Ukraine

Ministry of Energy and Coal Industry

Information Collection and Verification Survey for Ukraine Energy Sector

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Abbreviations

Abbreviation	Standard Nomenclatures
【A】	
AT	Automatic Transformer
【C】	
CETI	Coal Energy Technology Institute
CHP	Combined Heat and Power
CTF	Clean Technology Fund
【D】	
DBN	State Building Codes
DCS	Distributed Control System
【E】	
EBRD	European Bank for Reconstruction and Development
ENTSO-E	European Network of Transmission System Operator for Electricity
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EPC	Engineering, Procurement, Construction
ESP	Electrostatic Precipitator
EU	European Union
【F】	
FDF	Forced Draft Fan
F/S	Feasibility Study
【G】	
GDP	Gross Domestic Product
GIS	Gas Insulated Switchgear
【H】	
HTLS	High Temperature Low Sag
【I】	
IBA	Important Bird Area
IBRD	International Bank for Reconstruction and Development
IEC	International Electro technical Commission
IEEJ	Institute of Energy Economics, Japan
IDF	Induced Draft Fan

Abbreviation	Standard Nomenclatures
IFC	International Finance Corporation
IMF	International Monetary Fund
ITA	International Technical Aid
【J】	
JCOAL	Japan Coal Energy Center
JICA	Japan International Cooperation Agency
【L】	
LNG	Liquid Natural Gas
L/A	Loan Agreement
【M】	
MECI	Ministry of Energy and Coal Industry of Ukraine
MEDT	Ministry of Economic Development and Trade
MENR	Ministry of Ecology and Natural Resources
METI	Ministry of Economy, Trade and Industry of Japan
MOU	Memorandum of Understanding
MRDBH	Ministry of Regional Development, Building and Housing
【N】	
NCRE	National Commission for Regulation of the Electric Power Sector
NEDO	New Energy and Industrial Technology Development Organization
NERC	National Energy Regulation Commission
NKREKP	National Commission for regulation in the energy and utilities
NRC	National Reform Council
【O】	
OEM	Original Equipment Manufacturer
【P】	
PCB	Poly Chlorinated Biphenyl
PLF	Plant Load Factor
PSPP	Pumped-Storage Power Plant
【R】	
ROW	Right of Way
【S】	
SAEE	State Agency on Energy Efficiency and Energy Saving
SCADA	Supervisory Control and Data Acquisition
SPF	State Property Fund

Abbreviation	Standard Nomenclatures
SRPC	Static Reactive Power Controller
SVC	Static Var Compensator
【U】	
UCTE	Union for Coordination of Transmission of Electricity
UNFCCC	United Nations Framework Convention on Climate Change
【V】	
VAT	Value Added Tax
【W】	
WB	World Bank
WEM	Wholesale Electricity Market

Executive Summary

1. Introduction

Concerning the primary energy situation in Ukraine, due to the stoppage of natural gas supply from Russia and the instability of anthracite supply from the eastern regions, the country must effectively utilize a wide variety of coal from the point of energy security.

In terms of the composition of power sources, coal-fired thermal power and nuclear power account for almost 80%, however, the supply is tight due to the above-mentioned instability of primary energy supply. Another issue concerns the need to renew deteriorated facilities. Concerning power transmission facilities as well, many overhead transmission lines and substation devices are being used beyond their design service life and are now badly deteriorated, and the country is advancing the renewal of facilities in conformance with EU standards while receiving assistance from donors. In addition, concerning heat supply system in Ukraine, supply of natural gas, which accounts for almost 90% of heat sources, is unstable and there is urgent need to address issues such as reducing fuel usage and improving the efficiency of energy use.

So far Japan has not provided yen loan assistance to the energy sector in Ukraine, however, related agencies have conducted support such as diagnosis of coal-fired thermal power plant and demonstration testing of high-efficiency turbines, and further assistance is being considered. This Study is intended to collect and sort basic information for examining possible assistance projects in the energy sector of Ukraine. In geographical terms, it targets mainly not only Kyiv city and Kyiv oblast but also covers the entire area of Ukraine including the western region where there is Lviv city, and the eastern region where there are Kharkiv oblast and Dnipropetrovsk city. In terms of topics, the Study covered the following 3 fields: energy sector in general, electric power fields (thermal power generation, transmission and substation), and district heat supply (including waste power generation), and they were investigated from the viewpoints of primary energy, organization and policy, laws and regulations, environmental and social consideration, economy and finance, and trends of assistance from international donors.

2. Outline of the Energy Sector

The ultimate decision-making body on energy policy in Ukraine is the Cabinet of Ministers, however, due to complex political issues; the parliament and President are involved. Moreover, numerous government ministries and agencies such as MECI and MRDBH are involved in executing policies and supervising energy operators (See Table 2.1-1).

2.1 Industrial Structure (coal, gas, petroleum)

The main coal producing areas are Donbass in the east, Lviv/Volyn near the western border with Poland, and Dniepr and so on in the central-eastern region. Due to the advance of privatization, the volume of production from private coal mines operated by DTEK and so on now exceeds production by state-run mines. The price of coal from private mines is generally higher. Imports of coal have been totally liberalized (See Figure 2.1-1).

Concerning natural gas, Ukrtransgaz, a subsidiary of the state-run corporation Naftogaz, transports gas via high-pressure pipelines. Importing has been liberalized and is mostly conducted by Naftogaz. In each city, district distribution companies known as Oblgaz supply gas to final consumers via low-pressure pipelines (See Figure 2.1-2). As a result of privatization, many of the Oblgaz stocks were sold from Naftogaz to the private sector. Production of natural gas from the Autonomous Republic of Crimea is conducted by Chornomornaftogaz, which is a subsidiary of Naftogaz, however, following the governance of Crimea by Russia in 2014, the control of Naftogaz is no longer effective.

The petroleum market has been liberalized, and pipeline transportation is conducted by Ukrtransnafta, a subsidiary of the state-run corporation Naftogaz, however, in recent years the volume of Russian petroleum going through Ukraine to Europe has been declining. Ukraine has 7 refineries that refine domestically produced crude oil, however, due to the effects of privatization following disintegration of the Soviet Union, the price competitiveness against neighboring countries has been deteriorated due to the delayed modernization of facilities and as the result, the operating hours are decreased.

2.2 Industrial Structure (electric power)

Concerning the electric power supply system, the wholesale electric power market was introduced in 1996 based on reference to the pool market in Britain. The only purchaser of electric power in this wholesale market is the state-run corporation Energorynok. The state-run corporation Ukrenergo owns and operates trunk transmission systems in the 220 kV and higher voltage classes, and each generating company and small-scale operators transmit power to Ukrenergo. Ukrenergo transmits power to 42 distribution companies known as Oblenergo, one of which is found in each oblast and cities with special status, and the Oblenergo supplies electricity to each households (See Figure 2.1-5). Hydropower and nuclear power are state-run operations, while private enterprises such as DTEK are involved in thermal power, and the state-run corporation Centrenergo is also undergoing the procedure to become privatized. The prices of purchase by Energorynok are regulated, however, thermal power sources are open to tender. Moreover, supply at tariffs that differ from those for general contract holding consumers is recognized with respect to consumers that meet certain conditions.

In terms of administration and regulation, MECI is responsible for planning and implementing electric power infrastructure development, and NCRE is in charge of tariff regulations and licensing in the wholesale market.

2.3 Industrial Structure (heat)

The heat supply utility is largely operated by regional municipalities, however, as in the case of Kyivenergo in Kyiv, operation and maintenance of facilities is sometimes outsourced to the private sector. Heat sources consist of CHP, thermal power and nuclear power stations, industrial waste heat and district heating boilers. Out of 33,312 district heating boilers, approximately 85% are small-scale units with heat production capacity of less than 3,000 Gcal/h. Many district heat supply systems are deteriorated and in case of centralized heat sources, the heat loss is estimated to be 10 to 15% (See Table 2.1-3).

The total length of centralized heat supply system pipelines is 33,800 kilometers. Since heat loss is not controlled in many pipelines, the loss during transportation is estimated to be 30% or higher, however, because metering is insufficient in the phases of heat transportation, distribution and consumption, the exact situation is unknown.

2.4 Energy Demand and Supply

Looking at the primary energy supply volume between 1990 and 2013, it dropped suddenly following the disintegration of the Soviet Union in 1991 and gradually increased again from 2000 onwards, however, it has been gradually falling again in recent years due to the post-Lehman Brothers financial crisis in 2008 and the more recent conflict in the east of the country. In terms of the energy mix, the share of nuclear power increased over this period, while the share of petroleum declined significantly (See Figure 2.2-1).

Concerning the future energy supply (up to 2035), gentle increase of around 0.1% per year is considered as the moderate scenario (reference: Ministry of International Trade and Industry of Japan: "Study of Developing Energy Policy Master Plan for Ukraine"). Moreover, due to the strained supply situation regarding anthracite and natural gas, which is impacting the industrial sector, and the conflict with Russia and/or the eastern area of the country, the GDP growth rate is being held back and there is a downside risk regarding demand for primary energy. Meanwhile, there is an upside risk arising from the steady progress to improve energy efficiency. It is thought that such factors will have the largest influence on primary energy demand and supply in the future (See Figure 2.2-2).

2.4.1 Coal

It is estimated that Ukraine has buried coal reserves of 117.54 billion tons, of which Donetsk basin accounts for 86%. Recoverable reserves amount to 45.54 billion tons. In terms of coal types, 80% of recoverable reserves comprise sub-bituminous coal and bituminous coal (See Table 2.2-2). In geographical terms, the east and west of the country produce anthracite and bituminous coal, while the center of the country mainly produces lignite (See Figure 2.2-3). Ukraine's coal production capacity in 2013 was 89.90 million tons, of which approximately 75% comes from Donetsk oblast and Luhansk oblast. However, since both these oblasts are located in the conflict-affected east of the country and more than half of the coal mines there are under the control of pro-Russian separatists, they are beyond the control of the Government of Ukraine, which has no access to information on coal production there.

Since almost all coalmines in Ukraine employ underground excavation of thin coal seams at deep levels, productivity is very low (between 5% and 50% of that in other countries). In these circumstances, the Government is abolishing subsidies to coalmines and promoting privatization in the sector, and it is forecast that the coalmines with low productivity will be closed from now on. Assuming that the suspension of supply caused by the conflict in the east of the country continues, it is forecast that coal production, which stood at 41 Mtoe in 2013, will fall to 32 Mtoe by 2035 (there is also an alternative view that production volume will remain roughly the same due to the effects of improved productivity resulting from privatization).

In consideration of the above points, it is forecast that coal imports in 2035 will be 11 Mtoe (more than the figure in 2013) and it will likely be necessary to strengthen the coal importing infrastructure (See Figure 2.2-5).

2.4.2 Petroleum

Crude oil production in Ukraine is in decline, falling from 5 million tons in 1990 to 2.45 million tons in 2015. Moreover, due to delays in the renewal and modernization of oil refining facilities following the disintegration of the Soviet Union and declaration of independence, imports of crude oil have almost dropped to zero. Meanwhile, concerning petroleum products, Ukraine has been a net importer since around the middle of 2000. In 2013, Ukraine imported approximately 60% of its domestic supply volume mainly from Belarus and Russia, which have more competitive refineries. Since there is little prospect of increased crude oil output or renewal of oil refineries in the coming years, it is expected that Ukraine will continue to remain reliant on imports of petroleum products for the foreseeable future.

2.4.3 Natural Gas

Ukraine's confirmed natural gas reserves are 0.6 Tcm, which is the 28th largest in the world and 4th in Europe/Eurasia, and it is estimated that these can be recovered for another 34.3 years. The production cost is around 3.3 to 5.5 USD/MMBtu, and it is thought that Ukrainian natural gas will stay competitive in comparison to piped natural gas and imported gas from Europe, which the IEA forecasts will cost around 10 to 12 USD/MMBtu until 2040.

Natural gas is mainly used for heat production in CHP stations and so on. Hardly any natural gas is used for dedicated generation purposes, and the Government is trying to curtail consumption in order to move away from dependence on Russia. Accordingly, use of natural gas will mainly be confined to heat production from now on (See Figure 2.2-8).

Ukraine is the main route through which Russia and Belarus transport natural gas to Europe (See Figure 2.2-9). However, due to a decline in natural gas consumption in Europe and establishment of the Nord Stream pipeline that doesn't pass through Ukraine in 2011, the transit volume has dropped sharply from 104.2 Bcm in 2011 to 67 Bcm in 2015. In future it is thought that Russia will continue to reduce the Ukrainian transit volume as a political strategy, and this will have a negative impact on the business condition of Naftogaz, for which transit tariffs are an important source of revenue.

Ukraine's natural gas production is 15to20 Mtoe, however, it depends on imports for the majority of supply (See Figure 2.2-10). In recent years it has increased imports from Europe and its dependence on Russia fell from 92% in 2013 to 37% in 2015. In future it is expected that domestic production will increase due to improvement of the investing environment, although it is expected that import levels will remain roughly the same as they are now. In order to improve reverse transmission capacity from Europe, it will take a few years to expand and enhance pipelines and facilities. On the other hand, underground reserves of natural gas in Ukraine amount to 31 Bcm, more than the annual import volume of 20 Bcm, and these can be used to stabilize supply in the winter and mitigate the cost of natural gas imports through exploiting price differentials in the summer. The fact that locations suitable for storage are located in central and western areas away from the conflicted region is another favorable factor.

2.4.4 Electric Power

The sharp decline in generated electric power between 1990 and 2000 arose because it was no longer necessary to supply electricity to regions of the former Soviet Union following its disintegration in 1991 (See Figure 2.2-11). After that, it steadily recovered apart from another temporary decline following the Lehman Brothers financial crisis in 2008. However, after peaking at 197 TWh in 2012, it declined to 158 TWh in 2015. Power generation in Ukraine has conventionally focused on thermal power fired by abundant domestic reserves of coal. Between 1980s and 1990s, advances were made in the introduction of nuclear power, while petroleum-fired thermal power all but disappeared. After that, due to a deterioration in relations with Russia over supply of natural gas in the latter 2000s, there was a shift from gas to coal. As a result, whereas the composition of power sources in 1990 comprised 26% nuclear power, 38% coal and high percentages of gas and petroleum, by 2013 the ratios of nuclear power and coal had increased to 43% and 42% respectively while gas fell to 7% and petroleum was almost zero. The mix of power sources that is primarily based on domestically produced uranium and coal may be described as rational from the viewpoints of energy security, economy, air pollution and carbon dioxide emissions.

