	N	B	N	B	Construction/Operation: Occupational injuries of workers are projected during the construction work.
【Others】						
1	Accidents	N	B	N	B	Construction phase: Potential for accidents during the construction works and operation of construction machines. Operational phase: Potential for accidents during operation of the facility and of vehicles.
2	Cross-boundary Impact and Climate Change	N	N	B	N	Construction phase: Although CO_2 will be generated during construction works, the construction period is limited and cross-boundary pollution and impact on climate change is projected as insignificant. Operational phase: CO_2 generated during the operation of TashTETs-2 is lower than during the production of traditional energy sources, hence the impact on climate change will be positive. No cross-boundary impacts from emissions, discharges and waste, generated by cogeneration thermal power plants, are expected.

Notes; The categorization criteria are as follows:

A: A significant positive/negative impact is expected.
B: A positive/negative impact is expected to some extent.
C: The extent of any positive/negative impact is unknown.
(Further examination is needed and the impact may be clarified as the study progresses.)
N: No impact is expected.

Source: JICA Study Team

8.10 Points That Have Been Taken into Consideration for the Environmental and Social Consideration Study

Considering items that could be affected, the current status of environment, impact prediction and mitigation measures are borrowed from the previous EIA report and pre- F/S document provided by the project proponent. The information is analyzed for certain items as required based on the aforementioned scoping result. The Terms of Reference are shown in Table 8.10-1.

The baseline data confirmation: Collecting the latest information regarding environmental impact prediction.

- Prediction and assessment of environmental impact: Based on the items confirmed through the scoping, the quantitative and qualitative prediction and assessment of impacts during construction and operational phases shall be conducted as required.
- Natural environment: the data on ambient air quality, meteorology, water quality, flora and fauna shall be acquired and organized. Consultation to relevant authorities is also conducted as required.
- Social environment: the data on social environment, such as land use, land traffic, fishery, sanitation, population status, education, social infrastructure, occupation and income as well as scenic area, cultural heritage and minority groups shall be acquired and organized. Consultation to relevant authorities is also conducted as required.
- Stakeholder meeting: Engagements with local residents shall be established to promote understanding of the EIA and its purposes. The project information shall be shared, opinions and comments collected and the response thereto given. The stakeholder meeting shall be held at least twice: Firstly during the scoping stage and secondly on completion of the draft EIA report.
- Confirmation of land acquisition and resettlement plan (if the development plan changes with different land requiring acquisition and resettlement): The land for cogeneration plants and other associated facilities as well as transmission lines, if already acquired, must be confirmed as compliant with JICA Guidelines, including the acquisition process. In case significant discrepancies of JICA Guidelines are identified, an action plan shall be proposed to resolve the same as far as possible. All the planned procedures shall comply with the JICA Guidelines and the local laws and regulation subject to the project implementation.

Table 8.10-1 Survey Items, Survey Method, Assessment and Mitigation Measures (TashTETs-2)

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Air pollution	- Environmental standard - Meteorological data - Current air quality	- Confirmation of air quality standards and standard of gas emissions - Confirmation of meteorological data (temperature, wind speed, wind direction, etc.) - Confirmation of the measurement result of air pollutants in ambient air	- During the construction phase measures should be taken to mitigate the effects of air pollution. - The standard of gas emissions must be confirmed during the operational phase. - Calculation of pollutant dispersion in the atmospheric surface layer is performed during the operational phase to verify compliance with environmental standards.	- Calculation of pollutant dispersion in the atmospheric surface layer was performed and measures developed to reduce pollution by the project proponent. Data analysis and additional forecast assessments must be performed as required.
Water pollution/ River water	- Corresponding environmental standard - Current state of flow - Current water quality	- Confirmation of water quality standard and polluted runoff discharge standard. - Confirmation of flow current state measurements results. - Confirmation of water quality measurement results in the Karakamysh Canal.	- During the construction phase, measures to mitigate the effects of water pollution should be taken. - Modeling of thermal discharge diffusion performed during the operation stage to demonstrate compliance with environmental standards. - Discharges of TashTETs-2 must be treated to meet the discharge standards of polluted runoff during operation.	A forecast evaluation was conducted and measures developed to reduce the pollution level by the project proponent. Data analysis and additional forecasting assessment must be performed as required.
Waste/Offensive odor	- Corresponding standards	- Confirmation of waste management standard	- General information about waste generated during construction and operation, ensuring reuse, recycling or treatment accordingly.	Measures to reduce pollution are developed by the project proponent. Data analysis and additional mitigation measures are considered as required.
Soil pollution	- Corresponding standards	- Confirmation of soil pollution standard	- Measures to reduce oil pollution should be taken during construction and operation.	Measures to reduce pollution level are developed by the project proponent. Data analysis and additional mitigation measures are considered as required.
Noise and vibration	- Corresponding environmental standard - Current state of noise and vibration	- Confirmation of noise standard. - Confirmation of noise and vibration measurement results.	- Measures to reduce noise and vibration should be taken during construction and operation. - Forecast of noise is conducted to confirm compliance with environmental standards.	Forecast of impacts and measures to reduce the level were conducted by the project proponent.

Environmental items	Survey item	Survey method	Assessment and mitigation measure	Considerations
Bottom Sediment	- Status of canal bottom sediment.	- Confirmation of available information of document.	- Measures to mitigate the impact on discharge water to canal should be taken during construction and operation.	- If the precious condition changes in the canal bottom sediment within the canal system at the project site relocation, other mitigation measures should be performed.
Existing Social Infrastructure and Services	- Current state of land use. - Current state of roads - Current state of infrastructure facilities. - Assessment of probability of traffic congestion during the construction.	- Collection of information on road conditions. - Data collection about infrastructure facilities. - Approval of the development plan for the local economy - Collection of data regarding actual traffic congestion along the construction purpose roads and some branched roads.	- Infrastructure for operational phase. - Development of measures to mitigate the consequences of injuries. - Taking traffic diversion to control traffic around the construction site as required.	Mitigation measures developed by the project proponent. Data analysis and additional forecast assessment should be conducted as required. Plan effective and minimum diversion route to reduce congestion as well as travel time while securing traffic safety as the diversion may require unusual driving directions in the local vicinity.
Misdistribution of Benefits and Loss	- Current status of employment and means of livelihood of the area - Approval of the local economy development plan.	- Collection of information about the condition of local employment and means of livelihood	- Development of fair terms of employment criteria.	- Development of mitigation measures as required.
Infectious Diseases such as HIV/AIDS	- Current state of morbidity level, including infectious diseases	- Collection of information about morbidity level in the project implementation area	Development of preventive measures to reduce morbidity.	Mitigation measures were developed by the project proponent. Data analysis and additional forecast assessment should be conducted as required.
Labor Environment (Including Work Safety)	Work safety rules	Studying of existing documents.	- Development of measures of safe labor organization	Data analysis and additional forecast assessments should be conducted as required.
Accidents	Assessment of probability of emergency situations.	Data collection about emergencies and injuries caused by them	- Development of mitigation measures of occupational injury consequences during construction and operation.	Mitigation measures were developed by the project proponent. Data analysis and additional forecast assessment should be conducted as required.

Source: JICA Study Team

8.11 Result of Environmental and Social Consideration Survey

8.11.1 Result of Project Study

The result of the project development environmental impact analysis on both TashTETs-2 and transmission line developments are collectively illustrated hereafter.

(1) During the Construction of Project Facilities

A) Air Pollution

Emissions of NOx (Nitrogen Oxide) and SOx (Sulfur Oxides) for construction equipment and heavy machinery are envisaged, but the amount will be very limited during the limited construction period. The following measures will also be taken into account, hence the environmental impact should be minimal:

- Implementation of periodical maintenance checks and cleaning of construction vehicles and equipment.
- Implementation of stop-idling of construction vehicles and equipment.
- Implementation of covering applications to materials transported by construction vehicles.
- Implementation of water springing where dust is expected during construction work.

B) Water Pollution / Bottom Sediment

Water will be taken from the city water-supply line during construction. Waste water, particularly that categorized as industrial waste, from construction activities will be treated and discharged. Common soil water will be discharged into the city sewer lines. Some muddy and greasy water will be collected at the site trench to ensure discharge of these pollutants is controlled. Accordingly, construction will only involve very limited water contamination.

C) Waste / Offensive Odor

Soil and other industrial waste from the construction activities will be controlled for regulated dumping at the designated site, to facilitate waste management in the project area. The illegal dumping of waste exists in the proposed and about 9,600m³ of soil will also be removed and transported to the designated waste dump site as part of plans, to be confirmed by Uzbekenergo JSC before performing the work.

An offensive odor according to waste removal during earlier on-site construction activities will occur with dust spreading as unregulated waste dumping is cleared. Some construction measures such as sprinkling water while moving the waste will reduce the odor problem. Minimizing the waste removal work time will reduce the major impact on the neighboring community and the other odors may also be short-lived, so the impact should be minimal.

The implementation agency will prepare a proper waste management plan for waste reduction, separation and others with worker training, to ensure appropriate waste management and disposal. Accordingly, scope for waste management and odor problems during construction work will be minimal.

D) Soil Contamination

During the site clearance and level control in the project site, a significant volume of existing waste should be removed from the site and works may involve the release of some oil-containing materials and watery soil leaking into the ground. However, a well-designed construction plan and method as well as implementation of the same (including an oil trap and leak prevention system installation) should help minimize such causes of contamination to the site.

E) Noise and Vibration

During construction, noise and vibration may be emitted from the construction equipment and machinery. Accordingly, an appropriate construction plan and method should be made and implemented to minimize emissions to surrounding buildings and facilities. The implementation agency should set out the following action plans to minimize the negative impact on the surrounding communities, hence minimal noise and vibration can be expected during the construction period:

- Use low-noise and vibration construction equipment
- Apply periodical maintenance checks and cleaning of construction vehicles and equipment
- Limit construction working hours during daytime
- Install a noise barrier or panel at the construction perimeter

F) Existing Infrastructure and Social Services

Possible construction-oriented accidents and traffic congestion are envisaged during construction. To protect the local community and people, the construction site and roads will be supervised and operated by designated construction security and guard officials located in appropriate positions. The following measures shall be taken:

- Reducing vehicle speed within or around school and residential areas
- Minimizing driving during school hours in the morning and afternoon

A well-organized construction plan and method and implementation of the same will reduce and minimize accidents and congestion.

G) Misdistribution of Benefits and Loss

There will be possible employment and material purchase for construction works in the local community and a positive impact on the local economy, albeit small. However, such employment or resource opportunities will be limited within the region and the fairness of opportunity distribution should be effectively taken into account for larger areas of the city.

H) Infectious Diseases such as HIV/AIDS

There will be construction-oriented migration from other regions of the country and some problems involving transmission of infectious diseases may occur among people living in or around the project construction area. Such disease-related education and infection protection measures should be effectively taken to prevent disease-transmission activities among people and implementing such prevention measures will minimize the negative impact.

I) Construction Working Environment / Accidents

All relevant laws and regulation concerning the working environment and worker protection will be followed during the construction period and implementation organization as well as contractors preparing a safety management program to follow. There will also be periodical training or instructions given to workers using safety gear and on methods of handling hazardous materials. Through such practices, work safety control and management should be implemented effectively throughout the entire construction period.