In terms of generation equipment, coal-fired thermal power currently accounts for approximately 20 GW and nuclear power for 14 GW. Combined, these 2 sources account for approximately 70% of total output, and this situation is expected to continue over the coming 20 years (See Figure 2.2-13). Many power stations were constructed during the era of the former Soviet; in particular, many coal-fired thermal power stations were constructed in 1960s to 1970s. At the end of 2010, the cumulative operating time of 84% of thermal power stations was beyond 200,000 hours, which is regarded as the service life in Ukraine (See Figure 2.2-15). Since it takes 7 to8 years to prepare and construct a thermal power station, it is urgently necessary to compile new construction plans. Many of the country's nuclear power stations were constructed in 1980s and will reach 40 years of service from 2020 onwards, however, it will be necessary to extend the service life of these stations until Khmelnytska Units No.3 and No.4 (2 x 1,000 MW) station currently under construction will go into operation. Ukraine is also advancing the introduction of renewable energy through making use of FIT (feed-in tariff).

2.4.5 Heat

The volume of heat supply mainly for industrial uses dropped sharply from 1990 onwards, however, it still stays in a declining trend after that. Energy saving measures are being advanced in the heat supply sector from the viewpoint of reducing gas consumption, so it is thought that the volume of heat supply will continue to decline from now on.

Viewed in terms of each fuel, natural gas accounts for approximately 80% or more of heat supply, and it is likely to remain the main source of heat supply for the following reasons: the already established natural gas supply infrastructure can be utilized, coal is unsuitable in central urban areas where heat sources are located, introduction of biomass based on FIT, etc. and seems to be limited.

2.5 Energy Policy

As a result of the 2014 conflict with Russia, it became necessary to revise "Energy Strategy of Ukraine to 2030" (hereinafter referred to as the "Energy Strategy"), which was released in 2006 and was updated and approved by the Cabinet of Ministers in 2013. In 2015, "Energy Strategy to 2035 (draft)" was announced by MECI but has been reviewed. This draft indicates the policy direction upon dividing the period up to 2035 into 3 stages (See Table 2.3-1).

In the demand projection, it is assumed that GDP will increase at a mean annual rate of 3.5% per year from 2010 onwards. However, due to the minus growth of 2013to15 and other uncertain elements in the economy, it is possible that other major deviations will arise. In the field of primary energy supply, up to 2035 it is projected that coal will be reduced due to development of nuclear power and that natural gas will be reduced due to use of renewable energy in heat supply (See Table 2.3-2).

Concerning supply of electric power, it is forecast that deteriorated thermal power facilities will be decommissioned, there will be construction of new biomass generation and nuclear power facilities, and further development of small hydropower and hydraulic pumped-storage generation facilities, however, the dissemination of wind power and solar power is expected to be limited (See Table 2.3-3). The demand for heat is expected to grow at a mean annual rate of 1.9%. On the supply front, it can be expected that consumption of natural gas will drop due to increased use of biomass (cereal waste, etc.).

Concerning fuel production, Energy Strategy includes policies for promotion of higher efficiency and technology development geared to self-sufficiency in coal and natural gas, mitigation of risk based on diversification of importing sources for petroleum. In addition, suggestions are made regarding reform of consumers' awareness of energy saving, introduction of certification systems and incentives for energy saving, improvement of governance, adoption of transparent administration, enhancement of market efficiency (See Table 2.3-7).

2.5.1 Reform of the Energy Sector

In July 2014, the National Reform Council was established to oversee reform, including the energy sector. It has raised strategic goals including market liberalization, effective regulations, diversification of supply and improvement of efficiency (See Table 2.4-1), and respective tasks have been set for each sector of coal, electric power, gas and energy saving (See Table 2.4-2).

2.5.2 Privatization of State-run Enterprises

IMF requested Ukraine should tackle anti-corruption, reduction of troubled assets and improvement of productivity under the condition IMF gave in order to fight financial deterioration. The privatization in energy sector is going further like those of state-run corporations. Incidentally, Naftogaz (petroleum and natural gas), Ukrhydroenergo (hydropower generation), Energoatom (nuclear power generation), and Ukrenergo (power transmission) are not targeted for privatization but rather are placed under the jurisdiction of special companies under the Cabinet (See Figure 2.4-2). Meanwhile, concerning Centrenergo (thermal power generation), the decision was made to execute the privatization process in February 2016. Since many of the enterprises targeted for privatization have poor finances and are basically given governmental guarantees, they will face extreme difficulties in utilizing international finance.

2.5.3 Reform of the Electric Power and Gas Sectors

In Ukraine, which aims to become integrated with the EU market, the European electric power and gas market framework (3rd Energy Package) will be introduced (See Table 2.4-5). In the gas sector, surcharges will be set; Naftogaz will undergo unbundling, and all consumers will have the free access to choose their own gas suppliers. In the electric power sector, the single buyer system based on Energorynok is adopted, however, the role of Energorynok will be limited by introducing the adoption of bilateral transactions, the spot market and so on from now on.

2.5.4 Reform of Energy Prices

In Ukraine, although major abuses about too low energy price have been pointed out, they have undergone hardly any reform. However, in response to forceful requests by IMF and so on, Ukraine announced hikes in energy prices in each sector in February to March 2015, and it is planned to increase prices to a level that covers supply costs by April 2017. If appropriate pricing can be realized for energy, it can be expected that the infrastructure investing environment will be greatly improved and energy saving investment will be accelerated. Each sector is briefly described in the following table.

Electric power	5-phase increases of electric power tariffs over 2 years starting from April 1, 2015 (See Figure 2.4-4).
Natural gas	Increase of household gas tariffs equivalent to raw with cost up to April 2017 (approximate doubling in price terms) (See Figure 2.4-5).
Heat prices	Increase of Household heat tariffs with approximately 67%will be raised approximately 67% (not including heat that is supplied from CHPs and power stations) to a level equivalent to raw cost by April 2017.
Meter installation	Introduction of energy saving incentives in line with revision of the tariff system (from fixed charge to metered charges tariffs) based on installation of gas meters and heat meters.
Energy saving in ordinary households	Heat insulation works in houses and energy saving public announcement (collaborated with joint support by the Government, banks and IFC)

2.5.5 Issues in the Energy Sector

The biggest issue facing the energy sector in Ukraine is the critical natural gas and coal supply situation caused by the deterioration in relations with Russia, however, there are other complex issues including the low efficiency of energy utilization, deterioration of infrastructure, lack of market transparency, corruption and political confusion. The following paragraphs describe the issues facing each sector.

2.5.5.1 Natural Gas

The major issues concern the need to reduce dependence on imports and to diversify importing sources.

Domestic natural gas production	Increase of Naftogaz retail prices, and improvement of system transparency through improvement of the investing environment including overseas capital through improvement of system transparency and stabilization of policy
Conversion to alternative fuels	Reducing consumption of natural gas has a direct effect, however, it is necessary to introduce carefully while monitoring impacts on environment and cost.
Improvement of efficiency	Improvement of utilization efficiency and introduction of energy saving incentives in both the industrial sector and civilian sector, and reduction of power for gas transportation compressors, etc.
Diversification of import sources	Installation of transportation facilities for catering to reverse transitions from the European side, and new construction of LNG importing facilities and pipelines

2.5.5.2 Heat Supply

Issues that need to be addressed in order to directly and indirectly improve efficiency are as follows.

Raising tariffs and installation of meters	These are prerequisites for investment in operators and energy saving incentives among consumers.
Facility renewal and modernization	These are essential for aging order to address facilities deterioration, however, it will be necessary to invest on an appropriate scale in light of energy saving and technical innovative reform.
Examination on Review of the heat supply method	It is necessary to promote optimum choices including conversion to individual separate heating in light of changing circumstances, and also to take drastic measures that also include city planning.

2.5.5.3 Coal

The main issues are as follows.

Diversification of the coal supply structure	Since the biggest issue concerns impediments to the supply of anthracite coal for power generation, it is necessary to diversify the demand and supply in terms of coal types and production areas as well as renewing deteriorated thermal power facilities and/or, converting to bituminous coal and utilizing lignite.

Improvement in efficiency of domestic coalmines	Even discounting the handicap to dig in underground tunnels seeking for coal from casting of thin coal seams, it is essential to reform the subsidy-dependent structure of the industry and to advance the closure of inefficient coalmines (while also taking steps to address unemployment).

2.5.5.4 Electric Power

In the power generation field, it is necessary to consolidate and modernize the deteriorated facilities that have survived from the era of Soviet Union.

Thermal power	Concerning coal-fired thermal power, it is necessary to take environmental measures in line with EU standards and to address the tight supply situation of anthracite.
Nuclear power	It is necessary to move away from dependence on Russia and introduce Western technology.
Renewable energy	This is suited to investment because purchase prices are based on the Euro, however, it is predicated on political stability to mitigate the currency exchange risk.
Transmission field	It is urgently necessary to renew deteriorated facilities, and it is also necessary to expand and renew transmission lines and substation facilities on a planned basis upon considering taking into account long-term forecast in the composition and arrangement of power sources and transitions in the demand distribution.
Distribution field	It is necessary to rehabilitate and renew facilities, improve operations and maintenance with appropriate voltage, and introduce energy saving incentives based on installation of electric power meters.

2.5.5.5 Petroleum

In the field of domestic resources development, it is necessary to improve the long-term investing environment including the utilization of foreign capital. Concerning the effective utilization of domestic oil refineries, it is necessary to conduct renewing investment that also addresses the need to introduce high-specification products geared to the European market.

2.5.5.6 Energy Efficiency

Energy utilization efficiency in Ukraine is very poor and there is much room for improvement. Based on establishment of SAEE in 2011 and formulation of the energy saving action plan until 2020 by MRDBH, it is indispensable to execute the policies and adopt appropriate pricing (increase prices) and promote metering in order to promote voluntary actions by consumers.

3. Legal Systems and International Financing for Energy Sector

3.1 Legislative and Administrative Systems, Laws and Regulations

In Ukraine, following the proclamation of independence from the Soviet Union, Ukraine has adopted a parliamentary democracy (republic) with separated powers of administration, legislation, and judicature, and politics and administration are operated by the President and parliamentary cabinet system. The types of legislation and regulations in Ukraine and main decision-making entities are as follows.

Ukrainian laws	Enacted based on proposals by the Cabinet of Ministers or parliamentary members and approved by the Supreme Council
Decree of Presidents	Issued in cases where urgency is required by President
Order of Cabinet	Executed based on approval by the Cabinet of Ministers
Detailed rules	Executed by ministers, heads of administrative divisions or autonomous districts, and lower level administrative agencies

3.2 Laws and Regulations in the Energy Sector

In the energy and electric power fields, domestic laws and regulations are successively being established geared to the early realization of the top priority issue of EU directives. The main laws and regulations are as follows.

- Protocol in order for Ukraine to participate in the Energy Community Treaty
- Approval of the action plan for obligatory implementation based on the Energy Community Treaty
- Revision of fundraising agreements for ongoing support programs aimed at realizing Ukraine's Energy Strategy, and signing of additional treaties between EU and Ukraine represented by the European Commission
- Launch of pilot projects for energy connection between EU and Ukraine
- Operating regulations for the electric power market in Ukraine

Moreover, regulations related to infrastructure construction in Ukraine include EU Directives and Regulations, the State Building Codes (DBN) related to disaster prevention and strength of buildings, Ukraine State Technical standards (SOU) stipulating environmental controls and frequency stability, etc. for conforming to EU standards, UkrSEPRO - the certification system that is required in order to import industrial products to Ukraine and pas them through customs, the former Soviet standard for electrical products (GOST), which is used for the import and customs clearance of products in the absence of UkrSEPRO and so on.

3.3 Licenses required for Electric Power Equipment Works

The licenses required for the rehabilitation and installation of electric power facilities comprise the following steps.

First, in the planning and design stage before works, the proponent prepares the feasibility study and design, consigns assessment to a nationally certified inspection expert, and obtains consent from the Town Master Planning Authority. Next, it conducts detailed design, exchanges opinions and reaches agreement with the related government agencies and electric power company, and acquires building permission through a qualified construction firm that is nationally certified. After that, works are implemented, however, it is necessary to obtain connection permission concerning electricity, gas, water supply and sewerage as the need dictates. Following the completion of works, it is necessary to have completion documents and permission from the company in charge of the energy market in order to connect to the power grid.

In order to undergo these procedures, it is necessary to add at least 18 months to the works period in the project schedule.

3.4 International Support for the Energy Sector

3.4.1 International Financing Procedures

The procedures in cases where state guarantee is needed are as follows.

- Application for F/S by the proponent
- Approval by the proponent's superior ministry and consent of related ministries (Ministry of Finance, MEDT, MRDBH and Ministry of Justice, etc.)
- Inquiry to International doners from Ministry of Finance
- Confirmation of availability of financing from Internationl doners
- Cabinet approval based on application by the proponent's superior ministry (essential if the investment amount is UAH 4 million or more)
- Decision by the Supreme Council on the draft bill submitted by the Cabinet
- Approval by the President

Moreover, one of the following is required in order to obtain governmental guarantee.

- Accordance with ITA (International Technology Agreement)
- Accordance with bilateral governmental agreement approved separately
- Project approved by either state-run corporations or local government under the national budget

In addition, the governmental guarantee will be granted if even a project by local government meets the requirement. In such cases, the funds that are internationally loaned to Ministry of Foreign Affairs ministry are allocated to the local governments as state subsidies.

3.4.2 Cases of Support by Japan

- In 2014, JCOAL implemented facility diagnosis with a view to improving efficiency in deteriorated coal-fired thermal power stations in Ukraine. In addition to examining fuel conversion and making proposals on efficiency improvement and environmental load reduction, it implemented overhaul inspections in preparation for rehabilitation of turbines.
- In 2015, NEDO implemented a preliminary survey with a view to implementing a demonstration project for upgrading deteriorated steam turbines in Ukrainian coal-fired thermal power stations to the latest Japanese systems.
- In 2015 to 2016, NEDO was advancing a project to improve efficiency and reduce environmental load through introducing a Japanese gas turbine combined cycle system to a district heat supply station of Kyivenergo, however, this failed to progress because the local side was unable to raise the necessary funds.
- In sectors apart from energy, in 2015, the project to improve Bortnich sewage treatment station having Kyiv city as the project proponent was formed based on a yen loan from JICA to the Government of Ukraine with the governmental guarantee.

3.4.3 Assistance by Other Donors

EBRD is the largest donor in the area of assistance to Ukraine. It is mainly engaged in projects for improvement of transparency, improvement of the business environment and, in the energy sector, improvement of heat efficiency, carbon reduction, and improvement of energy security. A feature of aid by EBRD is that it does not always demand governmental guarantees: for example, loans for district heat supply operated by provincial or municipal authorities are provided without governmental guarantees. It also provides loans to private sector companies.

World Bank, similar to the EBRD, also makes it a basic policy to improve transparency. In the energy field, it is implementing projects related to transmission and smart grids, and it has also set a major financing framework based on sector loans in the district heat supply field. However, due to the impact of the conflict in the east of the country, it has not formed or executed individual projects.

Moreover, because World Bank requires state guarantees, loans are made to Ministry of Finance, which subsequently lends money to each district heat supply project. MRDBH acts as the practical window agency also screens projects. These are major differences from projects by the EBRD, which directly makes loans to municipal authorities.

4. Environmental and social consideration

4.1 Administrative Mechanisms

In the central government, Ministry of Ecology and Natural Resources (MENR) is in charge of environmental protection administration. Meanwhile, in local governments and Kyiv city and

Sevastopol city which has the special status, the Departments of Ecology and Natural Resources have this duty. Each Department of Ecology and Natural Resources belongs under the jurisdiction of its affiliated local government and is accountable to MENR.

4.2 Requirements concerning Legislative System and EIA

According to Article 50 of the Constitution, citizens' environmental rights and right of access to information on the environment are guaranteed, and the Environmental Protection Act, Air Quality Protection Act, Water Code, Wastes Act and so on are established based on this article (See Table 4.2-1). The following table outlines EIA requirements in these laws.

Law on Environmental Protection Act, Article 51	Environmental Protection Act Article 51 requires implementation of environmental impact assessment with respect to projects in all business activities.
Law on Atmospheric Air Protection, Air Quality Protection Act, Article 23	Air Quality Protection Act Article 23 requires air quality preservation in the design, construction and reconstruction of new facilities. Moreover, Article 11 of this law prescribes items concerning emissions of air pollutants from fixed generation sources and stipulates that emission license must be acquired from local governments, Kyiv city or Sevastopol city.
Water Code, Article 96	Water Code, Article 96 prohibits the implementation of projects for which impact assessment on water sources hasn't been implemented.
Water Code, Article 35	Article 35 prescribes standards concerning water utilization, water preservation and recovery of water sources.
Water Code, Articles 37 to 41	Articles 37 through 41 prescribe the category-separate water quality indexes, maximum permissible emission standard, sector-separate technical standards concerning emissions, technical standards concerning water utilization, environmental safety standards, and regulations prohibiting emissions of substances for which the peak permissible emission standard hasn't been set to water bodies.
Water Code, Article 49	Article 49 stipulates about licensing for special water uses (water supply from water sources to facilities, discharge of wastewater to water sources and so on).
Law on Wastes, Article 32	Law on Wastes, Article 32 prohibits the operation of new projects without the introduction of technologies and devices for the safe management of wastes.
Law on Wastes, Article 17	Law on Wastes, Article 17 makes it compulsory to acquire a wastes management license in projects where the total wastes generation rate exceeds 1,000.
Basel Convention	Concerning management of coal ash, there is legislation that guarantees implementation of international obligations based on the Basel Convention, and fly-ash is classified into either the Yellow List or the Green List depending on its components.

4.3 Ukraine Environmental Standards

Air	The national sanitary regulations concerning prevention of air pollution prescribe maximum permissible concentrations (instantaneous maximum and daily mean) and risk classifications for sulfur oxides, nitrogen oxides and particulates (See Table 4.3-1).
Atmospheric discharge standards in the power generation sector	MEMR regulations prescribe emission standards on atmospheric pollutants (particulates, sulfur dioxide, nitrogen oxides and carbon monoxide) from thermal power stations with output of more than 50 MW (See Table 4.3-2 to 4.3-5). The current standards are effective with respect to existing facilities until December 31, 2017, however, harsher standards will be applied to new facilities and existing facilities that are reformed on or after January 1, 2018.
Noise	Based on the national building standard, the equivalent noise level and maximum permissible equivalent noise level are prescribed for daytime (07:00 to 23:00) and nighttime (23:00 to 07:00) according to each sensitive area such as residential areas, tourism areas, sanitariums, nature protection reserves, etc.) (See Table 4.3-6).
Water quality	The surface water protection regulations prescribe maximum permissible concentrations concerning suspended solids, pH, salt content, dissolved oxygen, BOD, COD and organic and inorganic dissolved substances according to each water body use (potable water, household water, bathing water or water used in sports) (See Table 4.3-7). Moreover, in Cabinet Regulation No.1100, each substance is listed according to 4 classifications.

4.4 Comparison with EU Standards

The current atmospheric discharge standards in Ukraine conform to the Directive 2001/80/EC for large-scale combustion facilities that was compiled in 2001. The action plan to make standards compliant with the stricter Directive 2010/75/EU was approved by the Cabinet of Ministers in September 2014, and work on revising the law is being advanced at MENR, MEDT, MECI and so on. Now, on the working level too, operators are required to comply with the Directive 2010/75/EU (See Table 4.5-1 to 4.5-4).

4.5 Environmental Approval (EIA Procedure)

Environmental impact assessment (EIA) in Ukraine is conducted according to the following procedure: designation of the EIA drafter by the project proponent, agreement between the parties and announcement of intentions, assessment by the EIA compiler based on DBN, disclosure (implementation of notification and public hearings and consideration of public comments via local administration as needed), and scrutiny and approval by the central government (See the main text Section 4.6.1 and Table 4.6-1).

Projects that entail high environmental risk and require implementation of a detailed EIA are listed in DBN Annex A. Such projects in the energy sector include thermal power stations, generation facilities that use fossil fuels (generation capacity 200 kW or higher), transmission lines and substations (330 kV or higher), general wastes management facilities and so on. EIA reports are required to include the basis for EIA implementation, geographical characteristics of the project implementation site, contents of the project, environmental impact assessment, social and environment assessment, industrial environment assessment, environmental impact assessment during the works, and environmental impact statements. Projects not listed in Annex A require preparation of a simplified EIA report.

5. Overview of Each Field and Support Needs and Candidates for support

5.1 Thermal Power Generation

There are 5 large thermal power generation companies in Ukraine, the coal-fired power plants by state-run Centrenergo is the target of investigation due to the possibility of the governmental guarantee.

5.1.1 Outline of the field

In the Study, investigation of needs for assistance was conducted at 2 large-scale thermal power stations (Trypilska and Zmiivska) owned by Centrenergo. Prior to the survey of the 2 stations, the Study Team prepared a menu of 4 improvement proposals (Replacement of Turbines, Installation / Modernization of Environmental Facilities, Modernization of Control System (Upgrading to DCS), Modernization with GIS at Switchyard) in which it is anticipated Japanese technology can be used upon referring to a report of a thermal power generation facilities diagnosis project that was implemented by JCOAL in 2014 (See Table 5.1-1). In the site surveys at both power stations, upon indicating these proposals, local personnel were interviewed concerning their needs and priorities, information was collected and opinions were exchanged concerning the state of equipment and site conditions, and other support needs were surveyed.

The resulting support needs at these 2 power stations were thus compiled; the findings were submitted to Centrenergo headquarters and MECI (the ministry with jurisdiction) and the policy of these superior organizations was confirmed.

5.1.2 Trypilska Power Station

Trypilska Power Station is located along the Dnieper River on the outskirts of the capital city Kyiv (approximately 45 kilometers to the south). It has 4 supercritical coal-fired units (No.1 to 4) and 2 gas-fired units (No.5 and 6) including the first unit that was commissioned in 1969, and it has total output of 1,825 MW (See Table 5.2-1). The station uses anthracite from the Donbass region in eastern Ukraine, however, operations have become extremely difficult from 2014 due to the impact of the conflict that broke out in that region from February 2014. Accordingly, based on instructions from MECI in February 2016, it is scheduled to remodel part of the station's facilities to bituminous coal-fired facilities.

5.1.3 Zmiivska Power Station

Zmiivska Power Station is located 50 kilometers in the south southeast direction from Kharkiv city, the capital city of Kharkiv oblast. It is older than Trypilska Power Station, its first unit was commissioned in 1960. All units burn coal (anthracite) and they comprise 6 x 175 MW subcritical units (No.1 to 6) and 4 x 300 MW supercritical units (No.7 to 10). The station has total output of 2,230 MW (See Table 5.2-3). As is also the case at Trypilska, since this station uses anthracite from the Donbass region in eastern Ukraine, operation has been disrupted from 2014 onwards. For this solution, combustion testing is being conducted with a view to expanding mixed combustion with bituminous coal.

5.1.4 Support Needs and candidates for support

The following table summarizes the support needs of the 2 power stations, Centrenergo headquarters and MECI.

5.1.4.1 Trypilska Power Station

The counterpart assented to the 4 proposals as a whole that were prepared in advance by the Study Team as possible options for future assistance. Meanwhile, the most urgent issue in the power station is the tightness of ash pond capacity, and it is hard to acquire an additional site for ash pond newly. However, acquiring site and promoting effective utilization of coal ash, which would be required to establish necessary laws etc., is out of scope which Japan can support.

5.1.4.2 Zmiivska Power Station

The counterpart assented to the 4 proposals as a whole that were prepared in advance by the Study Team as possible options for future assistance. However, the tightness of ash pond capacity like Trypilska Power Station and temperature increase in summer by sedimentation in cooling pool are also out of scope which Japan can support.

5.1.4.3 Centrenergo and MECI

Their hope of new bituminous coal-fired power station was extended to the Study Team, considering the coal-fired power station facility in Ukraine has been aging and it is getting hard to acquire anthracite coal continuously.

5.1.4.4 Candidates for support

As a result of meeting with both power stations, Centrenergo and MECI, candidates of support from Japan are summarized in the list below (See Table 5.4-1). Contents requested by the respective power stations are a bit different; however, the items which are expected to assist from Japan are identical.

Candidates for support	Installation / Modernization of Environmental Facilities
	Modernization of Control System (Upgrading to DCS)
	Modernization with GIS at Switchyard
	Replacement of Turbines
	Fuel Conversion for Boiler / Remodeling of Boiler
	Installation of New Unit at existing Power Station
	Installation of New Unit at 3rd point

5.1.5 Conclusion

All of 4 proposals and new add-on of generating unit are consistent with interests of Japanese firms, which means they may break into those plans. However, during our 2nd survey, it was expressed that all of the state-owned shares in Centrenergo would be transferred to SPF, and the new investors would be found for the future (i.e. perfect privatization). Therefore, since there is no possibility to grant governmental guarantee to Centrenergo in future, those candidates would be regrettably out of scope which Japan can support.

Meanwhile, the generating facilities in Ukraine were constructed in 1960s to 1970s, which signifies that it has generally passed over 40 years since the commencement of the operation. There is no specific definition to the lifetime of power station. The lifetime can be extended by renewing the aging parts one by one. However, it should be generically done on the basis of medium-and-long-term maintenance plan, because the investment to generating facility normally becomes expensive. Most of the generating facilities in Ukraine have not been rehabilitated on a large scale, attributing also to the lack of fund; therefore, the aging is expected to advance as it is. Generally, it takes 7 to 8 years at least to construct power station, therefore, needless to say, the current pressing issue in Ukraine, namely to advance actively development plan of new facilities in parallel, remains unchanged even if some parts of existing facilities are renewed and extended the lifetime.

5.2 Transmission and Substation

5.2.1 Outline of the field

The electric power transmission and distribution line network of Ukraine consists of 8 voltage classes which are 800 kV (D.C.), 750 kV, 500 kV, 400 kV, 330 kV, 220 kV, 110 kV and 35 kV. The total length of the overhead transmission lines is approximately 23,000 kilometers and approximately half of the lines have been operated for 40 years or more. There are 137 substations in the network and total capacity of the network transformers is 78.6 GVA. The transmission lines are entirely operated by the state enterprise Ukrenergo, however, distribution lines are under the jurisdiction of 42 distribution companies located in each oblast and cities with special status.

The networks of Ukraine are interconnected with neighboring countries of Russia, Belarus, Moldova, Romania, Hungary, Slovakia and Poland, and it is able to import and export electric power. Since the Memorandum of Understanding on cooperation in the energy sector between EU and Ukraine was exchanged in 2005, Ukraine carried out activities on preparation for adaptation of its legal framework to that of EU and has also adopted international technical standards.

Ukrenergo has the central load dispatch center in Kyiv and regional dispatch centers in 8 regions of the country (central, north, south, west, southwest, Dnipro, Donbass and Crimea) (See Table 6.1-2, Figure 6.1-5 and 6.1-6).

5.2.2 Transmission and Substation facilities

Ukrainian electrical transmission/substation facilities have become deteriorated: for example, 90% of transmission lines of 220 kV class or higher and 55% of major substations have been operating longer than 25 years of their lifetime, and some have been operating over 40 years without rehabilitation. Accordingly, Ukrenergo receives support from European donors to update or newly construct facilities, however, the following concerns exist due to the deterioration of so much facilities.

- Facilities that have been operated over the long term without rehabilitation are noticeably aged exhibiting rusting and discoloration.
- Due to the aged deterioration of analog equipment and mechanical protective relays, there is concern about whether the facility will work properly in case of failures.

When the increase in demand for power is also taken into account, the implementing agencies are also well aware that urgent equipment renewal and upgrading is needed in order to guarantee stable operation over the long term. However, there have been cases where investment has failed to ensure adequate effects due to the financial constraints and shortage of procurement management capacity.

- The construction of 330 kV class transmission lines in Ivano-Frankivsk has been suspended after completing 60 kilometers out of the total distance of 104 kilometers, and now the remaining funding is awaited.
- The bolstering of transformers in Zakarupatcha, western Ukraine, has been suspended with only the transformers procured and stored in the substation, and now funding is waited for other material procurement.