(2) During the Operational Stage

A) Air Pollution

It is envisaged that NOx (Nitrogen Oxide) may be emitted from the TashTETs-2 facility during its operation. The facility will use natural gas as fuel, to minimize SOx and particulate matter. To operate the facility under Tashkent prepared EIA, an NO_2 distribution simulation was made. After the new facility becomes operational, three (3) old boilers of TC-4 (Nos. 1, 2 and 3) will be gradually shut down and an EIA conducted for the simulation in the city within 4km square of land with change in air quality within 30 minutes as illustrated in the following table:

Table 8.11.1-1 Origin of Emission and Criteria for evaluation after the Project Implementation

#	Facility	Origin of Emission	Stuck Height（m）	Stuck Diameter（m）
1	TC-4	No. 4	55	3.2
2		No. 5	55	3.2
3		Nos. 6～12	150	7.2
4	This Project Facility	No. 1	80	5
5		No. 2	80	5
6		No. 3	80	5
7		No. 4	80	5

Note: There is no regulation for stuck height under the environmental evaluation perspective other than the structural regulation.

NO_2 distribution level simulation before the project implementation with all TC-4 boilers operated (Figure 8.11.1-1) and after the operation (Figure 8.11.1-2) are shown hereafter. The NO_2 emission within the area will be reduced from 0.77MPC at maximum (0.77 times of MPC) to 0.50MPC (0.5 times MPC) and the simulation result of the project is deemed to improve air quality. In addition, the project facility is considered with a low NOx burner to reduce NOx.

Accordingly, the impact of the project facility exhaust is considerably minor and the surrounding environment will be improved. Once the EIA for the project is approved, a new Normative Document should be prepared in accordance with the instruction by Goskompriroda before the operation.

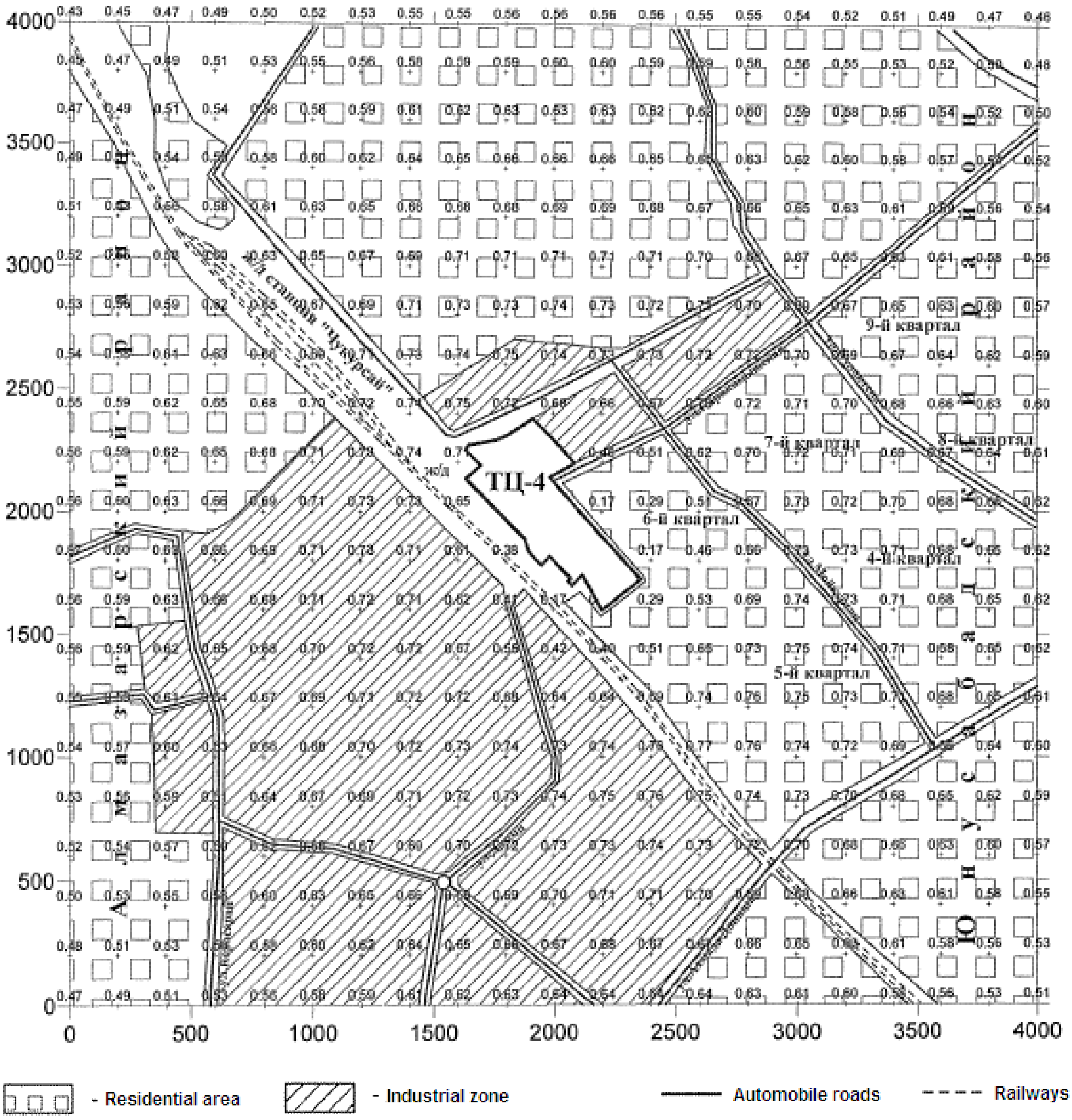


Figure 8.11.1-1 Air Quality Change Simulation Result (NO_2) – Before Project Implementation

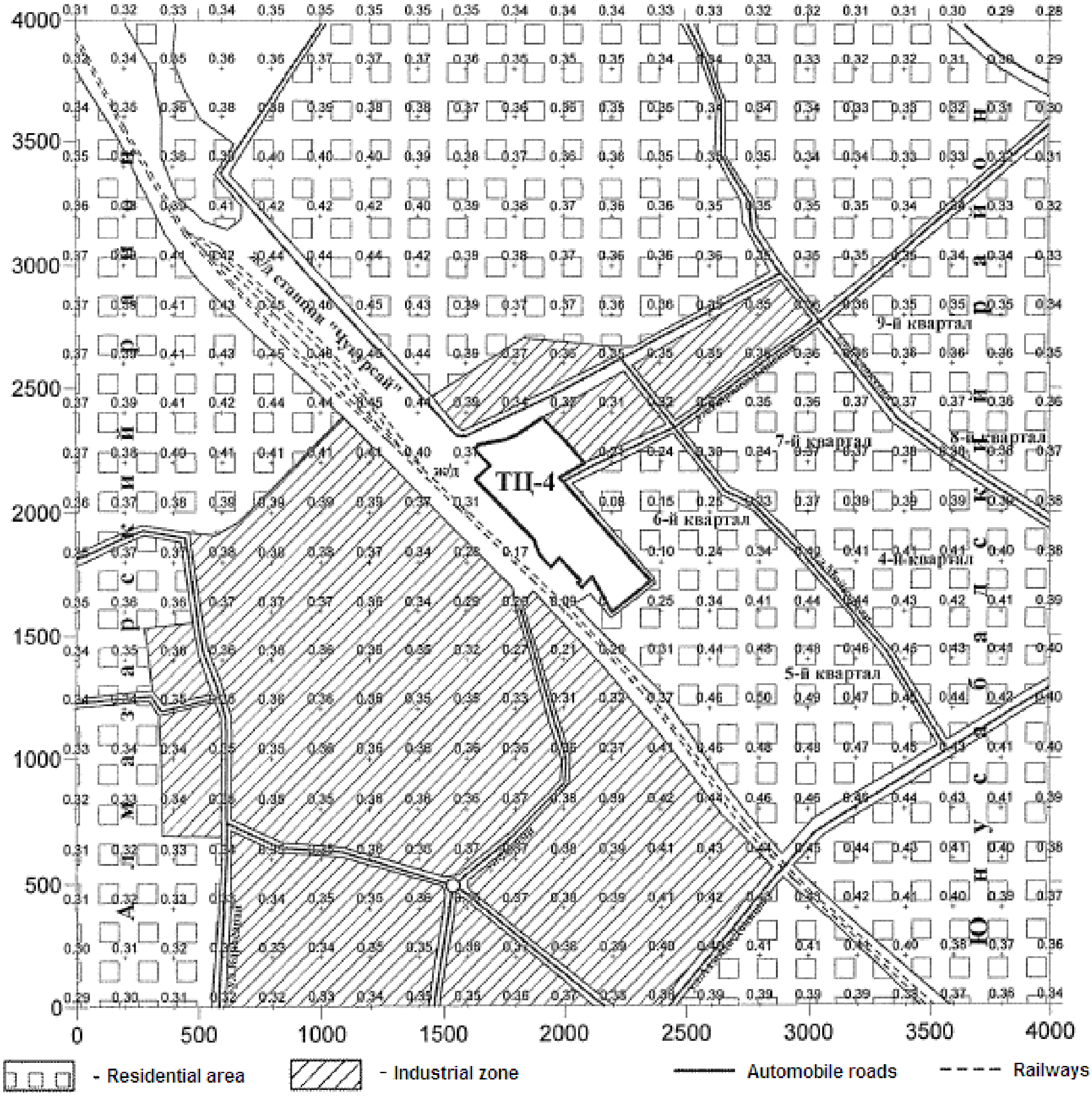


Figure 8.11.1-2 Air Quality Change Simulation Result (NO_2) – After Project Implementation

B) Water Pollution / River Water / Bottom Sediment

Waste water discharge from TashTETs-2 includes hot water, boiler water and cooling blow water and hot water and boiler water supplied from the treated water from TC-4 as well. This means no hazardous materials to be used in bulk in the facility and the water quality from TashTETs-2 should resemble that of TC-4. Cooling water will be supplied from the city mains as a sealed supply system, so the discharged cooling blow water should have quality equivalent to the city water supply. TashTETs-2 is planned to have waste water treatment tank to control the water temperature and water will be discharged to Karakamysh Canal after cooling down. Furthermore, the amount of treated waste water discharged into the canal will be minimal compared to the water volume of the Karakamysh Canal, so the impact will also be minimal and the water temperature increase will be limited to under 3 degrees Celsius. Accordingly, the impact on the canal water by the discharge of facility waste water is considered minimal based on the above noted treatment method and system. Moreover, since there are no fishery activities along Karakamysh Canal, nor any precious species existing in the same, the impact on the lower reach is also minimal. After the EIA for the project is approved, a new Normative Document should be prepared in accordance with the instruction by Goskompriroda before the operation.