Western Ukraine has large-scale nuclear power stations and ample supply capacity, however, there is a lack of capacity in the system for transmitting power to the central and eastern regions, resulting in insufficient and unstable power supply to the capital, Kyiv, and other cities (See Figure 6.1-2). However, since the new transmission line connecting between western part and central part has commenced the operation from December 2015, it is attracted attention if that can contribute to the improvement of system and operation of power source in future.

5.2.3 International Power Interchange

Ukraine does not yet belong to ENTSO-E (European Network of Transmission System Operator for Electricity), however, ENTSO-E operates/manages power transmission between Ukraine and neighboring countries except Belarus, Moldova, and Russia. The area known as the "Burshtyn Island" in western Ukraine is a hub for receiving power supply from Hungary, Slovakia and Romania, synchronized with EU, and connecting with surrounding areas, and ENTSO-E is involved in its power supply operations. Slovakia is connected via 750 kV transmission lines, however, plans are being examined with a view to switching to the European standard voltage of 400 kV. In future, Ukraine intends to coordinate with the EU system in all regions and it has plans for related investment. Currently, a European consortium for power system operation led by Romania is examining feasibility of synchronous connection between Ukrainian and Moldovan electric power systems and the European ENTSO-E system.

5.2.4 Demand and Supply and System Operation

In recent times, due to the disruption of anthracite procurement caused by the conflict in the east of the country, the regional demand and supply unbalance has been extreme. This, combined with the aforementioned aged deterioration of facilities, is making it increasingly difficult to conduct system operation. Looking at each region, in Donbass, where coal-fired thermal generation is the main power source, the demand-supply situation is extremely tight, while in the central region, there are supply shortages due to the recent rapid increase in demand in Kyiv, and similar shortages are also occurring in the north of the country and Crimea. Conversely, there is ample supply capacity in the west, southwest, south and Dnipropetrovsk regions where nuclear power stations are located.

Domestic systems are currently operated separately from the EU-interconnected sections that are operated and managed by ENTSO-E, however, in the event where EU-interconnected sections expand within the country from now on, there is concern that this could diminish stability of the transmission line network. Ukrenergo implements system analysis every 5 years and when examining each project, however, since it uses the same methods that were used during the Soviet era, its demand projections do not reflect economic conditions.

5.2.5 Transmission Network Development Plan for 10 Years

Ukrenergo each year prepares the electric power plan for the next 10 years in readiness for liberalization of the electric power market. The development plan approval procedure is to prepare the draft plan by Ukrenergo, to confirm and coordinate with NERC, MECI and other related ministries, and to deliberate in the Cabinet of Ministers. The latest draft of development plan for the next 10 years 2016-25 has been already disclosed on the website of Ukrenergo, however, only the 2014-23 plan (prepared in 2013) has so far acquired government approval, while approval for the 2016-25 version is still pending. This plan has the objectives of ensuring energy security in normal condition and in emergency situations, creating conditions for full integration of the Ukraine network into the EU network, increasing the reliability and efficiency of the electricity sector and so on. In terms of its contents, it includes assessment of the current operating situation, electric power demand and supply, development plans, and development investment costs.

The 10-year plan includes development plans for transmission and substation. As plans to reinforce, renew and modernize transmission and substation facilities, the latest plan aims to bolster transmission lines by a total of 3,899 kilometers, substation capacity by 18,413 MVA, and optic fiber cables by 600 kilometers. This facility investment includes contents for which support by EBRD, EIB and KfW has been decided (See Table 6.1-4).

5.2.6 Support Needs and Candidates for support

The followings summarize the support needs in the transmission and substation field.

- The transmission network plans, which are a precondition for compiling Ukrenergo's business plans, employ methods from the former Soviet era that are not suited to current conditions. Accordingly, Ukrenergo seeks assistance in compiling an appropriate master plan.
- In Ukrenergo's transmission line equipment diagnosis report and hearings at the time of the local observations, the local side regarded the renewal of badly deteriorated existing equipment as the top priority issue.
- No needs were recognized concerning adoption of HTLS wire for transmission lines.

5.2.6.1 Candidates for support

Out of the projects mentioned in the national electric power system plan, Ukrenergo wants the following 5 to be earmarked for assistance (See Table 6.3-1).

Candidates for support	Renewal of 330 kV Adjalyk Substation
	Renewal of 330 kV Mykolaivska Substation etc.
	Renewal of 330kV Kozyatyn Substation
	Construction of New 330 kV Slobozhanska Substation etc.
	Stepping-up at Tsentrolit Substation from 220 kV to 330 kV etc.

Since importance is also attached to assistance for substations that are interconnected with the EU, the following 2 items listed in the national electric power system plan were also selected in the discussions with Ukrenergo (See Table 6.3-1).

Candidates for support	Additional Installation of Transformer in 400 kV Mukachevo Substation
	Replacement of Major Equipment in 330 kV Bogorodchani Substation etc.

5.2.7 Conclusion

Aging in facilities of the transmission line and substation in Ukraine is a critical issue; however, the operation has been continuing by exercising various ingenuities of employees in respective substation. Those aging facilities have been gradually renewed; however, it seemed that some of projects had not advanced due to the financing aspect. However, only extremely limited drawings and materials have been disclosed by Ukrenergo, while the Study Team was not allowed to take photographs of the substations, so numerous things remain unclear about the scale of works and the specifications. Moreover, because Ukrenergo's transmission and substation facilities are so extremely deteriorated, it is necessary to advance systematic renewal and upgrading including master plan formulation in addition to the above projects.

Furthermore, the feasibility of new construction of transmission line was unable to verify, since there was no master plan of transmission line system in Ukraine. Meanwhile, the transmission line system in Ukraine has been planned by the connecting system of EU, and its roadmap is currently under consideration including ENTSO-E which is European Generating Transmitting Management Organization.

In future, it is important to make a transmission line development plan in Ukraine newly after making an announcement of the roadmap.

5.3 District Heat Supply

Unlike in Japan, heat supply pipeline network has been built as social infrastructure in Ukraine, by distributing hot water for heating purpose to respective households and public facilities through pipelines for heat sources. Heat tariff is treated as public one like electricity and water.

5.3.1 Outline of the field

Since Ukraine is located in a cold region, 43% of all households are connected to district heat supply, however, since natural gas is used as the heat source for many of these consumers, there is concern over energy security. There are numerous other issues such as: energy utilization efficiency is low due to the existence of numerous inefficient units that have been operated in excess of their service life; funds for equipment renewal cannot be acquired because tariffs have been set too low; and there are no incentives to encourage energy saving.

The annual volume of heat production is 109 million Gcal (2014), of which approximately 60% is derived from boiler facilities and approximately 30% comes from CHP. Ukraine has 3,510 boiler facilities, however, heat losses from these amount to 13.5 million Gcal, equivalent to approximately 14% of produced heat (See Table 7.1-1). MRDBH is the governmental agency with jurisdiction over the heat supply utility: it issues licenses, while NCRE authorizes prices. Utility operators comprise approximately 900 district heat supply companies under local government. These companies conduct all activities including heat production, purchase, supply and retailing, however, MRDBH is advancing the unbundling of heat production from supply and retailing. There are also 22 CHP facilities, of which approximately 80% use natural gas as the heat source.

5.3.2 Kyivenergo

Kyivenergo was originally established as a state-run enterprise in 1930, but it became a subsidiary of DTEK following privatization in 1998. It conducts electricity and heat supply operations in Kyiv city utilizing its own transmission, distribution and substation facilities and heat supply facilities, as well as operation of heat supply facilities and a waste incineration plant that are owned by Kyiv city. Its business share in Kyiv city is 100% in the electricity utility and 75% in the heat supply utility.

Kyivenergo's heat supply station (CT-1) initially started operation as a coal-fired CHP, however, it currently operates 7 natural gas-fired hot water boilers. Usually only 4 boilers are operated. Even in the coldest season when it is necessary to conduct full-capacity operation, the station is prevented from operating all units due to controls on waste gases. Kyivenergo procured a stack, boilers and water treatment system based on credit from World Bank that was approved in 2001, however, except for the stack, these facilities have not been installed and lie idle inside the premises because Kyivenergo has been unable to pay the cost of the installation works.

5.3.3 Lvivteploenergo

Lvivteploenergo is a heat supply public corporation that is entirely financed by Lviv city. It owns a natural gas-fired station (CHP-1) in the urban area in the south of the city as well as a gas-fired hot water supply station (CHP-2, originally planned as a coal-fired thermal power station) in the north of the city, although this does not generate power. These stations do not have pipeline connections, however, they cover 80% of the city in total.

Currently EBRD is planning to install Individual Heat Points, introduce wood-derived biomass cogeneration, replace deteriorated pipes, introduce SCADA and so on, however, Lvivteploenergo plans to aims to convert CHP-2 to a coal and waste-fired station with increased output and connect CHP-1 and CHP-2 pipelines with a view to decommissioning CHP-1.

5.3.4 Kaluska CHP

Construction of this gas-fired CHP in western Ukraine was started in 1967 as part of the business of the state-run thermal power company Zakhidenergo, and it started operation with 4 boilers. The generation utility apart from Kaluska CHP was subsequently privatized, while Kaluska CHP was incorporated into the business of Ukrinterenergo after temporarily being operated by the oblast, and it now supplies electric power to surrounding areas (heat supply has been suspended). After 2008, due to the sudden inflation in Russian natural gas, the station upgraded the No.1/2 boilers to bituminous coal-fired units using its own funds, however, No.3/4 boilers remained gas-fired and have since been idle.

Kaluska CHP is currently considering conversion of No. 4 turbine from a back-pressured type to a condensing type, however, because it does not have the funds to pay the required investment of approximately UAH 2.5 billion for this, it has submitted to F/S report to MECI with the request that MECI carry out the conversion work or raise the necessary funds (loan). However, because Kaluska CHP has not been excluded from the list of targets for privatization, the State Property Fund is not optimistic about executing governmental guarantees.

5.3.5 Dniprodzerzhinska CHP

Dniprodzerzhinska CHP was commissioned as a gas and coal CHP in 1932, however, it became a dedicated gas-fired facility in 1972 and is currently only operated during the cold season (October to April) as a heat-electricity co-supply facility (heat supply 330 Gcal/h, generation 47 MW) having 10 boilers and 4 turbines (condensing type and back-pressured type). Heat from the station is supplied to the central area of the city and Pagrisky, while electricity is connected by 150 kV transmission line to Dniproska Substation. Although this is a state-run enterprise, it is listed for privatization.

The station currently has plans to newly install one bituminous coal and sub-bituminous coal-fired boiler (made by Kharkiv is envisaged, with coal being transported by rail from Pavlograd) and one condensing turbine (made by Turboatom is envisaged) so that it can operate all year-round, and the application for approval to start the F/S has been submitted to the Cabinet of Ministers via MECI.

5.3.6 Kharkiv CHP-3

Kharkiv CHP-3 was commissioned as a coal-fired CHP on August 1, 1934, but it switched to natural gas in 1985. In addition to the CHP that runs on 8 boilers (made by Taganrog) and 4 turbines (Kharkiv, Siemens, etc.) (heat supply1,353 Gcal/h, generation 66 MW), it has 5 hot water boilers (total 5, 800 Gcal/h) for peak use.

As modernization plans, it is scheduled for World Bank to upgrade Turboatom-make turbine installed between Units No. 3 and 4 while adding additional capacity of 20 MW (contracted in 2012) based on governmental guarantee. It is also in discussion with Lithuanian investors with a view to adding generation facility to CHP-4, modernizing boiler chambers in 58 locations throughout the city based on World Bank loan (tender in progress), and improving efficiency based on waste gas and heat recovery.

5.3.7 Support Needs and Candidates for supports

The following tables summarize support needs in the district heat supply field (See Table 7.10-1 and 7.10-2).

5.3.7.1 Kyivenergo

Kyivenergo, from the point of view that is operating heat supply facilities which belongs to Kyiv city, voiced a desire as following.

Candidates for support	Installation of Economizer
	Introduction of hydraulic coupling to heat supply pumps of 350 kW or more
	Renewal of local pipes not yet renewed
	Elimination of central heat sources by creating local heat supply
	Renewal of the heat supply base (CT-1)

5.3.7.2 Lvivteploenergo

Lvivteploenergo wants to convert the current natural gas CHP to a coal-fired facility. Since some of the facilities planned as a coal-fired thermal power at the start of construction has been left uncompleted and there is still enough space to resume coal-fired thermal power generation, the company wishes to construct a coal-fired 100 to 150 MW-class CHP and conduct mixed combustion with sorted municipal solid wastes. However, the wish is not large enough to adopt supercritical and/or ultra-supercritical technology that offers Japanese companies with a technical advantage, but rather subcritical facilities would need to be adopted. Moreover, since the mixed combustion of solid wastes would cause boiler internal parts to get corroded by chlorine, the realistic option is to construct dedicated coal-fired small-scale boilers.

Candidates for support	Construction of 100 to 150 MW, coal-fired CHP

5.3.7.3 Kaluska CHP

Kaluska CHP wants to change the No.4 turbine from an extracting back-pressured type to an extracting-condensing type (110 MW) as well as upgrade the dedicated gas-and/or heavy oil-fired No.3/4 boilers to a coal-fired unit with a view to reducing fuel costs and improving the power load factor. Concerning the turbine, there is still room to offer Japanese technology; however, since the boilers were made in the former Soviet Union and it is necessary to inherit the basic design and development concept of OEM, it is difficult to make a contribution through Japanese technology. Moreover, since the current Kaluska CHP is targeted for privatization, it will be difficult to secure governmental guarantee or apply a yen loan.

Candidates for support	No. 4 turbine replacement

5.3.7.4 Dniprodzerzhinska CHP

Dniprodzerzhinska CHP has already plans to newly install 115 MW CHP facility; however, it envisages procuring from a Ukrainian maker and is currently waiting for approval of the F/S implementation by MECI. Accordingly, it didn’t express any desire for support from Japan.

Candidates for support	Nothing special

5.3.7.5 Kharkiv CHP-3 and Kharkiv oblast

Kharkiv CHP-3, the facility is deteriorated like others and the local voiced a desire to renew. However, their facility combination is very complicated and moreover the scope of renewal plan has not been cleared to the Study Team. Therefore, in case of support from Japan in the future, the target range makes sure to be cleared.

Kharkiv oblast, remodeling the existing CHP with the firing natural gas to biomass-derived firing (chips and waste of wood, straw, etc.), also there was a voice to desire to establish newly with 5 MW of electrical output.

Candidates for support	Renewal of Kharkiv CHP-3
	Construction of small CHPs with biomass-derived fuel

5.3.8 Conclusion

The deteriorated district heat supply system, both boiler facilities and heat pipelines causing noticeable heat loss, needs to be refurbished sooner or later. However, district heat supply business, are mostly carried out by the local government or its affiliates and even the one owned by the Government of Ukraine has been the subject of privatization. In order to perform the yen loan for each local governmental asset, sovereign guarantee for local business is indispensable. At present, it is very difficult to support under the current scheme since JICA does not provide the loan scheme directly to local governments (so-called sub-sovereign system).

In addition, in the case of CHP that is mainly used for district heat supply, in many cases, the capacity needs to be around 100 to 150 MW at most. Specification of the boiler of this class is inevitably considered to be subcritical drummed type but this is not a field with a particular dominant technology of Japanese companies.

For the desire to retrofit the existing boiler firing natural gas to biomass-derived fuel, including chips and wastes of wood, and straw, etc. The boiler capable of firing such a wide variety of fuel needs to be a circulating fluidized bed type in specification. There is not also superiority in technology among Japanese company against those overseas.

5.4 Waste enegy sector

In Ukraine, waste incinerators were planned in 4 areas in the era of the former Soviet Union. However, waste incinerator in Kyiv is the only one which went into actual operation. Even in Kyiv city which has the plant, every waste generated from the city is not incinerated at the plant and landfilling is still a basic and major treatment of wastes in Ukraine.

5.4.1 Kyiv city

5.4.1.1 Outline of General Wastes in Kyiv city

The quantity of general wastes generated in Kyiv city and Kyiv oblast in 2014 is 1,089,000 tons and 263,000 tons respectively. The quantity of waste generation in Kyiv city increased between 2005 and 2014, however, no major trend of increase was observed in Kyiv oblast (See Figure 8.1-1).

The average density of wastes generated in Kyiv city was 186 kg/m^3; water content was 39.04% and calorific value was 1,500 kcal/kg. Excluding recyclable substances, the water content rises to 48.3% and calorific value falls to 1,300 kcal/kg, which means that the wastes become less valuable as fuel. However, if noncombustible materials and food residues are removed, the water content falls to 25% and heating value increases to 2,500 kcal/kg, meaning that the materials can be utilized as fuel for power generation. Wastes in Ukraine have similar water content and calorific value to wastes that have been used for power generation in Japan.

In Kyiv city, Kyiv Commune Service (KCS) was established in 2004 mainly with the objective of managing wastes from multiple dwelling houses (managed by public utilities service provider or individual building). According to KCS, out of the wastes that were generated in Kyiv city in 2014 (approximately 1.1 million tons/year), 0.7 million tons came from multiple dwelling houses managed by Kyiv city and the remainder of 0.4 million tons came from other sources. The 0.7 million tons of wastes discharged from multiple dwelling houses managed by Kyiv city were treated by means of incineration (230,000 to 240,000 tons/year), recycling (70,000 to 80,000 tons/year) and landfill (360,000 tons/year).

Out of 21 recycling facilities in Ukraine, 6 are established in Kyiv city. These sorted wastes on a small scale mainly based on manual work, and the total treatment capacity is between 100,000 to 120,000 tons. When these 6 facilities are fully operating, they can treat approximately 10% of the wastes generated in Kyiv city. Final landfill disposal sites currently operating in Kyiv city are No. 5 final landfill (general wastes) and No. 6 final landfill site (construction-derived wastes). Both these sites have already exceeded their capacity and are in need of improvement to the treatment system.

Waste management operators provide services based on the waste management tariffs that have been set by Kyiv city. The waste management tariffs are set with respect to the costs for waste transportation and landfill disposal. The tariffs are funded by taxes levied from citizens and subsidies from the city, however, as is also the case in other cities of Ukraine, the tariffs are set too low to be able to realize the upgrading and modernization of disposal sites.

At the end of 2015, a bill has been drafted to make manufacturers of plastic bottles and other products that eventually become wastes responsible for their collection and recycling, however, it is not clear whether this will be passed or not.

5.4.1.2 Overview of Energia Waste Incineration Plant

This plants have the capacity to treat approximately 20 to 35% of the general wastes that are discharged in Kyiv city (250,000 to 300,000 tons/year), however, due to the overflow of the landfill disposal site, the city requires around 2 waste incineration stations of similar scale.

Surplus heat from this treatment plant was connected to the supply network of Kyiv city in 2014, and currently 167,000 Gcal of heat is utilized. Since the calorific value of the wastes is lower than the design value at around 1,600 to 1,650 kcal/kg, the actual generated amount of steam is also low at 22 to 23 t/h compared to the design value of 40 t/h. The facility is old but well-maintained and seemed to function well without fetidness. The central control room is large enough to accommodate future expansion. However, the waste reservoir was full up and appeared to be undersized.

5.4.2 Dnipropetrovsk city

5.4.2.1 Outline of General Wastes in Dnipropetrovsk city

The quantity of general wastes generated in Dnipropetrovsk city and Dnipropetrovsk oblast is 307,000 tons (2013) and 2,593,000 tons (2014) respectively, representing standard quantities compared to Ukraine overall (See Table 8.2-1). In Dnipropetrovsk city, since analysis is not conducted on the necessary properties and calorific value of wastes for use as basic data in power generation, no data are available, however, wastes generated in the city are composed of 26% of food wastes, 15% of street wastes, 13% of plastics and so on (See Table 8.2-2).

Dnipropetrovsk city is divided into 8 areas for waste collection and the sanitation operators are appointed by tender. The waste collection operators sign contracts with each household, however, the operators end up bearing the cost of unpaid tariffs. The purchase price of plastic wastes has increased to between UAH 3,000 to 12,000 per ton in recent years, however, the authorities have so far conducted no initiatives, although the movement of the separation of waste at the general public level there.

5.4.2.2 Final landfill disposal site in Dnipropetrovsk

In November 2011, Pravoberezhny landfill disposal site (area 130 hectares) was opened in compliance with EU standards approximately 5 kilometers from Dnipropetrovsk city. It is a plan to continue to use effectively this landfill sites for the time being. Before this, a disposal site owned by a private sector company in Kulebovka was used.

5.4.3 Kharkiv oblast

5.4.3.1 Outline of General Wastes in Kharkiv

The per annum quantity of general wastes generated in Kharkiv city and Kharkiv oblast is 443,000 tons (2014) and 2,172,000 tons (2015) respectively and these figures remain fairly constant in recent years.

5.4.3.2 Final landfill disposal site in Kharkiv city

Kharkiv oblast currently has 2 final landfill disposal sites now in use (Dergachi site and Kharkiv site) and 2 disposal sites under construction (Lyubotyn site (works progress 60%)), Bogoduhov site (works progress 90%)), and there are plans for a further 6 sites. There are also plans to build 2 disposal sites only for gas and liquid wastes.

Kharkiv oblast thus makes it a core policy to conduct the landfill disposal of wastes. It is also considering incineration disposal, however, it doesn't consider this to have merit because it would entail higher treatment costs. Instead, it is examining plans to sort wastes that are brought into final disposal sites with a view to recovering secondary resources such as plastics, glass, etc. and selling these for additional revenue. On receiving a loan of 45 million USD from World Bank, Kharkiv oblast plans to install sorting facility on final disposal sites and will conduct a tender around June 2016 in order to decide the EPC contractor.

5.4.4 Support Needs and Candidates for support

The following tables summarize the support needs in the wastes management field (Table 8.6-1, Table 8.6-2).

5.4.4.1 Kyiv city

In Kyiv city Energia waste incineration plant, the counterpart wants to install facilities for treating flue gases except for ESP in line with EU standards (denitrification and desulfurization), recover uncollected waste heat from a back-pressured turbine generator (output 4 MW) and add a new waste treatment line on the site. Judging from the generated amount of wastes in Kyiv city, treatment capacity of Energia, and strained situation at landfill disposal sites, it will also be necessary to newly install waste incineration facilities with enough capacity to treat 350,000 tons per year (heat output 120 MW, generation capacity 40 MW) in a new site.

Candidates for support	Installation of a 4 MW steam turbine generator
	Installation of flue gas treatment facilities
	Add-on of a new waste treatment line
	Installation of a new treatment facility at 3rd point

5.4.4.2 Dnipropetrovsk city

Dnipropetrovsk city officials are extremely positive about incinerating wastes and voiced a desire for the installation of waste power generation facilities. However, so far they haven't conducted analysis on the specific scale of facilities and the calorific value of waste, as important data for waste power generation, although they appear currently to be in an information collecting phase pertaining to incineration disposal. The officials have a keen interest in the wastes treatment administration of Japan and asked many questions concerning this issue to the Study Team.

Candidate for support	Capacity building concerning waste administration in Japan
	Installation of a new waste incineration plant

5.4.4.3 Kharkiv oblast

Kharkiv oblast is interested in the sorting of wastes, however, it has concluded that treatment tariff need to be increased for this purpose to have a waste incineration plant. Rather than incineration, numerous landfill disposal sites as the basic disposal policy are currently under construction or are planned. In constructing new disposal sites, there are also plans to install sorting facility on sites so that valuable wastes can be recovered and sold as secondary resources.

Candidate for support	Nothing special

5.4.5 Conclusion

Waste treatment operation is categorized in activities of respective local administrations. This signifies that the governmental guarantee is required to the operation by respective local administrations in order to grant yen loan to that. Therefore, it is hard to support from Japan, because JICA currently has no credit scheme to local administrations (so-called sub-sovereign scheme).

Also, it is circumstance that Japanese companies who both deal in waste power generation facilities and have an interest to Ukraine are absent at the moment. Moreover, since waste power generation facilities are generally equipped with stoker furnace, there is no area where Japanese companies have technical advantages in particular. As an observation of the Study Team's survey up to now, Ukraine is in an initial stage which started to collect the knowledge and information related to waste power generation. Therefore, it would be important to heighten the interest of Ukraine by carrying out capacity building through seminars in relation to waste treatment and facility visit etc. by inviting the Ukrainian staffs engaged in management of waste treatment to Japan. Furthermore, it is supposed to be one of triggers in order for Japanese companies to be motivated to break into this area if a master plan of waste power generation in Ukraine can be supported as an international cooperation program of Japan.

CONTENTS

Number of Figure

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1. Introduction

1.1 Background

The Government of Ukraine is tackling issues in the energy sector based on the Energy Strategy of Ukraine until 2030 drawn by the Ministry of Energy and Coal Industry of Ukraine (MECI) and with the help of donors. The Government of Ukraine also works to adjust its energy policies and systems to the EU standards, according to the European Energy Community Treaty which was signed in September 2010 and requires the ratification of energy-related legal framework in compliance with the European standards. As for primary energy, it is necessary for Ukraine to effectively utilize many types of coal produced domestically including bituminous coal in order to achieve energy security, since the anthracite supply from the eastern region is unstable. Coal-fired thermal power and nuclear power account for almost 80% of Ukraine's power sources, while natural gas, hydroelectric and renewable energy constitute the rest. Currently, coal-fired thermal power makes up for a shortage in power supply, since the operation of gas-fired thermal units has been suspended due to the disruption of natural gas supply from Russia. With insufficient fuel coal supply from the eastern region, the nation suffers a tight electric supply. Ukraine also faces issues of aged power transmission facilities, as 35% of the 220 to 330 kV overhead transmission lines have been in service for 40 years or longer, and devices at 55% of substations have passed their design operation periods. Ukraine is in the process of facility renewal thanks to the aids from donors such as the World Bank and European Bank for Reconstruction and Development (EBRD). Ukraine being subject to cold climate, the nation enjoys well-developed heat supply by district heating systems, especially in urban areas. Natural gas accounts for nearly 90% of the heat sources; however, since the natural gas supply from Russia is unstable, it is urgent that Ukraine reduces its reliance on import from Russia and fuel gas use in the district heating systems, and improves energy utilization efficiency.

In the August 2014 meeting between the then Minister of Economy, Trade and Industry fo Japan, Mr. Motegi and the then Minister of Energy and Coal Industry of Ukraine, Mr. Prodan, Japan announced its plan to offer technological support to Ukraine in improving efficiency of aged coal-fired thermal power stations. It led to an undertaking where Japan Coal Energy Center conducted facility diagnosis toward the improvement of steam turbine efficiency for the existing coal-fired power stations and the environment, and Kyushu Electric Power Co., Inc. carried out general O&M diagnosis as a member of diagnosis team. The New Energy and Industrial Technology Development Organization (NEDO) conducted high-efficiency turbine demonstrations for heat supply and combined heat and power (CHP) facilities. Prior to these moves, the Institute of Energy Economics (IEEJ) examined the National Energy Master Plan (FY2014-15). At this point, there has been no yen-loan-financed support in the energy sector of Ukraine; however, support by Japan's related organizations is being considered mainly for coal-fired thermal power generation.

1.2 Purpose

The purpose of the Study is to collect and compile basic data to examine the specific candidate projects for yen-loan-financed support in the energy sector of Ukraine, based on "1.1 Background" above.

1.2.1 Target regions

The regions targeted by the Study are the entire country of Ukraine. And in order to confirm the possibilities of the local district heat supply, the power transmission/distribution and waste derived generation in the capital Kyiv and its surrounding are, and the eastern region like Kharkiv oblast and Dnipropetrovsk city, regional wide surveys have been conducted. Any site surveys conducted in the concerned areas will be handled as necessary based on the safety considerations and discussions with the Japan International Cooperation Agency (JICA).

1.2.2 Target fields

The Study fields are Energy Sector in general, Electricity (thermal power and grid), and District Heating. These 3 fields are studied from viewpoints such as primary energy, organization and policy, law and regulation, environmental and social considerations, economic and finance, and support trend of various donor countries.

1.2.3 Study content and schedule

The Study is implemented by following the steps in Figure 1.2-1 below. The work content in each step is detailed in the flow chart in Figure 1.2-2.