C) Waste

The amount of waste generated during the facility operation will be limited and treated in accordance with the applicable regulation of Uzbekistan as required. Although the material generated from system operation will be harmless, all waste will be treated and processed in accordance with the applicable law and regulations of Uzbekistan. The waste management plan is as follows:

Table 8.11.1-2 Waste Management Plan

Type of waste	Treatment/recycling plan
Scrap ferrous metal, scrap non-ferrous metal, ferrous metal chips, electrode waste	After temporary storage ferrous metals are transported to ferrous metal recycling enterprise (Vtorchermet), non-ferrous metals are transported to “Tashrangmetzavod” JSC in Tashkent city.
Transformer oil waste, used turbine oil	Reuse of used oil at the plant after temporary storage. Part of the oil is transported to the nearest petroleum storage depot.
Waste tires	Transportation to the recycling enterprise after temporary storage.
Sediment from turbine oil purification	Transportation to the nearest petroleum storage depot for recycling.
Waste batteries, sludge from wastewater treatment unit, sediment from preliminarily purified raw water, sediment from chemical purification of compressors and pipelines, waste lime, waste salt, waste insulating material, construction waste	Transportation to a specially allocated place at the solid domestic waste landfill site of Tashkent city.
Solid domestic waste	Transportation to the solid domestic waste landfill site of Tashkent city.
Waste paper	Recycling
Waste fluorescent lamps	Transportation to a specialized company “Selta” for demercuration.
Food waste	Reuse as fodder.

D) Soil Contamination

Possible oily waste will be discharged from the facility equipment, but such materials will be corrected by the installed trench system and treated at the waste treatment facility in the TashTETs-2. Where any leakage of pollutant or waste is identified, absorption, protective or leak blockage measures will be conducted immediately so that such leak can be collected within the facility perimeter. Accordingly, the impact on the soil environment after the operation is considered minimal.

E) Noise and Vibration

When the TashTETs-2 facility equipment is operated, noise and vibration will be generated and distributed. The calculated possible noise level at the site perimeter is 55 to 70dB and the level in the residential area (approximately 200m away) is about 45dB, which is under the regulated noise level of Uzbekistan as well as the IFC/WB standard. Accordingly, the noise impact of the project facility should be relatively small. The detailed design of the foundation, main structure and architectural details will come with noise- and vibration-reducing mechanisms or absorbent material, so that it is also considered that such building design limits the distribution of noise and vibration to the surrounding area below the regulated level.

F) Offensive Odor

A major cause of odor from the facility after the operation started was the exhaust from the daily workers' use and waste such as food waste dumped into the trash container. However, periodical waste management and measures as well as continuous cleaning of the facility will minimize the odor impact on the region, hence the impact is considered minimal.

G) Misdistribution of Benefits and Loss

The facility operation requires certain technicians and engineers to employ, but the final decisions will be made by the implementation agency, Uzbekenergo JSC and this employment activity will not have a significant impact on the local economy. However, given the cleaning, security and assistance tasks required to operate the facility, a small but positive impact on local employment is expected. When employment plans and activities are arranged in accordance with the facility operation, effective and fair social care to the surrounding community should be made to avoid conflict.

H) Accident

An accident may occur during the facility operation due to maintenance and repair works. Preparing maintenance and operation as well as repair-related activity manual will help minimize the cause and event of accidents.

8.11.2 Result of the Survey of Environmental and Social Consideration

The environmental impact assessment according to the survey results is described in Table 8.11.2-1.

Table 8.11.2-1 The Environmental Assessment Result

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
【Pollution】										
1	Air pollution	N	B	N	B	N	B	N	B	Construction phase: Dust formation during excavation and other construction works is expected. Formation of air pollutants (SOx, NOx, etc.) is assumed from the operation of heavy machinery and trucks, but the effects are local and will be limited to the construction site. Operational phase: Emission from the stacks includes NOx. According to the simulation previously conducted by Tashkent City, the maximum concentration at ground level complies with the environmental standards of Uzbekistan, as well as international standards.
2	Water pollution	N	B	N	B	N	B	N	B	Construction phase: Turbid water formed by dredging and land preparation. Waste water containing oil generated during the construction phase, but the effects will be limited to the construction site. Wastewater is collected in specially designed ponds and transported in special vehicles to the treatment plant in the city of Tashkent. Operational phase: Wastewater generated during the operation of cogeneration plant is discharged into the Karakamysh Canal. Wastewater from water treatment station and other wastewater is treated before discharge. Since the amount of thermal wastewater is significantly less than the water of the irrigation canal, the increase in water temperature will not exceed 3^{o}C and warmed water area will be limited to the vicinity of the water outlet. Sewerage waters produced by the project are discharged into the municipal sewer system.
3	Waste	N	B	N	B	N	B	N	B	Construction phase: Consumer waste or hazardous waste is generated as a result of construction works. However, the project proponent will prepare a developed Waste Management program to minimize the impact. Operational phase: Consumer waste, production and consumption waste, including hazardous waste, is generated. However, the project proponent will prepare a developed Waste Management program.
4	Soil pollution	N	B	N	B	N	B	N	B	Construction phase: The possibility of soil contamination caused by leakage of fuel and lubricants from construction machinery and vehicles, but the effect will be limited to within the boundaries of the construction site. Operational phase: The possibility of soil contamination caused by leakage of fuel and lubricants during the operation of TashTETs-2.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
5	Noise and vibration	N	B	N	B	N	B	N	B	Construction phase: The impact of noise and vibration caused by the operation of heavy machinery and trucks will be limited to within the construction site. The effect of high noise, such as pile-driving, will be effectively controlled by limiting construction to daytime. The noise standard for daytime will be respected. In addition, no construction work will take place at night. Accordingly, no noise will be generated at night time. Operational phase: The noise will be generated from the facility. However, with noise prevention measures installed, the impact of noise and vibration from operating the cogeneration thermal power plant will not exceed the established standards.
6	Ground Subsidence	N	N	N	N	N	N	N	N	Construction/Operation: No groundwater is used.
7	Offensive odor	N	B	N	B	N	N	N	N	Construction/Operational phase: Delayed removal of waste containers to landfill will result in an objectionable odor. However, the amount of garbage such as food waste which causes odor is likely to be small considering the scale of the facility, hence the impact of offensive odor will be negligible.
8	Bottom sediment	N	B	N	B	N	B	N	B	Construction/Operation: Discharge of untreated wastewater may contaminate sediments. Although the amount of wastewater should not impact on the bottom environment of the canal or its aquatic activities, prevention measures to protect the canal sediments should be properly installed..
【Natural environment】										
1	River water	N	N	N	B	N	N	N	B	Construction phase: No river water is used. Operational phase: Because the facility utilizes a closed cooling system, the amount of wastewater discharged into the canal is expected to be minimal. However, proper treatment for temperature and oil contamination is necessary.
2	Ground water	N	N	N	N	N	N	N	N	Construction/Operation: No groundwater is extracted during the construction and operational phases.
3	Protected area	N	N	N	N	N	N	N	N	The area of TashTETs-2 is not located in a protected area and there are no protected areas located within 50km.
4	Terrestrial ecosystem and precious species	N	N	N	N	N	N	N	N	Construction/Operation: The project site is unused land, without management or vegetation. There are no precious species of flora / fauna subject to major protection at the project site.
5	Marine ecosystem and precious species	N	N	N	N	N	N	N	N	Construction/Operation: This section does not apply to the project.
6	River ecosystem	N	N	N	N	N	N	N	N	Construction/Operation: Few aquatic organisms exist in Karakamysh Canal and the adverse effects on the ecosystem are very limited.
7	Marine condition	N	N	N	N	N	N	N	N	Construction/Operation: This section does not apply to the project.
8	Geographical features	N	N	N	N	N	N	N	N	Construction/Operation: The project site is located on a slightly sloping plain and its geographical features will remain unchanged.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction Period		Operation Period		Construction Period		Operation Period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
【Social environment】										
1	Involuntary resettlement Land acquisition	N	N	N	N	N	N	N	N	Implementation of the project does not require resettlement.
2	Poor People	N	N	N	N	N	N	N	N	Minimum income of every citizen of Uzbekistan is guaranteed by law. There are no poor people around the construction project site.
3	Minorities and Indigenous Peoples	N	N	N	N	N	N	N	N	There are no groups of minorities or Indigenous Peoples living around the project site.
4	Deterioration of Local Economy Such as Losses of Employment and Livelihood Means	B	N	B	N	B	N	B	N	Construction phase: There is the chance to provide work to local residents in construction; construction materials and equipment can be purchased from local trade organizations. Operational phase: New workplaces will possibly be created while TashTETs-2 is in operation.
5	Land Use and Utilization of Local Resources	N	N	N	N	N	N	N	N	Construction/Operation: The project site is located on state-owned land and involuntary resettlement will not happen. The project site comprises unused land and land use and the use of local resources are not infringed by the project.
6	Water use	N	N	N	N	N	N	N	N	Construction phase: Tap water from the existing water-supply system will be used for construction and drinking needs of construction workers. Operational phase: Tap water is used to meet the technical and domestic needs of TashTETs-2. Waste water will be discharged into Karakamysh Canal, which is used for irrigation and fishing is not normally conducted, so water use is hardly affected by the project.
7	Existing Social Infrastructure and Services	N	B	N	N	N	B	N	N	Construction/operation: The ride to and from work of power plant staff will increase traffic on adjacent roads and the surrounding road network. Proper measures should be implemented.
8	Social Institutions such as Social Capital and Local Decision -making Institutions	N	N	N	N	N	N	N	N	There is no impact on social life and services envisaged by both construction and operation.
9	Misdistribution of Benefits and Loss	N	C	N	C	N	B	N	B	Construction/Operation: There might be inequality in local employment and contracts, which will lead to misdistribution of profit. Although hardly any poor are observed around the site, misdistribution of benefit and losses around the site should be carefully considered.

No.	Items	Assessment at the scoping				Assessment based survey results				Reason for assessment
		Construction period		Operation period		Construction period		Operation period		
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	
10	Local Conflicts of Interest	N	N	N	N	N	N	N	N	Local conflicts of interest are not expected due to the absence of resettlement.
11	Cultural heritage	N	N	N	N	N	N	N	N	There are no historical, cultural, religious and archeological sites and heritages around the project site.
12	Landscape	N	N	N	N	N	N	N	N	There is no scenic area to be damaged around the project site.
13	Gender	N	N	N	N	N	N	N	N	Construction/Operation: No specific impact on gender is expected in the project.
14	Children's Rights	N	N	N	N	N	N	N	N	Construction/Operation: No specific impact on children's rights is expected in the project.
15	Infectious Diseases such as HIV/AIDS	N	B	N	N	N	B	N	N	Construction phase: A temporary influx of migrants during the construction period may increase the risk of infectious diseases. The project proponent will develop a management plan for health and safety and perform regular medical examinations. Operational phase: only limited personnel will access the facility and property, so no high risk of infections is envisaged.
16	Labor Environment (Including Work Safety)	N	B	N	B	N	B	N	B	Construction/Operation: Occupational injuries of workers are projected in the construction work. The project proponent will implement the project in accordance with the Labor Law. The project proponent will develop a management plan for health and safety and carry out regular medical examinations. The project proponent will subcontract with a security company to use security.
【Others】										
1	Accidents	N	B	N	B	N	B	N	B	Construction phase: Possibility of accidents during the construction works and operation of construction machines. Operational phase: Potential for accidents during operation of the facility and operation of vehicles.
2	Cross-boundary Impact and Climate Change	N	N	B	N	N	N	B	N	Construction phase: Although CO_2 will be generated during construction works, the construction period is limited and cross-boundary pollution and impact on climate change is forecast to be insignificant. Operational phase: CO_2 generated during operation of TashTETs-2 is lower than in the production of high-capacity traditional energy sources.