1. Basic information collection
   - Organize and check data such as current situation, policy and intent of the Government of Ukraine, related laws and regulations, structure of the related organizations, specific needs for support, and latest support trend of other donors related to primary energy, electricity and district heating.
2. Finding/organizing of candidate projects
   - Screen the candidate projects from the perspectives of appropriateness/ significance of Japan's support in Ukraine's energy sector, viability/profitability and applicability of specific technologies of Japan based on the work in 1 above.
3. Listing and road mapping (draft)
   - Conduct risk analyses and scenario analyses on the candidates from the screening result in order to deliver the proposed support. Roadmap (draft) the support measures and propose yen-loan-financed candidate projects based on the short-term (1 to 3 years) and middle-term (4 to 5 years) feasibility.

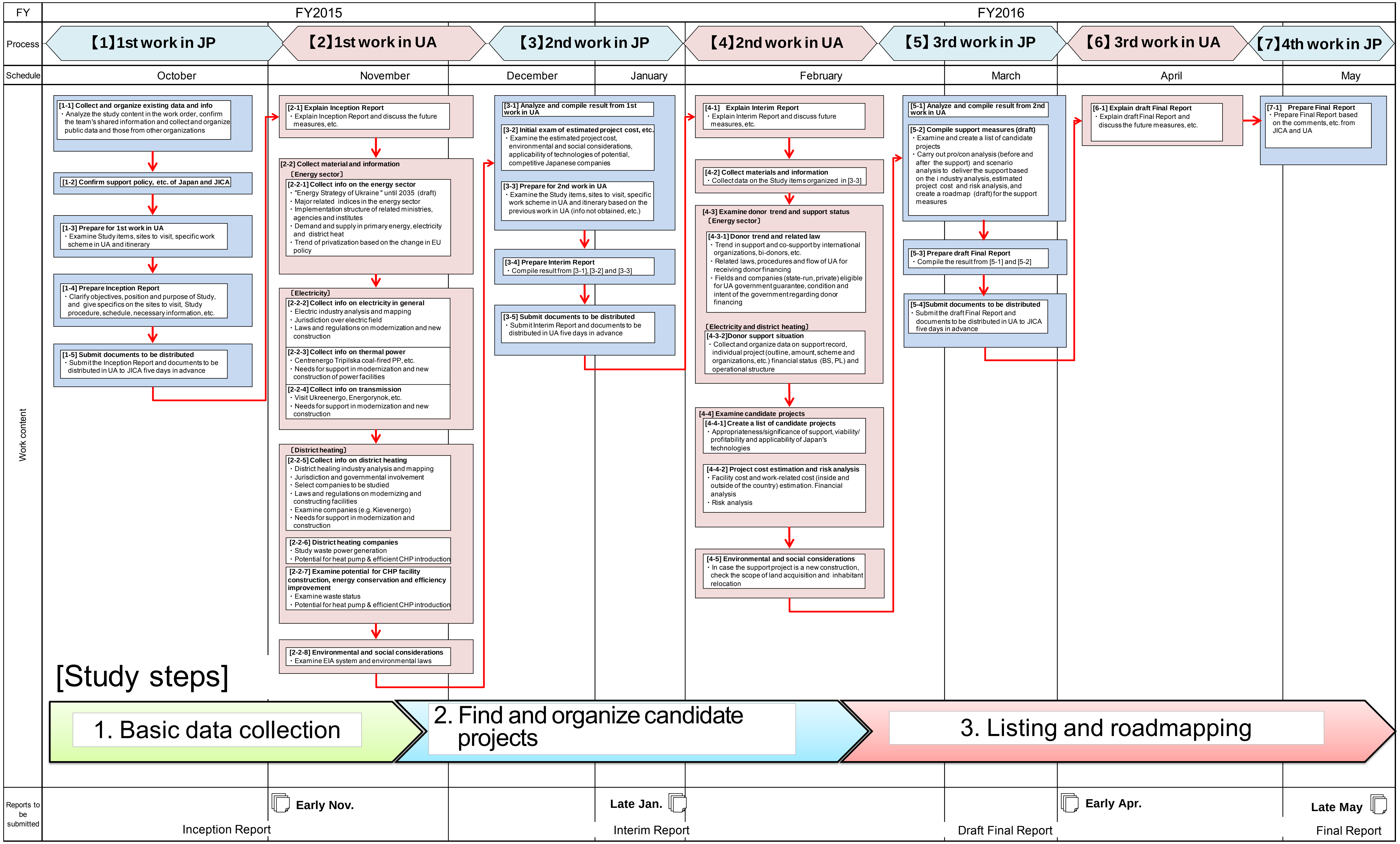
Figure 1.2-1 Study steps

Table 1.2-1 below lists the evaluation perspectives for screening candidate projects explained in "Finding/organizing of candidate projects" in Figure 1.2-1. The screening will have additional risk analyses as much as possible for comprehensive evaluation including the risk mitigation, transference and bearers, and the resultant candidates will be organized in the final list (draft) based on the discussion with JICA.

Table 1.2-1 Perspectives for evaluating candidate projects

Perspective	Item
Appropriateness/ significance of the support	➢ Consistency between Ukraine's politics and Japan's support policy ➢ Intent of central government offices and implementing entity (implementation/loan) ➢ Development of necessary conditions for smooth support including legislations ➢ Whether support was considered by other donors and possibility of co-financing ➢ Existence of governmental guarantee ➢ Environmental and social considerations
Viability/profitability	➢ Viability/growth potential of the project based on the industry analysis ➢ Estimated project cost (investment cost, profit, operation cost, etc.) ➢ Structure, financial and business conditions, and technological and operational ability of the operator (borrower)
Applicability of specific technologies of Japan	➢ Japanese companies' intent for investing in and exporting to Ukraine ➢ Related infrastructure necessary for the introduction, and its export methods, possibility of its installation and maintenance and supply of materials, etc. ➢ Possibility of being replaced by other countries through competition for reasons of cost and technology (competitiveness of Japanese technology)

Source: JICA Study Team



Source: JICA Study Team

Figure 1.2-2 Overall work flow

The schedule of the Study is shown in Figure 1.2-3 below.

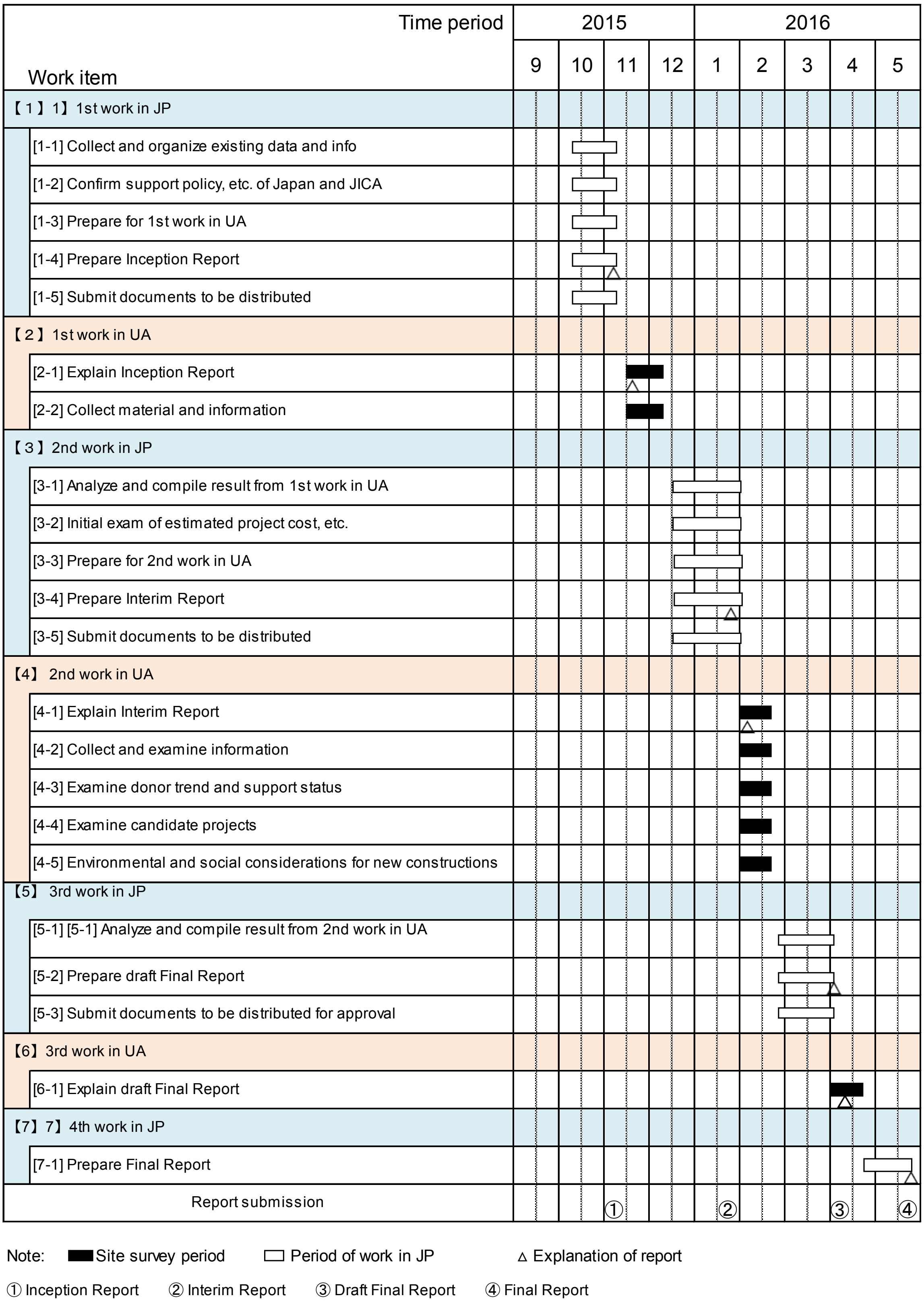


Figure 1.2-3 Study schedule

1.3 JICA Study Team composition

The composition and work contents of the Study Team are shown in Table 1.3-1 below.

Table 1.3-1 Composition and work contents of Study Team

<table>
<tr><th>Name</th><th>Assignment</th><th>Work content</th></tr>
<tr><td>Hiroshi FUCHINO (KYUDEN)</td><td>Team leader/ power development plan</td><td>➢ Team leader/safety control official
➢ Establish policy, content and plan of the Study
➢ Collect and analyze data on the energy sector in general
➢ Collect and analyze data on the power development plans
➢ Negotiate with organizations covered by Study and supervise subcontractors
➢ Examine and propose candidates for yen-loan-financed support projects in the energy sector, based on the donor trend and consistency with upper level plans</td></tr>
<tr><td rowspan="2">Michio MIHARA (KYUDEN)</td><td rowspan="2">Thermal power generation plan(1) /CHP plan</td><td>[CHP plan]
➢ Collect and analyze data on district heating
➢ Collect and analyze data on donor support record, individual project, etc.
➢ Check issues and support needs, and examine the implementation policy and structure and estimated project cost
➢ Examine support measures for heat supply/CHP/waste power generation</td></tr>
<tr><td rowspan="2">[Thermal power generation plan]
➢ Collect and analyze data on thermal power generation (coal & gas)
➢ Collect and analyze data such as status of the existing PPs, environmental measures and improvement plans
➢ Collect and analyze data such as donor support record, individual project
➢ Check issues and support needs, and examine implementation policy and structure and estimated project cost
➢ Examine support measures in the thermal power field</td></tr>
<tr><td>Yasunori SAKAMOTO (KYUDEN)</td><td>Thermal power generation plan(2)</td></tr>
<tr><td>Tomio KUBOTA (JCOAL)</td><td>Law & regulation</td><td>➢ Collect and organize data on laws and regulations applicable to the energy sector in general
➢ Consistency between internal legal system and EU policy
➢ Examine laws and regulations related to technology and procedures for facility modernization, etc.
➢ Check and compile domestic standards and systems related to the compliance of EU standards, etc.
➢ Laws and procedures for receiving donor financing, and conditions and related laws for governmental guarantee, etc.</td></tr>
</table>

<table>
<tr><th>Name</th><th>Assignment</th><th>Work content</th></tr>
<tr><td>Ichiro KUTANI / Mitsuru MOTOKURA (IEEJ)</td><td>Primary energy</td><td>➢ Organize main indices, issues, governmental policy, etc. related to the energy sector
➢ Confirm government agencies and organizations relevant to the energy sector
➢ Confirm the trend and policy of privatization and gas sector unbundling based on EU schemes such as the Third Energy Package (TEP)
➢ Investigate the current status and change in the transaction price of primary energy (coal & gas) and wholesale price of heat and power (including FIT)</td></tr>
<tr><td>Kiyotaka TSUKIMOTO (KYUDEN)</td><td>Transmission</td><td rowspan="2">➢ Collect and analyze data on transmission and substation
➢ Collect and analyze data such as operation status of transmission lines and substations, environmental measures and improvement plans
➢ Collect and analyze data such as donor support record and individual project
➢ Check issues and support needs, and examine implementation policy and structure and estimated project cost
➢ Examine support measures in the transmission and substation fields</td></tr>
<tr><td>Keiichiro OHASHI (WJEC)</td><td>Substation</td></tr>
<tr><td>Katsumi YOSHIDA (KYUDEN)</td><td>Economy and finance</td><td>➢ Pro/con analysis (investment cost, O&M cost, investment recovery efficiency, etc.) and risk analysis of support measures, such as rehabilitation of existing facility and new construction in the electricity field
➢ Financial analysis of the thermal power, transmission, substation and heat supply facilities, etc. that received donor support</td></tr>
<tr><td>Yohei SUZUKI (ERM)</td><td>Environmental and social considerations/ waste study</td><td>➢ Check the consistency between the legal system related to environmental and social considerations and the EU standards
➢ Check the environmental approval process including the need for EIA, domestic standards and status of air pollutants, scope of land acquisition and inhabitant relocation in case of new facility construction
➢ Check the current status and issues of waste collection in Kyiv city</td></tr>
</table>

1.4 Summary of Study progress

In accordance with the Study plan such as Section 1.2.3 above, field study in Ukraine was conducted 3 times.

(1) 1st Work

The 1st Work was conducted between November 22 (Sun) and December 13 (Sun), 2015. The Study Team explained to MECI the purpose and basic itinerary of the Study, which were compiled in the Inception Report, and requested their indirect support such as the coordination of interviews at the sites to be visited. The Study Team then visited the energy-related Ukrainian governmental offices and electric and district heating companies. The main sites visited are listed in Table 1.4-1 below.