Notes: The categorization criteria is as follows:
A: A significant positive/negative impact is expected.
B: A positive/negative impact is expected to some extent.
C: The extent of any positive/negative impact is unknown. (Further examination is needed and the impact may be clarified as the study progresses.)
N: No impact is expected.

Source: JICA Study Team

8.12 Implementation Organization and Mitigation Measures

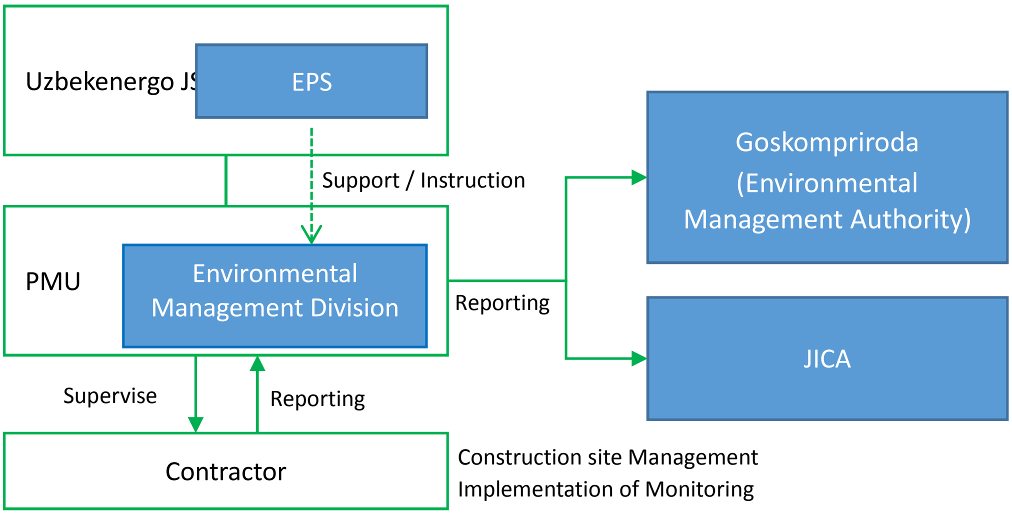
8.12.1 Implementation Organization

(a) Construction Phase (Figure 8.12.1-1)

The PMU (Project Management Unit) should be organized under Uzbekenergo JSC as the project implementation and management agency, should carefully consider construction activities and stimulate the General Contractor to thoroughly understand the necessary measures and their implementation at the beginning of the construction phase. At the same time, the environmental management division should be organized in the PMU before the construction activities and experts (administrator of environmental management) shall be appointed within PMU and work under the direction of EPS, Uzbekenergo JSC.

During the construction phase, PMU, with Uzbekenergo JSC's support and instruction and in collaboration with the consultant, will aid in understanding the essence of the construction content and schedule and mitigation measures to the surrounding public, to gather the views of local residents and take mitigation measures as required. The PMU, on behalf of EPS, shall regularly report to JICA and Goskompriroda with a Project Status Report according to the progress of environmental monitoring and monitoring reports during the construction. The PMU should regularly conduct explanations for locals to share details of project progress and implement environmental monitoring.

Besides, the Regional Grievance Committee should also function as an organization on complaints, to understand and address grievances from local people during construction and operation and conduct appropriate mitigation measures.



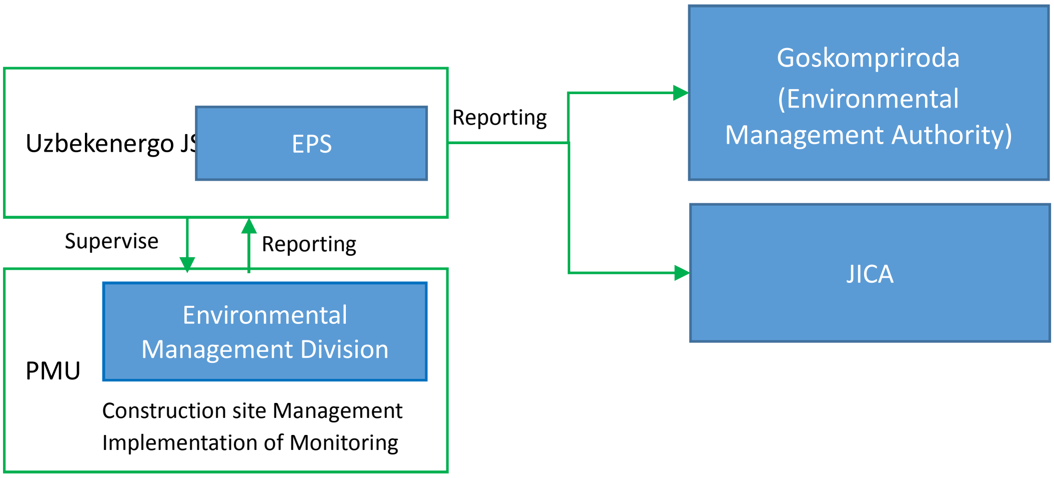
Source: JICA Study Team

Figure 8.12.1-1 Environmental Management Organization (during the construction)

(b) Operational Phase (Figure 8.12.1-2)

The management of Tashkent TashTETs-2 is going to organize an environmental management unit to develop and implement an environmental management plan as a mitigation measure. The management should improve understanding of the environmental management plan by project designers before the operation and continue regular training during the operational phase. The management should also act to organize complaint processing and decision-making in response to complaints from local residents during the operational phase.

The manager of the Environmental Division of Tashkent TashTETs-2 should report on the content and implementation status of the environmental management plan and environmental monitoring plan, described below, to EPS, Uzbekenergo JSC. The manager of the Environmental Division, PMU should regularly conduct an explanation for the relevant organizations and administration of Uzbekenergo JSC, whereupon Uzbekenergo JSC shall report on the environmental monitoring to JICA as well as "Goskompriroda."



Source: JICA Study Team

Figure 8.12.1-2 Environmental Management Organization (during operation)

8.12.2 Mitigation Measures and Cost

As for Tashkent TashTETs-2 and power transmission lines, the major environmental consequences, mitigation measures, responsible organizations and expenses for each environmental component during the construction and operational phases as well as responsibility for the implementation cost and bearing agency(s) are listed in Table 8.12.2-1.

Table 8.12.2-1 Environmental Management plan

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Construction phase					
Air pollution	Temporary emission of air pollutants (SOx, NOx, etc.) from heavy machines and vehicles and flying dust may occur	- Periodic checkup and maintenance of vehicles - Shutdown of engine during waiting time - The rear deck of the sand-transport trucks shall be covered - Periodic watering of the site and surrounding road in case of strong winds	Continuously	Main contractor, Environmental Consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
Water pollution/ bottom sediment	Turbid water after rain, domestic waste water generated by workers is temporarily generated	- Installation of temporary rainwater drainage - Installation of a temporary sedimentation pond and oil-separating system - Installation of a septic tank and temporary toilet	Continuously	Main contractor, Environmental Consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
Waste	Domestic waste, waste oil, waste material will be generated	- Development of a waste management program, including education of workers to encourage reduction and reuse of waste - Prohibition of illegal dumping - Proper storage of waste (oil and chemical materials) in a storage site and method to prevent permeation into the ground - Separation of waste by waste type and hazard level, recording the amount of waste, storage in an appropriate storage site and legal disposal in an appropriate disposal site	Continuously	Main contractor, Environmental Consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
Soil pollution	Soil contamination caused by leakage of fuel and lubricants from construction machinery and vehicles may occur.	- Periodic checkup and maintenance of vehicles - Proper storage of waste (oil and chemical materials) in a storage site and method to prevent permeation into ground - Emergency spill kits (absorbents etc.) are equipped.	Continuously	Main contractor, Environmental Consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
Noise and vibration	Temporary noise from the construction machines and vehicles will be generated	- Periodic checkup and maintenance of vehicles - Construction activity and traffic of vehicles is essentially limited to daytime - Use low-noise/vibration type equipment - Temporary soundproof wall around the project site	Continuously	Main contractor, Environmental Consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
Existing social infrastructure and services	- Increase of traffic and damage of the road in the surrounding area.	- Slowdown of vehicles in the residential and school area - Traffic of construction vehicles during school commuting hours shall be avoided - Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)	Continuously	Main contractor, PMU	Expenses shall be included in the contract cost by the main contractor.
Misdistribution of Benefits and Loss	Income gap between the project workers and the local residents may occur	- Prioritize employment of local residents, particularly project-affected people - Provision of job training for employment	Continuously	Main contractor, PMU	Expenses shall be included in the contract cost by the main contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Infectious Diseases such as HIV/AIDS	- Influx of workers may generate infectious disease, HIV, conflict with local residents	- Compliance with safety regulations and laws - Development of a safety and sanitation management plan and implementation regular medical checkups	Continuously	Main contractor, PMU	Expenses shall be included in the contract cost by the main contractor.
Labor environment (including work safety)	- There is a risk of workers getting in a labor-related accident. - There is a risk that security agents threaten the security of the local residents.	- Compliance with safety regulations and laws - Development of a safety and sanitation management plan and implementation regular medical checkups - Construction of a medical facility on the work site with an on-site nurse - Establishment of a cooperative relationship with the local medical facilities	Continuously	Main contractor, PMU	Expenses shall be included in the contract cost by the main contractor.
Accident	There is the possibility of accidents by construction work and operation of construction vehicles.	- Compliance with safety regulations and laws - Traffic of construction vehicles during school commuting hours shall be avoided - Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn)	Continuously	Main contractor, PMU	Expenses shall be included in the contract cost by the main contractor.

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Operational phase					
Air pollution	Emission of NOx from gas turbine	- Introduction of low NOx combustion appliances - Use of high stack	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Water pollution/ bottom sediment/ river water	Cooling tower blowdown and washing wastewater from water demineralizer will be generated	- Installation of a water treatment facility - A drain system will be introduced to gather oily rainwater - Domestic wastewater will be properly connected to the public sewer system	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Waste	Waste oil, sludge, domestic Waste will be generated	- Development of a waste management program, including education of workers to encourage reduction and reuse of waste - Prohibition of illegal dumping - Proper storage of waste (oil and chemical materials) in a storage site and method to prevent permeation into the ground - Separation of waste by waste type and hazard level, recording the amount of waste, storage in an appropriate storage site and legal disposal in an appropriate disposal site	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Soil pollution	Soil contamination caused by leakage of fuel and lubricants, or hazardous materials may occur.	- Periodic checkup and maintenance of vehicles and equipment - Proper storage of waste (oil and chemical materials) in a storage site and method to prevent permeation into ground - Emergency spill kits (absorbents etc.) are equipped.	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Noise and vibration	Noise from cooling tower fan, turbine and pumps is predicted	- Use low-noise equipment - Use of a GT enclosure, GT intake silencer, louver for cooling tower, turbine building - Use of low-vibration equipment - Construction of buildings with strong foundation - Regular equipment maintenance - Tree-planting and installation of a soundproof wall around the project site, as required	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Misdistribution of Benefits and Loss	Income gap between the project workers and the local residents may occur	- Priority employment of local residents, particularly those affected by the project - Provision of job training for employment	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant

Items	Potential impact	Mitigation measures	Period of Management	Responsible organization	Budget
Labor environment (including work safety)	- There is a risk of workers getting in a labor-related accident. - There is a risk that security agents will threaten the security of the local	- Compliance with safety laws and regulations and laws - Development of a safety and sanitation management plan and implementation of regular medical checkups - The workers will have a medical examination every year - Establishment of a cooperative relationship with the local medical facilities	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant
Accident	- Fire disaster, serious accident may occur during operation of TashTET-2 - There is the possibility of accidents by work	- Development of a gas-leakage prevention management plan - Gas-leakage alarm system - Installation of a stationary fire prevention system, fire hydrant, fire extinguisher, fire escape exit, fire alarm, fireproof compartment, emergency exit, etc. - Installation of an automatic control system - Construction of fire-fighting facility - Compliance with safety regulations and laws - Inspection of equipment - Checking of traffic regulations, driving safety education, checkup of vehicle equipment (brake, horn)	Continuously	Tashkent Cogeneration plant	Uzbekenergo JSC, Tashkent Cogeneration plant

Source: JICA Study Team

8.13 Monitoring Plan

Details of the environmental monitoring plan for Tashkent TashTETs-2 and power transmission line during construction and operation are given at the end of the section and a summary is given in Table 8.13-1 (TashTETs-2). Moreover, the project proponent shall discuss the environmental monitoring plan with JICA.

Table 8.13-1 Environmental Monitoring Plan for TashTETs-2

No.		Item	Method	Location	Frequency	Responsibility	Budget
Construction phase							
1	Air pollution: ambient air quality	NO_2, NO, SO_2, dust	Ambient air quality analyzers	Determine after the development of detailed design documentation of F/S is completed. Four (4) monitoring points shall be selected by the project proponent.	Quarterly	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
2	Water pollution/ bottom sediment: river water quality	pH, SS, oil and grease	Sample analysis	Point of discharge into Karakamysh Canal. One (1) monitoring location at the canal (possibly water discharging point) shall be selected by the project proponent.	Quarterly	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
3	Waste	- Storage method (oil and chemical materials) - Separation of waste by type and hazard level and amount - Appropriateness of storage and legal disposal - The type and amount of waste	Contract and record	Waste storage area	Continuously	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
4	Soil pollution	Soil conditions (transformation of soil, leakage of hazardous materials)	Visual inspection	Excavation sites and earth fill	During construction	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
5	Noise and Vibration	Noise level Vibration level	1) Sound-level meter 2) Monitoring of grievance	1) Measuring points shall be determined after the development (at the site boundary and residential area). 2) Recording	1) Quarterly 2) Continuously	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
6	Existing social infrastructure and services	Traffic congestion and accidents around the construction site	Monitoring of grievance	Recording	Continuously	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
7	Misdistribution of benefits and loss	Inequality of local employment and contract and misdistribution of benefit and loss around the site	Monitoring of grievance	Recording	Continuously	Main contractor, Environmental consultant, PMU	Expenses shall be included in the contract cost by the main contractor.
8	Infectious diseases such as HIV/AIDS	Worker's health and public health around the site	Monitoring of grievance	Recording	Continuously	Main contractor, health and safety consultant, PMU	Expenses shall be included in the contract cost by the main contractor.

No.		Item	Method	Location	Frequency	Responsibility	Budget
9	Labor and working conditions	Conformity of local laws and regulations	Inspection	Entire construction site	Continuously	Main contractor, PMU, health and safety consultant	Expenses shall be included in the contract cost by the main contractor.
10	Accident	Conformity of laws and regulations, occurrence of accidents	Inspection (Accident log)	Entire construction site	Continuously	Main contractor, PMU, health and safety Consultant	Expenses shall be included in the contract cost by the main contractor.
11	Grievances	Numbers, contents and processing results of grievances	Recording	Construction site of thermal power station	Daily	Main contractor, PMU, City government (Khokimiyat)	Expenses shall be included in the contract cost by the main contractor.
Operational phase							
1	Air pollution: ambient air quality	NO_2,NO	Ambient air quality analyzers	Sampling points shall be determined after the development of detailed design documentation is completed. Four (4) monitoring points shall be selected by the project proponent.	Quarterly	Cogeneration plant	Expenses shall be included in the production cost
2	Air pollution: exhaust gas	NOx	Continuous Emission Monitoring System (CEMS)	Gas ducts	Continuously	Cogeneration plant	Expenses shall be included in the production cost
3	Water pollution /river water/ bottom sediment: wastewater	Temperature, pH, SS, BOD, Oil and grease, Nitrite, Nitrate, Ammonia-nitrogen, Sulfate, Chloride, Phosphate, Fe, Cu, Zn	Sample analysis	One (1) monitoring location at discharge into the Karakamysh Canal from the outlet of the wastewater treatment facility	Quarterly	Cogeneration plant	Expenses shall be included in the production cost
4	Water pollution /river water/ bottom sediment: river Water quality	Temperature, pH, SS, BOD, Oil and grease, Nitrite, Nitrate, Ammonia-nitrogen, Sulfate, Chloride, Phosphate, Fe, Cu, Zn	Sample analysis	Control point in the Karakamysh Canal upstream and downstream of the wastewater discharge point.	Quarterly	Cogeneration plant	Expenses shall be included in the production cost
5	Waste	The type and amount of waste (waste oil, sludge, other hazardous and domestic waste)	Contract and record	Waste recycling and handling site	Annually	Cogeneration plant	Expenses shall be included in the production cost
6	Soil pollution	Soil conditions (transformation of soil, leakage of hazardous aterials)	Visual inspection	Hazardous material handling area	Continuously	Cogeneration plant	Expenses shall be included in the production cost

No.		Item	Method	Location	Frequency	Responsibility	Budget
7	Noise and vibration	Noise level Vibration level	1) Sound-level meter 2) Monitoring of grievance	1) Measuring points shall be determined after the development. (at the site boundary and residential area). 2) Recording	1) Twice a year 2) Continuously	Cogeneration plant	Expenses shall be included in the production cost
8	Misdistribution of benefits and loss	Inequality of local employment and contract and misdistribution of benefit and loss around the site	Monitoring of grievance	Recording	Continuously	Cogeneration plant	Expenses shall be included in the production cost
9	Labor and working conditions	• Conformity of laws and regulations and laws	Inspection	Tashkent Cogeneration plant	Continuously	Cogeneration plant	Expenses shall be included in the production cost
10	Accident	• Conformity of laws and regulations, , occurrence of accidents	Inspection (Accident log)	Tashkent Cogeneration plant	Continuously	Cogeneration plant	Expenses shall be included in the production cost
11	Grievances	Numbers, contents and processing results of grievances	Recording	Tashkent Cogeneration plant	Daily	Cogeneration plant	Expenses shall be included in the production cost

Source: JICA Study Team

8.14 Public Consultation

To obtain the consent of the residents, Uzbekenergo JSC convened two stakeholder meetings based on the JICA Guidelines.

(a) Prior to the Interview

Prior to the first meeting with the public, individual work with the community residents was held. Leaflets in Russian and Uzbek languages with the annotation of the project and environmental and social considerations of its implementation were distributed and interviews were conducted as part of a door-to-door poll of residents of houses closest to the TC-4. In total, 24 houses were covered by the poll of residential houses of the 6th block, Yunus- Abad District, which are located in close proximity to the TC-4 “Severnaya.” Most people interviewed expressed their support for the TashTETs-2 development and requested the earliest possible implementation to improve the local environment.

(b) First Public Consultation

On March 10, 2015 consultations with the public were performed by Uzbekenergo JSC in Mahalla “Turkistan,” 6th Block of Yunus- Abad district, Tashkent, to explain the goals, objectives and essence of the project and its environmental and social aspects. The text of the stakeholder meeting program, which was distributed in advance to invited officials and population, is provided in the Annex. The venue of the meeting was the assembly hall of School No. 21.

Fifty-six people attended (36 of whom women), including experts of the JICA Study Team, chairman of the local self-government body (Mahalla committee), public officials, representatives of Tashkent City Committee for Nature Protection, Uzbekenergo JSC “Tashteplotsentral,” “Teploelektroproekt,” “Uztyazhneftegazhimproekt,” press, school administration and local residents living in close proximity to TC-4.

Table 8.14-1 describes the questions and comments from residents on the project made during the public consultation. An attendance list of participants is given in the Annex. All questions were answered satisfactorily by organizers of the meeting.

The following table summarizes the first stakeholder meeting in accordance with the JICA Guidelines:

Table 8.14-1 Record of Stakeholder Meeting, March 10, 2015

Date & Time	March 10, 2015	
Language	Uzbek, Russian	
Participant	Name	Belonging
	Rasulov Ilhom Mamadjanovich	Chairman of Mahalla Committee “Turkiston”
	Maksumova N.	Chairman Assistant of Mahalla Committee “Turkiston”
	Mirkurbanova Sh.	Deputy Director of School No. 21
	Mr. Hiroyasu Kudo	JICA Project Consultant
	Kasimova Yuliya	Interpreter of JICA
	Mirzakhalilov Rustam	Interpreter of JICA
	Mubarakshin Ruslan Gazizovich	Director of JSC “Tashkent heat and power plant”
	Maksudova Svetlana Muhitdinovna	Deputy Director of JSC “Tashkent heat and power plant”
	Muminova Magfirat Pulatovna	Head of Environmental Protection Service of SJSC Uzbekenergo JSC
	Iskandarova D.	Engineer of Environmental Protection Service of SJSC Uzbekenergo JSC

Date & Time	March 10, 2015

Homova T. V.	Head of Department of Ecology, JSC “Teploelektroproekt”
Mansurov R. H.	Senior specialist of Department of Ecology, JSC “Teploelektroproekt”
Eliseeva Ya. V.	Engineer of Department of Ecology, JSC “Teploelektroproekt”
Inbragimov M. N.	Head of a group of computer-aided design JSC “Teploelektroproekt”
Djalilov Zuhriddin Erkinovich	Chief engineer assistant for operation, JSC “Tashteplocentral”
Arutyunov Evgeniy Aleksandrovich	Head of division, SI “Uztyazhneftegazhimproekt”
Mirzabaeva S. A.	Deputy Head of STIC “Uzinformceter”
Shoahmedov Z.	Correspondent of STIC “Uzinformceter”
Mahamatov Sabirjon	Government controller of Tashkent city State Committee for Nature Protection
Teshaev Andrey	Correspondent of newspaper “Narodnoe slovo”

Locals are 36 persons (representative of the school: 1 person, residents: 35 persons (women: 29 persons).