Table 1.4-1 Main sites visited in the 1st Work

- Energy-related governmental offices and organizations
  MECI: coal and energy policy in general
  MRDBH: trend of heat demand
  State Agency on Energy Efficiency (SAEE): State support for district heating
  CETI: status of research on the utilization of low-quality coal such as brown coal
  KIEP: technological standards and procedures for work and facility introduction
- Related Ukraine organizations and Kyiv City
  [Electricity]
  Centrenergo: power generation and fuel supply & demand
  Ukrhydroenergo: hydroelectric & pumped storage plans
  Ukrenergo: transmission and substation
  Energorynok: trend in wholesale electricity trade
  [District heating]
  Kyivenergo and Kyiv City: heat and CHP facility related matters
  Naftogaz and its subsidiary Vuglesyntezgaz: trend in natural gas supply and demand and gas sector privatization
- Donors
  European Bank for Reconstruction and Development (EBRD): present situation of donor's actions
- Energy facilities in the region
  Trypilska Power Station: Coal-Fired Thermal Power Plants operated by Centrenergo located near to the capital of Kyiv
  Zmiivska Power Station: Coal-Fired Thermal Power Plants operated by Centrenergo located in Kharkiv of eastern Ukraine

Source: JICA Study Team

During the 1st Work, basic data were collected (See Figure. 1.2-1 above), and hearings were held to understand specific support needs.

(2) 2nd Work

The 2nd Work was conducted from February 10, 2016 (Wed) to February 27, 2016 (Sat). The Study Team deepened its investigation on the issues of Kyiv's CHPs and the feasibility of distribution and waste-fired power generation, by reflecting the requests from JICA based on the result of the 1st Work. The Study Team also visited the head dispatch center of Ukrenergo, and the transmission and substation facilities in western Ukraine, and according to the introductions made by State Agency on Energy Efficiency and Energy Saving (SAEE). The Study Team also visited the CHPs in Lviv. The survey was able to cover wider areas and subjects including the status of activities by World Bank and EBRD, trend in privatization and national guarantee.

Table 1.4-2 Main sites visited in the 2nd Work

- Energy-related governmental offices and organizations
  MECI: coal and energy policy in general
  MRDBH: trend of heat demand
- Related Ukraine organizations and Kyiv City
  [Electricity]
  Centrenergo: power generation and fuel supply & demand
  Ukrhydroenergo: hydroelectric & pumped storage plans
  Ukrenergo: transmission and substation
  [District heating]
  Kyivenergo and Kyiv City: heat and CHP facility-related matters
- Donors
  European Bank for Reconstruction and Development (EBRD): current status of support activities
  World Bank (WB: IBRD and IFC): current status of support activities
- Energy facilities in region
  Lvivteploenergo: district heating utility owned by Lviv City in western Ukraine
  Kaluska CHP: state-run CHP company in western Ukraine
  Zakhidnoukrainska Substation and others: regional major and distribution substation in western Ukraine

Source: JICA Study Team

(3) 3rd Work

The 3rd work was conducted from April 14, 2016 (Sun) to April 28, 2016 (Thu). Based on the almost completion of supporting candidates until 2nd work, the 3rd work was conducted through the discussions with the officials of Dnipropetrovsk city and Kharkiv oblast, in order to screen the possibilities of waste incineration power generation in local regions and local heat supply.

In addition, the Study Team visited western dispatch center of Ukrenergo (Lviv city) which controls operations of power transmission/substation, which had been targeted for the site survey of 2nd work, and main substation in eastern region Dnipropetrovsk and eastern local dispatch control center (subordinate organization of eastern dispatch center), to collect the condition of power transmission/substation facilities and the structure of dispatch as a whole.

Table 1.4-3 Main sites visited in the 3rd work

- Energy-related governmental offices and organizations
  MECI: coal and energy policy in general
- Related Ukraine organizations and Kyiv city
  [Electricity]
  Ukrenergo: transmission and substation
- Energy facilities in region
  Dniprodzerzhinska CHP: state-run CHP company in Dniprodzerzhinsk city
  Kharkiv CHP-3: Kharkiv city's district heating utility owned by Kharkiv
  Eastern region's solid waste management authority: Dnipropetrovsk city and Kharkiv oblast
  Western Power System: local dispatch control center covers 5 western oblast in Lviv
  Zaporizka Substation: major substation and transmission center in Dnipropetrovsk region

Source: JICA Study Team

1.4.1 Overall energy sector

According to MECI, they prepared the "Draft Energy Strategy up to 2035" in July, 2015 for cabinet approval, but because of the problem of credibility concerning statistical data released by the State Statistics Service and used by MECI to draft the said Strategy, work is in progress at present to improve the statistical data, including the statistical tools to be used, with the cooperation of experts invited from overseas to rectify the problem. As such, there is no energy strategy approved by the Government of Ukraine at present. For this reason, the energy strategy of Ukraine and other relevant matters are described later in this Study report based on the Draft Energy Strategy document prepared by MECI. The present intention of MECI is to finalize the strategy in the first half of 2016.

The situation of the tight supply of anthracite because of the conflict in eastern Ukraine is becoming quite serious. MECI believes that the construction or remodeling of new coal-fired thermal power stations is necessary. This means the increased use of bituminous coal as a national policy. According to Coal Energy Technology Institute (CETI) which provides MECI with guidance on the national coal policy and also on the highly efficient use of coal and plant operation techniques for Centrenergo (a state-run coal-fired thermal power generating company), the application of measures designed to facilitate the use of bituminous coal is being examined to compensate for the shortage of anthracite. In fact, some actual practices were conducted at a power station operated by Centrenergo. However, positive effects hoped for, including a good cost performance, have been very slow to materialize and CETI considers that the way forward may well be the more active introduction of bituminous-firing boilers.

1.4.2 Power generation

To obtain data in the field of thermal power generation, the Study Team visited the headquarters of Centrenergo and Trypilska and Zmiivska coal-fired thermal Power Stations to tour facilities and exchange opinions on their current status, issues and support needs. The short-term and middle-term support measures that the Study Team suggested and the counterparts generally agreed on were "Replacement of Turbines", "Replacement of Control System", "Installation/Modernization of Environmental Facility" and "Replacement with Gas-Insulated Switchgear (GIS) at switchyard". The long-term support needs were new constructions that include power plant scrapping & building or perfectly new installation.

The main reasons for new power plants construction were that the majority of power stations in Ukraine have been in operation for 40 years or longer and can hardly meet the environmental standards imposed by EU in addition to low power generation efficiency, and that Ukraine must expand the bituminous coal use by remodeling boilers and building new power plants, due to tight domestic anthracite supply caused by the conflict in the eastern region. These issues were pointed out during the hearings with MECI and CETI.

The Study Team inquired about the current costs for power plant and facility in order to analyze the economic effect of the support measures. Unfortunately, the managerial accounting has not been introduced and the information was considered confidential. The Study Team confirmed that such information would not be disclosed in any case. Consequently, the Study Team carried out the trial calculation of the investment cost, etc. for the improvement proposals, based on the findings from Japanese manufacturers. It must be noted however that the estimates do not always consider the local costs.

As for hydroelectric power, the civil engineering work of Dnister Pumped-Storage Power Station such as reservoir development has been completed and the 1st stage construction (Units No. 1 to 3 with 972 MW in total) is slated to be completed in 2016 based on the initial plan to install 7 generators. Regarding this plant, Ukrhydroenergo approached the Study Team for financial assistance towards the 2nd-stage construction (Units No. 4 to 7 with 1,296 MW). Reportedly, there is no financial negotiation underway with other donors. The Study Team explained to Ukrhydroenergo that it is necessary to verify cost, scale and various social and environmental items with regard to hydropower and how advanced Japanese technologies are, even though it is difficult to decide on the framework for short-term support.

1.4.3 Transmission and substation

To learn about the transmission and substation status, the Study Team visited Ukrenergo to hear about their issues and support needs. At the time of the 1st Work, they had secured financing from donors, etc. for much of their facility plans and didn't require support from JICA. Thus, the Study Team requested Ukrenergo to review the latest 10-year business plan (2016 to 25) and to submit projects for which support from JICA might be expected. As a result, the outline of 5 projects including one for which the feasibility study (F/S) has been completed was submitted. During the 2nd Work, the team visited the base substation connected to EU network in the western region, as recommended by Ukrenergo, as well as 3 substations planned for renewal.

While the Study Team conducted an interview at the headquarters of Ukrenergo, a comment was given from the company that "they prepare a te10 years plan every year and apply for an approval. But, an approach from the former Soviet Union has been used in the preparation of grid plans including the

Master Plan (M/P) which serves as the base for the 10 years plan. They are aware that the approach no longer works for the current situation, and need support from the Study Team with preparation of more appropriate M/P."

During the 3rd Work, the Study Team narrowed the projects for which support was requested down to 7 based on the result of observing the major facilities in the regions during the 2nd Work and other activities. The Study Team then obtained consent from Ukrenergo and MECI by positioning these projects as those for which Ukrenergo requests support. There was interest expressed in the examination of the outline for the transmission and maintenance technology-related collaboration project, which was brought up by the JICA headquarters in response to the technical collaboration requested by Ukrenego through the Study.

During the Work, the Study Team collected information at the Ukrenego headquarters and toured the head load dispatch center. It also visited the only load dispatch center and major substations in the western region that are connected to EU, as well as the major substation and transmission center in Dnipropetrovsk region which is an industrial manufacturing base of Ukraine. These activities helped the team look into the facilities and their operational status throughout the eastern and western regions of Ukraine and narrow down the candidate projects for support.

1.4.4 District heating

The Study Team visited Kyivenergo that supplies heat as well as electricity to Kyiv, the capital of Ukraine, to verify their issues and need for support from JICA in the field of district heating. The Study Team learned that even though they require significant renewal of their aged distribution and substation facilities and heat supply piping, they are not sure if they can obtain national guarantee. It is because they are a private enterprise (75% funded by DTEK and 25% by the Government) and they have practiced non-debt management without receiving any donor support. The Study Team plans to further research needs for support, check the details on the availability of national guarantee from the legal and regulatory aspects and hear as much as possible about the Government's intent during the 2nd Work. The Study Team learned that Kyiv city has a potential to supply heat by incinerating waste which has been disposed in landfill, and plans to further investigate matters from waste management to the possibility of waste use for power generation during the 2nd Work.

According to Ministry of Regional Development, Building and Housing (MRDBH), state banks, Naftogaz and Oblgaz (local gas supply company) have been accumulating massive debts due to the loss margin between the import cost and retail price of natural gas. As this loss margin is particularly large with buildings and ordinary homes, the promotion of energy saving at these places is an urgent task for Ukraine. The Government of Ukraine has assigned MRDBH to prepare an energy saving strategy and plans and SAEE, a subordinate organization of MRDBH, to implement the strategy and plans while attempting to accelerate energy saving activities with the assistance of Western donors.

The Study Team visited Kyivenergo (its biggest shareholder is DTEK and is subject to privatization), CHPs affiliated with Lviv and operated by Livivteploenergo, Kharkiv CHP-3 of Kharkiv city's district heating utility, as well as the state-run CHPs: Dniproderzhinska CHP in Dnipropetrovsk district and Kaluska CHP in the western region. The purpose for the visits was to verify their current status and need for support. The findings were organized and evaluated by considering issues such as privatization and national guarantee since these items could become risks when implementing actual support measures.

1.4.5 Laws and Regulations

Many laws, regulations and technical standards concerning energies and electricity during the former period of the Soviet Union have been inherited by post-independence Ukraine. At the same time, new regulations, etc. are being introduced to conform to EU standards, creating a situation of the mixed existence of old and new regulations. Because of this, when the construction of a new power plant or the remodelling of equipment is planned, it is essential to seek the advice of a design agency which fully understands the intricate and unsystematic laws and regulations of Ukraine and has a competent history of handling the various procedures to obtain the necessary permits, etc.

Because of this situation, the Study Team visited the Kyiv Design Agency (called as "KIEP") which has a long history of engineering work for electricity infrastructure and is currently supporting the NEDO's turbine demonstration project to learn about the application steps and important points regarding the laws, regulations and procedures in Ukraine. The Study Team also examined the procedure for loans by donors and overseas aid organizations for Ukraine's energy sector. In view of the ongoing rapid privatization of the energy sector except for transmission and nuclear power generation, the Study Team conducted the 2nd Work to further investigate the conditions, targets, procedures, etc. to obtain a state guarantee for ODA loans provided by Japan and other donors for project implementing bodies.

1.4.6 Social and Environmental Considerations

The Study Team visited the Ministry of Ecology and Natural Resources (MENR) and others to learn about Ukraine's environmental regulations and standards which must be noted when the construction and operation of such energy infrastructure facilities as power plants and district heat supply systems are planned. According to MENR, Ukraine is required to implement an EU Directive (EU/2010/75 on industrial emissions: integrated pollution prevention and control) as a condition of becoming a member of EU but no moves have so far been made to revise the relevant laws to meet EU/2010/75. However, active efforts to enforce appropriate laws and regulations will be made in due course as new or remodelled power plants on or after January 1st, 2018 must conform to EU/2010/75.

1.4.7 Study potential on waste generation

During the 1st Work, the Study Team visited Kyiv Comun Service (KCS) which is an administrative body responsible for solid waste management in Kyiv and Kyiv Spets Trans (KST) which is involved in the collection and treatment of solid waste through operation of the only general waste disposal site (Unit No. 5 site) in Kyiv to learn about the management of solid waste which has potential as a fuel for district heat supply. Meanwhile, with CDM Engineering, a company with profound knowledge of solid waste management, has been selected as a local subcontractor during the 2nd Work to continually gather supplementary information on behalf of the Study Team on such issues as the link between gradually introduced environmental regulations in Ukraine and the comparable EU regulations, EIA procedure required in Ukraine and practice of solid waste management in Ukraine for which published official data is both limited and sketchy.

The initial plan for the Study focused only on the waste administration of Kyiv, which seemed to offer a promise for the introduction of waste power generation in the future. However, in the actual study, the Study Team visited Dnipropetrovsk city and Kharkiv oblast which boast a certain economic scale and potential for waste incineration and the use of resultant energy for heat and electricity, as well as related facilities, in order to investigate the latest trend in the regions' waste administration.