Agenda	1. Goals of the JICA Project 2. Project Implementation Schedule 3. Brief information about the construction plan of Tashkent thermal power cogeneration plant and transmission lines 4. Brief information about the Master Plan of Power Sector Development in Uzbekistan 5. Environmental and social considerations 6. Expected potential impacts during the project implementation

Comments

Questions, comments and answers

No.	Question/Comment	Belonging	Answer
1	When will construction begin?	Local resident	Now preparatory works are being conducted, followed by the design stage and then construction in accordance with the design.
2	Will landscaping be conducted?	Local resident	Naturally. Improvement of the cogeneration plant territory and adjacent territory.
3	How many years will it take to construct?	Local resident	According to Pre F/S it will take five years. 27 MW The gas-turbine unit at Tashkent heat and power plant was constructed in 36 months.
4	Will access roads be prepared?	Local resident	We have already mentioned this in speeches. Yes, they will be.
5	What will happen to the old boiler plant?	Local resident	The capacity may be reduced due to the withdrawal of boiler Nos. 1-3.
6	Will there be less noise from the new cogeneration plant?	Local resident	Yes, this is the main advantage of a thermal power plant: reduction of acoustic impact in comparison with existing TC-4 equipment and achievement of existing noise standards.
7	Is there a risk of it only remaining on paper?	Local resident	Experience in recent years shows that a number of investment projects in the energy sector using advanced gas turbine and combined cycle units were successfully implemented in Uzbekistan.
8.	Heavy equipment for a new thermal power plant will be delivered by car or by train?	Local resident	Both options are considered.
9.	Will the heating price increase after constructing gas-turbine units?	Local resident	After project recoupment, the cost will certainly decline.
10.	Will the existing chimneys of	Local resident	No, but their atmospheric emissions

Date & Time	March 10, 2015			
		TC-4 be dismantled?		will decline significantly.
	11.	Will fuel oil be burned?	Local resident	The gas-turbine unit will run on natural gas, TC-4 will use natural gas as the main fuel and fuel oil as backup fuel as before.
	12.	Is it possible to asphalt 7-8 km of in-roads in the framework of this project, our roads are in poor condition.	Chairman of Mahalla Committee and some local residents.	Once again, we emphasize that only access roads will be landscaped and prepared. Your request must be addressed to Khokimiyat.

Source: JICA Study Team

There were no deviations from the prepared program during the first meeting and no negative opinions about the project implementation and all participants unanimously supported the construction of Tashkent TashTETs-2 at the selected site.

Speech of RasulovI. M., Chairman of Mahalla Committee “Turkiston”

Speech of Mubarakshin R. G., Chairperson, Director of JSC “Tashkent Thermal Power Plant”

Speech of Muminova M. P., Head of Environmental Protection Sector, SJSC Uzbekenergo JSC

Homova T. V., Head of Department of Ecology, JSC “Teploelektroproekt” answering community comments

Source: JICA Study Team

Figure 8.14-1 Consultations with public on March 10, 2015

(c) Second Public Consultation

On April 10, 2015 in accordance with the requirements of JICA Guidelines, the second meeting with the public was held by Uzbekenergo JSC in Mahalla “Turkistan,” 6th Block of Yunus- Abad district of Tashkent, to summarize the results of the first meeting and finally identify factors of concern among the local population regarding the project implementation.

The meeting venue was the assembly hall of Scholl No. 21.

An attendance list and Meeting Program are attached.

Fifty-eight people attended (28 of whom women), including two experts of the JICA Study Team, chairman of the local self-government body (Mahalla committee), public officials, representatives of Tashkent City Committee for Nature Protection, Uzbekenergo JSC “Tashteplotsentral,” “Teploelektroproekt,” “Uztyazhneftegazhimproekt,” administration of the school and preschool institutions (kindergarten Nos. 511 and 611), Chairmen of the community committee and local residents living in close proximity to TC-4.

The following Table 8.14-2 summarizes the second stakeholder meeting in accordance with JICA Guidelines, as well as comments and suggestions made during the meeting.

Table 8.14-2 Record of Stakeholder Meeting, April 10, 2015

Date & Time	April 10, 2015
Language	Uzbek, Russian

Participant

Name	Belonging
Rasulov Ilhom Mamadjanovich	Chairman of Mahalla Committee “Turkiston”
Maksumova N.	Chairman Assistant of Mahalla Committee “Turkiston”
Mirzakarimova N.	Chairman of women’s association of Mahalla Committee “Turkiston”
Mr. Masaya Sugita	Expert of JICA
Mr. Matsuoka	Expert of JICA
Kasimova Y.	Interpreter of JICA
Mirzakhalilov R.	Interpreter of JICA
Mubarakshin R. G.	Director of JSC “Tashkent heat and power plant”
Maksudova S. M.	Deputy Director of JSC “Tashkent heat and power plant”
Mahamatov S.	Government controller of Tashkent city State Committee for Nature Protection
Iskandarova D.	Engineer of Environmental Protection Service of SJSC Uzbekenergo JSC
Polegaeva A. R.	Project Chief Engineer, JSC “Teploelektroproekt”
Homova T. V.	Head of Department of Ecology, JSC “Teploelektroproekt”
Mansurov R. H.	Senior specialist of Department of Ecology, JSC “Teploelektroproekt”
Eliseeva Ya. V.	Engineer of Department of Ecology, JSC “Teploelektroproekt”
Ibragimov M. N.	Head of a group of computer-aided design JSC “Teploelektroproekt”
Djalilov Zuhriddin Erkinovich	Chief engineer assistant for operation, JSC “Tashteplocentral”
Arutyunov Evgeniy Aleksandrovich	Head of division, SI “Uztyazhneftegazhimproekt”
Yun D. A.	JSC “Tashteplocentral”
Shoahmedova Z.	Correspondent of STIC “Uzinformceter”

Locals are 38 people (representative of the school: 1 person, representatives of preschool institutions: 2 people, residents: 35 people (women: 22 people)).

Agenda

1. Brief summary of the first stakeholder meeting.
2. Results of the study conducted by the JICA Study Team after the first meeting.
3. Opinions, comments and issues raised during the first meeting.
4. Discussions on the identification of environmental and social issues in the construction of the new cogeneration thermal power plant.

Comments

Questions, comments and answers

No.	Question/Comment	Belonging	Answer
1	Will the price for electricity and heat decrease?	Local resident	It does not depend on us, but in addition to thermal power, the station will generate electric power, the price of which is determined by our Government.
2	When is the scheduled completion of construction?	Local resident	By the end of the year, it is planned to complete the feasibility study, whereupon the project will be included in a government target program and completion of construction is targeted for by 2018.
3	Where is the main route for cargo delivery?	Local resident	Along the railroad.
4	Do you plan to repair roads in the Mahalla?	Local resident	Only the access roads required for project implementation will be landscaped and prepared.
5	What will happen to the trash dump?	Local resident	The existing trash dump will be eliminated, due to the huge amount of accumulated waste. It is planned to remove waste within six months.
6	Will there be less noise from the new cogeneration plant?	Local resident	At the present time, residents in homes adjacent to the TC-4, cannot open windows either in winter (during maximum load of TC), or summer, due to the noise and vibration. During

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				the construction of the new station this impact will be maximally reduced.
	7	What kind of fuel will used by the new station? Will fuel oil be burned?	Local resident	The new cogeneration plant will use only natural gas. TC-4 will burn fuel oil only in winter.
	8.	Will the existing fuel oil facilities of TC-4 be demolished?	Local resident	No, fuel oil facilities will not be removed, since oil fuel is used as a backup fuel at TC-4 and only in winter.
	9.	After constructing the new station will we pay for heat only during the winter period (namely, during the heating period: 3 months)?	Local resident	No, because it was decided to pay within 12 months by the government. If you pay only for 3 months, it becomes very expensive. Accordingly, to make it easier for the public, the payment burden was divided into 12 months.
	10.	Will the hot-water supply be cut off during construction and commissioning of the new station?	Local resident	No. Even if there will be any cutoff of hot-water supply, it will only be a scheduled outage.
	11.	Will Mahalla locals be involved during the landscaping?	Local resident	Yes. Mahalla residents will be involved, not only at the time of landscaping, but also to work on the new station. In particular young people.
	12.	Nearby there is a landfill of “Mahsustrans” to which vehicles bring garbage from three regions, also including the surrounding area. Is it possible to transfer this landfill?	Local resident	It is not under our control. You need to address this question to the municipal administration authorities.
	13.	Speech of the representative of Tashkent city State Committee for Nature Protection	Government controller of Tashkent city State Committee for Nature Protection, Mahamatov S.	Before the implementation, the project will be agreed in all instances, including the State Committee for Nature Protection of the Republic of Uzbekistan. At this stage, we support the construction of gas turbines, as it will ease the environmental impact due to using natural gas more efficiently and reducing the negative environmental impacts compared to the TC-4. I have seen the territory adjacent to TC-4 and noticed that the locals also throw a lot of garbage along the canal. I want to note that people living in this area, to improve their quality of life, should start from themselves and not throw garbage everywhere, but only in designated places.

Source: JICA Study Team

The representative of the State Committee for Environmental Protection gave his comments individually. He noted that before the implementation, this Project will be approved by all relevant authorities. Moreover, the construction of the new cogeneration plant will have a positive environmental impact due to more efficient natural gas utilization technology and a reduction in the negative environmental impact. In addition, he also noted that he passed through the territory near TC-4 and watched people throwing garbage along the channel. He informed local residents that they should improve their attitude and behavior first, limit the places where they throw away their garbage and use permitted areas for this purpose only.

Other than issues of garbage dump clearance and tariffs, there was no major argument regarding the development of the TashTETEs-2 and its related facilities.

	
Speech of RasulovI. M., Chairman of Mahalla Committee “Turkiston”	Speech of Mubarakshin R.G., Chairperson, Director of JSC “Tashkent Thermal Power Plant”
	
Speech of Mr. Matsuoka, Expert of the JICA Study Team	Questions and Answers

Source: JICA Study Team

Figure 8.14-2 Consultations with the public on April 10, 2015

8.15 Others

8.15.1 Environmental Check List

Table 8.15-1 Check List for TashTETs-2 Thermal Power Station

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
1Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country’s government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country’s government?	(a) N (b) N (c) N (d) N	(a) A draft EIA has been prepared under the Pre-F/S by Tashkent City in accordance with existing requirements for state environmental expertise at the State Committee for Nature Protection of the Republic of Uzbekistan. However, Uzbekenergo JSC shall consult Goskompriroda for further action regarding the Draft EIA since the project implementation agency has changed from the city, even if the project component stays the same. Accordingly, Uzbekenergo JSC will develop a new EIA for the project, starting July 2015. (b) The above Draft EIA has been approved by the State Committee for Nature Protection of the Republic of Uzbekistan (Approval No. 18-1132z dated November 21, 2013) in accordance with the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. 491 dated December 31, 2001. However, Uzbekenergo JSC needs to obtain approval for the new EIA, expecting November2015. (c) A draft EIA report has been unconditionally approved. The approval for the new EIA will be obtained in November 2015. (d) The project proponent shall develop a Statement of the consequences of environmental impact of the project implementation before construction of the facility. This statement shall set out the environmental standards for emissions, effluents and waste. All of the permits concerning this procedure shall be obtained at the State Committee for Nature Protection of the Republic of Uzbekistan.
1 Permits and Explanation	(2) Explanation to the Local Stakeholders	(a) Have the contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Has the understanding of local stakeholders been obtained? (b) Have comments from stakeholders (such as local residents) been reflected in the project design?	(a) Y (b) Y	(a) The project proponent had held two stakeholder meetings in March and April, 2015 under the JICA Project. The first stakeholder meeting was held on March 10, 2015. The second stakeholder meeting will be held on April 10, 2015. There is complete mutual understanding with local stakeholders. In February 2015, an opinion survey of residents of 24 dwelling houses adjacent to TC-4 was conducted. Information sheets containing the project outline and the results of a preliminary environmental and social study of the project implementation, as well as Uzbek and Russian language questionnaires have been distributed. 165 questionnaires were filled in by residents. It has been clarified that 100% of respondents positively accepted the project, 62% of respondents expected an improvement in environmental conditions and residents’ health, 64% of respondents expected improvement in living conditions due to the project implementation. (b) Comments have been adequately entered in the minutes of public meetings and reflected in the project through the environmental management plan.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined in terms of social and environmental considerations?	(a) Y	(a) Alternative plans were examined with respect to zero option, site selection, fuel selection and power generation technology.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
2 Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx) and soot and dust emitted by the power station operations comply with the country’s emission standards? Is there a possibility that air pollutants emitted from the project will result in areas that do not comply with the country’s ambient air quality standards? Are any mitigating measures taken? (b) In the case of coal-fired power stations, is there a possibility that fugitive dust from the coal piles, coal handling facilities and dust from the coal ash disposal sites will cause air pollution? Are adequate measures taken to prevent the air pollution?	(a) Y/N (b) N	(a) Natural gas, which is used as fuel, does not contain sulfur and solid particles, so minimal SOx and no dust is generated during its combustion. CO_2, soot and dust emission reduction is also achieved using improved combustion chambers and complete combustion of fuel. NOx concentration in emissions will comply with standards of Russia (GOST 29328-92). This standard value is equal to the value of Guideline for Thermal Power Plant (TPP), which is provided for in IFC/WB EHS Guidelines. Compliance with standard values is achieved using low-emission burners and water injection type nitrogen oxides suppression system. (b) The facility, which is being designed, is not a coal-fired power station.
	(2) Water Quality	(a) Do effluents including thermal effluents from the power station comply with the country’s effluent standards? Is there a possibility that the effluents from the project will cause areas that do not comply with the country’s ambient water quality standards or cause any significant temperature rise in the receiving waters? (b) In the case of coal-fired power stations, do leachates from the coal piles and the coal ash disposal sites comply with the country’s effluent standards? (c) Are adequate measures taken to prevent contamination of surface water, soil, groundwater and sea water by the effluents?	(a) Y/N (b) N (c) Y	(a) Effluents, including effluents from cooling system, will be discharged into the Karakamysh Canal. The temperature in the canal is expected to rise not beyond 3°C, which complies with the standards of the Republic of Uzbekistan (San PiN RUz No. 0172-04 “Sanitary requirements for surface waters protection in the Republic of Uzbekistan”). Qualitative composition of effluents will also comply with the above-mentioned standard, because influent tap water is used in the recirculating cooling system. Effluents from water treatment facility are conditionally clean and contain no toxic or aggressive matters. To reduce the salt content, effluents are being diluted in accordance with the rules of the Republic of Uzbekistan and IFC/WB EHS Guidelines. Rainwater with oil contents mixed in will be purified by the local surface wastewater treatment facility. (b) The project is not a coal-fired power station. (c) The project proponent will take the following measures to mitigate the impact on water quality: - Installing a water treatment facility. - Introducing a drain system to gather oily rainwater. - Monitoring wastewater and surface water of Karakamysh Canal.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
2PollutionControl	(3) Waste	(a) Is waste, (such as waste oils and waste chemical agents), coal ash and by-product gypsum from flue gas desulfurization generated by the power station operations properly treated and disposed of in accordance with the country’s regulations?	(a) Y	(a) Within the project the gas-fired power station will be constructed, therefore no coal ash and by-products from flue gas desulfurization will be generated. Industrial and domestic waste will be generated. Tanks and sites for collection and temporary storage of industrial and domestic waste are provided for within the TashTETs-2 site. The danger level of each type of waste shall be determined using Waste classification catalog according to Attachment No. 15 to the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. 14 dated January 21, 2014. The project proponent will develop a waste treatment/recycling plan and the majority of waste will be transported to a specialist recycling organization according to contracts concluded. Part of the waste will be reused at TashTETs-2 and part of it will be taken out to a domestic waste landfill site.
2PollutionControl	(4) Noise and Vibration	(a) Do noise and vibrations comply with the country’s standards?	(a) Y	(a) The predicted noise level is about 55-70 dB at the boundary of the TashTETs-2 site and about 45 dB in the residential area of the 6th block of Yunus- Abad District 200m from the boundary of TashTETs-2, which complies with environmental standard of the Republic of Uzbekistan and IFC/WB Guidelines for daytime/nighttime. Further mitigating measures include using “low-noise equipment” and “planting trees at the site boundary.” Installing a soundproof wall as a noise barrier will be considered, as required. There are plans to monitor the noise level at the working area and in the vicinity of the residential area.
	(5) Subsidence	(a) When extracting a large volume of groundwater, is there a possibility that this extraction will cause subsidence?	(a) N	(a) Water consumed by TashTETs-2 is supplied by the existing water-supply network. Groundwater will not be used.
	(6) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) Y	(a) Potential odor source is decaying domestic waste. To prevent odor from decaying matter, domestic waste will be taken out to the solid domestic waste landfill site of Tashkent city under a contract with City government. It is planned to use metal containers, which will be installed on concrete pad, to collect and temporarily store solid domestic waste.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
3 Natural Environment	(1)Protected Areas	(a) Is the project site located in protected areas designated by the country’s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) The project site is not located in a protected area and there is no possibility of the project affecting protected areas. The nearest nature reserve, Chatkal Nature Reserve, is located 50 km away.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country’s laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water (e.g. surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? (e) Is there a possibility that discharge of thermal effluents, intake of a large volume of cooling water or discharge of leachates will adversely affect the ecosystem of surrounding water areas?	(a) N (b) N (c) N (d) N (e) N	(a) The project site is located in an area not used for agricultural or other purposes, but actually used as an unauthorized landfill site. There is no greenery on the site. There is no virgin or natural forest located around the site. There are no coral reefs, mangroves or tidal flats located around the site. (b) The project site is located in an area not used for agricultural or other purposes, but actually used as an unauthorized landfill site. There are no valuable species of flora/fauna in the project site. Rodents (rats and mice) and birds of the crow family (crows, common myna), which inhabit the landfills, can potentially be found in the site. (c) No significant ecological impacts from TashTETs-2 are anticipated. Planned measures to mitigate the consequences of air, surface and ground water, soil pollution, measures to reduce noise and vibration will be taken properly to reduce the impacts on the ecosystem. (d) Water for TashTETs-2 will be supplied by the public water-supply system. Discharge of water from the cooling system will not affect the aquatic environment of the Karakamysh Canal. Furthermore, a very small amount of aquatic organisms inhabit the artificial irrigation canal, so the impact on the ecosystem will be quite limited. (e) The amount of thermal effluents is insignificant compared to the amount of water in Karakamysh Canal. Temperature will rise less than 3^{o}C. The affected water area will be limited to the wastewater discharge site.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is a resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is compensation going to be paid prior to the resettlement? (e) Are compensation policies prepared in documents? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, elderly people below the poverty line, ethnic minorities and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is an organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is a mechanism to redress grievances established?	(a) N (b) - (c) - (d) - (e) - (f) - (g) - (h)- (i)- (j) -	(a) No involuntary resettlement will be caused by project implementation.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, as required? (b) Is sufficient infrastructure (e.g. hospitals, schools and roads) available for the project implementation? If the existing infrastructure is insufficient, are any plans developed to construct new infrastructure or improve the existing infrastructure? (c) Is there a possibility that large vehicles traffic for transportation of materials, such as raw materials and products will have impacts on traffic in the surrounding areas, impede the movement of inhabitants and any cause risks to pedestrians? (d) Is there a possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, as required? (e) Is there a possibility that the amount of water used (e.g. surface water, groundwater) and discharge of thermal effluents by the project will adversely affect existing water uses and uses of water areas (particularly fishery)?	(a) Y (b) Y (c) Y (d) Y (e) N	(a) The possibility that the project will adversely affect the living conditions of inhabitants is extremely low. The project proponent will prepare an environmental management plan to reduce the risk of accidents, impacts of noise and vibration, air/water and soil quality degradation. (b) The project implementation area has sufficiently developed infrastructure, including health care facilities (outpatient clinics), schools, kindergartens, motor roads and railroad. The project proponent is planning to design the access road and on-site roads, on-site water-supply and sewage system, gas pipeline. (c) During the construction phase, some traffic congestion may be observed. The project proponent’s plans will be as follows for traffic safety: - Vehicle traffic during the construction period shall be limited to daytime. - Slowdown of vehicles in residential and school areas. - Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn). - Dust control using water distribution (spraying) to vehicles on motor roads when delivering construction materials and equipment. (d) A periodic medical checkup of construction and operating personnel (engineering and technical personnel etc.), including migrant workers, shall be conducted. Furthermore, education on health care issues, including infectious disease prevention, shall be conducted. (e) Surface water and groundwater is not used for process water and drinking water supply at TashTETs-2. Thermal effluents are discharged into Karakamysh Canal, which is adjacent to the project site. Fishery is not conducted there. Using the once-through process water-supply system will not affect the amount of used water. Hot water will be discharged, but will have only a minimal impact on the river environment, as a) there are no fishing activities for livelihood, b) no precious species exist in the canal and c) any increase in water temperature will be limited to within three (3) degrees Celsius.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural and religious heritage? Are adequate measures considered to protect the sites in accordance with the country’s laws?	(a) N	(a) There are no archeological, historical, cultural and religious sites located around the project site. The nearest architectural monument, Kukeldash madrasah, is located 5.5 km away.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There is no scenic landscape around the project site. The construction site is currently a landfill site. The project will not adversely affect the local landscape. On the contrary, the project will have a beneficial effect by eliminating the landfill site.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce the impacts on the culture and lifestyle of ethnic minorities and indigenous people? (b) Are all the rights of ethnic minorities and indigenous peoples in relation to and resources respected?	(a) N (b) N	(a) There are no groups of minorities living around the project site. There will be no impacts on ethnic minorities and indigenous peoples. (b) The rights of all residents living near TashTETs-2 will be respected.
	(6) Working Conditions	(a) Does the project proponent violate any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for the individuals involved in the project, such as installing safety equipment which prevents industrial accidents and managing hazardous materials? (c) Are intangible measures being planned and implemented for the individuals involved in the project, such as establishing a safety and health program and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that the security guards involved in the project do not violate the safety of other individuals involved, or local residents?”	(a) N (b) Y (c) Y (d) Y	(a) The project proponent ensures the observation of labor law and rules. (b) The project proponent ensures that the safety of workers is completely secured by installing safety equipment and managing hazardous materials to prevent industrial accidents. (c) The project proponent will develop a safety and sanitation management program, including traffic safety and public health education for workers. (d) The project proponent will supervise employees and ensure that all of them observe existing laws and rules. The project proponent will subcontract with a security company to employ the guards.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g. noise, vibrations, turbid water, dust, exhaust gases and waste)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a) Y (b) Y (c) Y	(a) The following preventive measures against pollution will be taken by the project proponent and main contractor during construction: <Air pollution> - Regular checkup and maintenance of vehicles. - Shutdown of engine during waiting time. - The rear deck of sand-transport trucks shall be covered. - Periodic car wash. - Periodic watering of the site and surrounding roads in case of strong winds. <Water pollution> - Installation of temporary rainwater drainage. - Installation of temporary sedimentation pond and oil-separating system. - Installation of septic tank and temporary toilet. <Waste> - Development of a waste management program, including education of workers to encourage the reduction and reuse of waste. - Prohibition of illegal dumping. - Separation of waste by waste type, storage in an appropriate storage site and legal disposal in an appropriate disposal site. < Noise and vibration> - Periodic checkup and maintenance of vehicles. - Construction activity and traffic of vehicles is essentially limited to daytime. - Use low-noise/vibration type equipment. - Temporary soundproof wall around the project site, as required. (b) The following measures will be taken by the project proponent and main contractor: - Measures to reduce air pollution, noise and vibration. - Construction of transmission lines will be conducted in a particular season to avoid damaging crops. - The transmission tower will be painted to reduce risk of accidents. Security system will be installed. - When creating a foundation pit for transmission line supports, land reclamation is provided. - To avoid the use of nesting for birds on towers, the tower will be painted in colors that will repel them, as well as installing protection against birds. (c) The following measures will be taken by the project proponent and main contractor: - Development of necessary infrastructures for the contractor’s mobilization area according to the contract. - Slowdown of vehicles in residential and school areas. - Construction vehicle traffic during school commuting hours shall be avoided. - Checking of traffic regulations, installation of traffic signs, driving safety education, speed restriction, checkup of vehicle equipment (brake, horn).
	(2) Accident Prevention Measures	(a) In the case of coal-fired power stations, are adequate measures planned to prevent spontaneous combustion at the coal piles (e.g. sprinkler systems)?	(a) N	(a) The facility, which is being designed, is not a coal-fired power station.

Cate gory	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)”
	(3) Monitoring	(a) Does the proponent develop and implement a monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) The project proponent will develop an environmental monitoring plan. (b) The plan contains monitoring of environmental and social items during construction and operation. Methods and frequencies are also planned. (c) The project proponent establishes an adequate monitoring framework for the project during construction and operation. (d) The project proponent will periodically inform the Statistic Agency of the Tashkent city government, “Ubekenergo” and the Tashkent city Committee for Nature Protection of results of emissions, discharges and waste generation monitoring.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g. projects including installation of electric transmission lines and/or electric distribution facilities). (b) Where necessary, pertinent items described in the Ports and Harbors checklist should also be checked (e.g. projects including construction of port and harbor facilities).	(a) Y (b) N	(a) The project proponent will use an existing road to procure/transport materials. (b) Ports and harbors are not used to deliver equipment.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans boundary or global issues should be confirmed (e.g. the project includes factors that may cause problems, such as trans boundary waste treatment, acid rain, destruction of the ozone layer and global warming).	(a) N	(a) No impacts related to trans boundary or global issues (trans boundary waste treatment, acid rain, destruction of the ozone layer and global warming) are expected during project implementation. This project intends to improve power and heat supply system in Tashkent as the Uzbekistan power sector should reduce its excess fuel consumption and significant CO_2 emissions and a more efficient power and heat supply system which takes LNG and generates fewer CO_2 emissions must be installed. Accordingly, it is highly expected to have high energy-efficient power and heat supply in the city, although periodical CO_2 emissions are expected during construction.

Source: EIA report and JICA Study Team (with reference to the EIA Report prepared by Tashkent city)

8.16 Monitoring Form

(1) Construction phase

(a) Air pollution: Ambient air quality

Location: to be determined (at the site boundary and in residential area) Unit: mg/m³

Item	Measured Value (30min)			Uzbekistan maximum permissible concentration (30min)	IFC/ EHC Guideline General; 2007
	Average	Max	Min		
NO_2				0.085	0.2(1 hour)
NO				0.6	-
SO_2				0.5	0.5(10 minutes)
Dust				-	0.125(24 hours)

*According to the sanitary norms, rules and hygienic standards of the Republic of Uzbekistan (San PIN No. 0179-04. “Hygienic standards. The list of maximum permissible concentration (MPC) of pollutants in the ambient air of populated areas in the territory of the Republic of Uzbekistan”)

Note: MPC at this table is tentative. After EIA approval, a project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(b) Water pollution/ bottom sediment: river water quality

Location: point of discharge Karalamysh Canal

Item	Unit	Measured Value	Environmental standard in Uzbekistan	IFC/EHC Guideline (General; 2007)
pH	―		6.5- 8.5	6-9
SS	mg/L		15	50
Oil and Grease	mg/L		0.05	10

**According to the sanitary norms, rules and hygienic standards of the Republic of Uzbekistan (San PiN No. 0172-04. “Hygienic -requirement for surface water protection in the territory of the Republic of Uzbekistan”)

Note: MPC at this table is tentative. After EIA approval, the project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(c) Waste: waste management practice in storage and disposal

Name of Waste	Hazardous Class	Place of waste generated	Storage amount (Unit: t or kg)	Disposal / transferred amount (Unit: t or kg)	Storage / Disposal / transferred method and place

(d) Soil pollution: soil condition

Location: Construction area (Excavation site and earth fill)

Date	Locations	Soil condition (transformation of soil, leakage of hazardous materials)	Provision	Remarks

(e) Noise

Location: to be determined (at the site boundary and in the residential area)

Unit: dBA

Date (Period)	Location	Average (Leq or L50)	Max (Lmax)	Uzbekistan Noise standards*	IFC/ EHC Guideline (General; 2007) residential area
				Residential area: Daytime: 55 Nighttime: 45	Residential area: Daytime: 55 Nighttime: 45

*According to KMK 2.01.08-96 "Noise protection" (The State Committee for Architecture and Construction of the Republic of Uzbekistan, Tashkent, 1996)

Note: The noise situation in residential area is mainly assessed by average value. The noise level of the project boundary is mainly assessed by maximum value.

(f) Labor and working conditions: conformity of laws and regulations

Work Contents	Inspection Item	Contents	Status	Provision	Remarks

(g) Accident: Conformity of laws and regulations and accident log

Construction Contents	Inspection Item / Accident	Contents	Status	Provision	Remarks

(h) Grievances: grievance and complaint from public to monitor social issues

Date	Name	Contents	Status	Results	Remarks

(2) Operational phase

(a) Air pollution: ambient air

Location: to be determined (at the site boundary and in residential area)

Unit: mg/m³

Item	Measured Value			Uzbekistan maximum permissible concentration		IFC/ EHC Guideline General;2007	
	30-min Max - Min	24-hr Max - Min	Average	30-min	24-hr	1-hr	1-yr
NO_2				0.085	0.06	0.2	0.04
NO				0.6	0.25	-	-

Note: MPC at this table is tentative. After EIA approval, the project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(b) Air pollution: Exhaust gas emission

Location: at gas ducts

Unit: mg/m³

Item	Measured Value		Uzbekistan maximum permissible concentration	IFC/ EHC Guideline (Thermal Power Plant; 2008)
	Max – Min	Excess period of the standard		
NOx			50	51

Dry gas base O_2=15%

Note: MPC at this table is tentative. After EIA approval, the project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(c) Water pollution/ river water/ bottom sediment: wastewater

Location: Water discharge outlet

Item	Unit	Measured Value	Standard of the relevant country	IFC/WB EHS Guidelines
Water discharged into Karakamysh Canal	t/ month		-	-
Temperature	°C		3℃	-
pH	-		6.5-8.5	6.5-9.0
SS	mg/L		15	50
Oil and Grease	mg/L		0.05	10
Nitrite	mg/L		0.02	-
Nitrate	mg/L		9.1	-
Sulfate	mg/L		100	-
Chloride	mg/L		300	-
Ammonium-nitrogen	mg/L		0.5	
Phosphate	mg/L		0.3	-
Fe	mg/L		0.05	1.0
Copper	mg/L		0.001	0.5
Zinc	mg/L		0.01	0.5
BOD	mg/L		3.0	0.5

Note: MPC at this table is tentative. After EIA approval, the project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(d) Water pollution/ river water/ bottom sediment: river water quality

Location: Downstream of the discharge point in Karalamysh Canal

Item	Unit	Measured Value	Standard of the relevant country	IFC/WB EHS Guidelines
Temperature	°C		3℃	-
pH	-		6.5-8.5	6.5-9.0
SS	mg/L		15	50
Oil and Grease	mg/L		0.05	10
Nitrite	mg/L		0.02	-
Nitrate	mg/L		9.1	-
Sulfate	mg/L		100	-
Chloride	mg/L		300	-
Ammonium-nitrogen	mg/L		0.5	
Phosphate	mg/L		0.3	-
Fe	mg/L		0.05	1.0
Copper	mg/L		0.001	0.5
Zinc	mg/L		0.01	0.5
BOD	mg/L		3.0	0.5

Note: MPC at this table is tentative. After EIA approval, the project-specific MPC will be calculated as a normative document and approved by Goskompriroda.

(e) Waste

Waste management practice in storage and disposal

Name of Waste	Hazardous Class	Place of waste generated	Storage amount (Unit: tor kg)	Disposal / transferred amount (Unit: tor kg)	Storage / Disposal/ transferred method and place

(f) Soil pollution

Location: hazardous material handling area

Date	Locations	Soil condition (transformation of soil, leakage of hazardous materials)	Provision	Remarks

(g) Noise

Location: to be determined (at the site boundary and in the residential area)

Unit: dBA

Date (Period)	Location	Average (Leq or L50)	Max (Lmax)	Uzbekistan Noise standards*	IFC/ EHC Guideline (General; 2007) residential area
				Residential area: Daytime: 55 Nighttime: 45	Residential area: Daytime: 55 Nighttime: 45

*According to KMK 2.01.08-96 "Noise protection" (The State Committee for Architecture and Construction of the Republic of Uzbekistan, Tashkent, 1996)

Note: The noise situation in residential area is mainly assessed by average value. The noise level of the project boundary is mainly assessed by maximum value.

(h) Labor and working conditions

Conformity of laws and regulations

Work Contents	Inspection Item	Contents	Status	Provision	Remarks

(i) Accident

Conformity of laws and regulations and accident log

Construction Contents	Inspection Item/ Accident	Contents	Status	Provision	Remarks

(j) Grievances

Grievances and complaints from the public to monitor social issues

Date	Name	Contents	Status	Results	Remarks

ATTACHMENT　Contact List

ATTACHMENT

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