1.4.8 Donor trend

The Study Team investigated the trend of donor support in various fields in the energy sector. According to EBRD, the Western donors have been actively supporting Ukraine in the transmission and substation, heat supply and energy conservation fields. During the 2nd Work, the Study Team created a list with support measures and their status. It also examined the approach by WB which requires the national guarantee to create a project the same way JICA does, and that of EBRD which offers financing (sub-sovereign loans) etc., to promising cities without national guarantee, by studying the latest support cases in the CHP field. At the same time, the Study Team interviewed Lviv and Kyiv, the actual recipients of the donor support, and MRDBH, ministry responsible for negotiation for the Government of Ukraine, regarding the trend of support by the western donors.

1.4.9 Visits to Other Organizations

In addition to the organizations mentioned so far, the Study Team visited Ministry of Economic Development and Trade (MEDT), Naftogaz (a state-run gas company), Vuglesyntezgaz (a subsidiary of Naftogaz), Ukresco which has been promoting energy saving, including efficient heat use, UTEM (a major general contractor capable of the construction of power plants, etc.), as well as Ukrinterenergo (a state-run company specialized in power generation engineering, created to efficiently deploy Ukraine's energy projects overseas), and will compile and report the findings in the interim report, final report, etc. in due course.

1.4.10 Explanation of issues in power generation, transmission/substation and heating and support measures in Ukraine

The Study Team explained the power generation-related issues and support measures, etc. to Centrenergo and received an overall consent. They agreed that the construction of new power plants or drastic renewal of facilities are in order based on the aging seen in the majority of the facilities, and requested Japan's support using its technological abilities. MECI was in agreement in general on these matters. MECI, MRDBH and SAEE acknowledged the issues regarding transmission/substation and heating as well as the support measures.

1.4.11 Trend in privatization and national guarantee

During the 1st Work, MECI stated regarding the privatization of Centrenergo that "even though it is planned for 2016, it should not be rushed if the transparency of the process cannot be guaranteed." On February 24, 2016 during the 2nd Work, the actual privatization process of Centrenergo started by State Property Fund (SPF), which practically shut down the possibility of investment or loan or related national guarantee toward the large-scale repair and other work. The Study Team explained JICA after the 2nd Work, that Centrenergo was no longer be eligible for support.

2. Overview of the Energy Sector

In terms of the energy sector in Ukraine, coal, natural gas, oil, and electricity are under the jurisdiction of MECI; heat supply is under the jurisdiction of MRDBH; and energy conservation/efficiency is under the jurisdiction of MEDT.

Regarding the aspect of the supply and demand of energy, in addition to possessing rich coal resources, especially anthracite, Ukraine also produces fuel such as oil, natural gas, and uranium. While Ukraine is in a relatively blessed position regarding energy resources, aspects such as Russia's declare of annexation of the Autonomous Republic of Crimea, as well as conflicts in the eastern region, are creating challenges for the country's primary energy supply. Namely, the eastern region contains abundant anthracite and the Crimean Peninsula and the surrounding sea area contain abundant natural gas, but in the current situation, Ukraine is unable to effectively utilize these resources.

The opposition with Russia is particularly intensifying with regard to the supply of natural gas. Natural gas is a vital heating energy for Ukraine, but the country had been relying on imports from Russia for a large portion of the supply. The conflict regarding the quantity and price of this natural gas supply has become an important political issue, and Ukraine is earnestly aiming to become politically and economically independent from Russia by freeing itself from dependence on Russia for the supply of natural gas. Accordingly, Ukraine is taking various measures with regard to supply, including the imports of natural gas from Europe, enhance the use of nuclear power generation, as well as studying the utilization of bituminous coal.

One can also perceive the signing of the Energy Community Treaty in September of 2010 as part of the movement to break free from Russia. By signing the treaty, Ukraine has become able to accept assistance from Europe regarding various aspects of the supply of energy. However, at the same time, this also led to being compelled to conduct painful reforms for improving the transparency of the market including the privatization of state-run companies, the liberalization of the energy and gas markets, and the eradication of corruption.

Of the various reforms, the rationalization of energy prices (the abolition of subsidies) can likely be considered to be highly difficult and crucial. Previously, energy prices were set at an inexpensive level that fell below the costs. This aspect inhibited reinvestments in infrastructure by energy companies, and also served to dampen consumers' desire to save energy. Even taking into account that energy consumption increases for heating are unavoidable due to the cold weather, the energy efficiency of Ukraine is extremely low compared to that of other countries. In order to lower the degree of dependence on Russia for the supply of energy, it is essential to improve Ukraine's energy efficiency; the raising of energy prices is essential in order to realize this. While this issue has been recognized since before, it has long been neglected due to political judgment giving consideration to national sentiment. Due to the heightened sense of crisis resulting from factors such as the intensification of the opposition with Russia and the energy supply shortage, the movement toward raising energy prices is finally advancing.

In addition to the energy price issue, the disorder following the disintegration of the Soviet Union in 1991 caused a decline in investment in Ukraine’s energy infrastructure. During the period of the Soviet Union, Ukraine functioned as a base for energy exports to the surrounding countries. Coupled with a decrease in energy demand due to economic recession following the disintegration of the Soviet Union, Ukraine is burdened with a large quantity of deteriorated, redundant capacities. The proper closure or renewal of these facilities is needed.

2.1 Organizations and Structure of the Energy Sector

2.1.1 Administrative Structure

The Cabinet of Ministers is the agency that makes final determinations regarding energy policy in Ukraine. It conducts activities such as the adjustment of policies and the monitoring of state-run energy companies. Energy policy is a political issue to a high degree, with the Verkhovna Rada (parliament) of Ukraine and the President of Ukraine taking part. The ministries and agencies involved in energy policy are show in Table 2.1-1.

Table 2.1-1 Ministries and Agencies Related to Energy in Ukraine

Ministry/ agency	Role
Ministry of Energy and Coal Industry	MECI is responsible for most energy supply policies and for co-ordinating energy policy across government and providing advice to parliament.
Ministry of Regional Development, Building and Housing	MRDBH develops policy and programs relevant at local levels. MRDBH is responsible for district heating.
Ministry of Ecology and Natural Resources	MENR is responsible for licensing and production sharing agreements for hydrocarbon development and for climate change policy.
State Environmental Investment Agency	SEIA has overall responsibility for the implementation of the provisions of the Kyoto Protocol and the UNFCCC Convention.
Ministry of Finance	MoF is responsible for taxation relevant to the energy sector.
Ministry of Economic Development and Trade	MEDT has the lead for energy efficiency policies, but responsibilities for implementation are shared among numerous ministries and agencies.
State Agency on Energy Efficiency and Energy Saving	SAEE, under MEDT, is the central governmental body responsible for advancing energy efficiency and renewable energy developments and promoting the deployment of energy efficient and renewable energy technologies.
National Commission for State Regulation of Energy and Public Utilities (called as NKREKP)	NKREKP supervises the natural gas and electricity markets as well as the heat sector.
Anti-Monopoly Committee	Fair Trade Commission
State Nuclear Regulatory Inspectorate	SNRI has regulatory responsibility for the operation of nuclear facilities, including uranium mining, radioactive waste storage and decommissioning at Chornobyl.

Source: IEA 2015

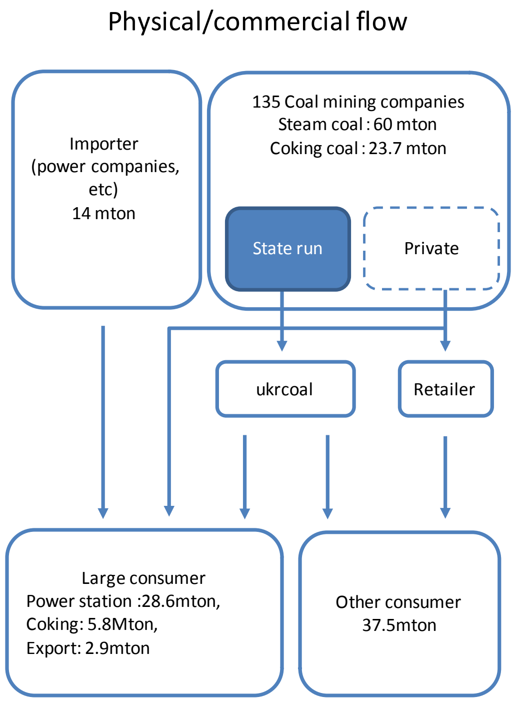
2.1.2 Industrial Structure

(1) Coal Industry

The main production areas are the Donetsk (also known as Donbass region) basin in the eastern region, the Lviv /Volyn basin near the Polish border, and the Dnieper basin in the mid-eastern region. Both state-run and private operations exist for coal mining, but due to the promotion of privatization, state-run coal mines continue to decrease. Currently, most of the production comes from privatized coal mines. Of the privately operated coal mining enterprises, DTEK has the largest scale. The company uses the coal it produces for purposes such as fuel for coal-fired thermal power for its company group.

While the sales prices for coal produced through state-run coal mines are regulated, there are no regulations for sales prices for private coal mines; these prices are settled through direct negotiations between the concerned parties. Generally, sales prices for private coal mines are higher than those for state-run coal mines.

The imports of coal are liberalized for both thermal coal and coking coal, and there is no regulation to enter the market. To this point, business operators such as Centrenergo (thermal power generation), Donbasenergo (thermal power generation), and Defnova (CHP) were importing coal for power generation, but currently, imports from Russia have halted, and only Centrenergo remains. Various companies are importing coking coal for the production of cokes.



Note: The shaded area represents state-run companies.
Source: MECI handbook, 2013 data

Figure 2.1-1 Coal Industry in Ukraine

(2) Natural Gas Industry

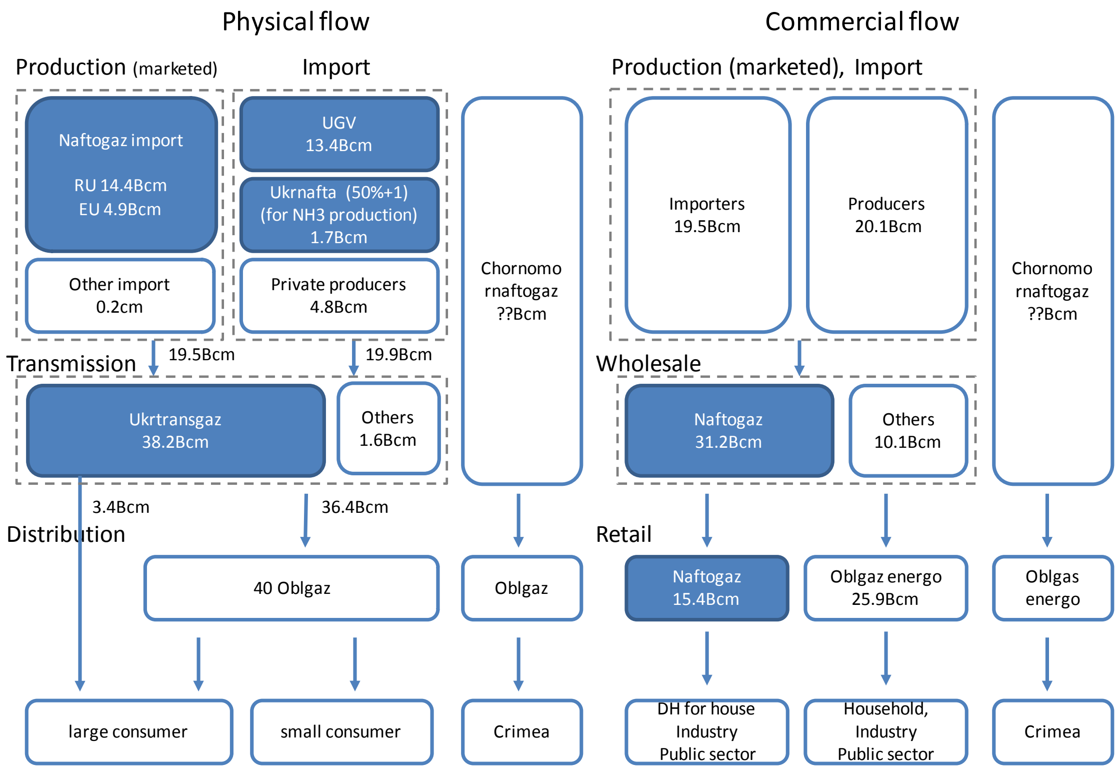
Domestically, MENR issues licenses to conduct exploration and production. Currently, 170 companies possess this license. Of those companies, the ones with the highest production quantities are subsidiaries of the state-run Naftogaz: UGV (Naftogaz 100%) and Ukrnafta (Naftogaz 50% + 1 stock). However, all of the natural gas produced by Ukrnafta is supplied for the feedstock of ammonia.

The imports of natural gas are liberalized, and while in actuality, private companies such as DTEK are also conducting imports the amounts are only slight, with the majority coming from Naftogaz.

For natural gas produced domestically or imported, the Naftogaz subsidiary Ukrtransgaz conducts transportation using high-pressure pipelines. Ukrtransgaz also owns and operates underground storage facilities. For industrial, large-volume consumers, there are cases in which natural gas is directly supplied by Ukrtransgaz using high pressure.

Each city has regional distribution companies known as “Oblgaz”, which conduct the distribution and sales of gas to the end consumers using low-pressure pipelines. At this time, Oblgaz energo handles the gas transactions with the end consumers. Before, most of the shares of Oblgaz were owned by Naftogaz; however, currently, most of the shares have been sold to private holders, and with the exception of a few companies, Naftogaz is a minority shareholder. Naftogaz directly sells gas to regional district heating companies which supply heat to households, as well as to industries and public facilities. Oblgaz energo supplies gas to households, industries, and public facilities.

Separate from these flows, there is an independent supply structure in the Autonomous Republic of Crimea. Chornomornaftogaz produces natural gas, which is supplied to end consumers via Oblgaz. Chornomornaftogaz was a subsidiary of Naftogaz, but since the annexation by Russia in 2014, Naftogaz has been unable to control the company.



Note: Consistent with the source, methods such as rounding have been used for the numerical values, so the totals are not consistent. The shaded areas represent state-run companies.
Source: Naftogaz Annual Report 2014

Figure 2.1-2 Natural Gas Industry in Ukraine

(3) Oil Industry

The oil market is liberalized, and there are no market entrance regulations or price regulations for crude oil imports, wholesale, or retail.

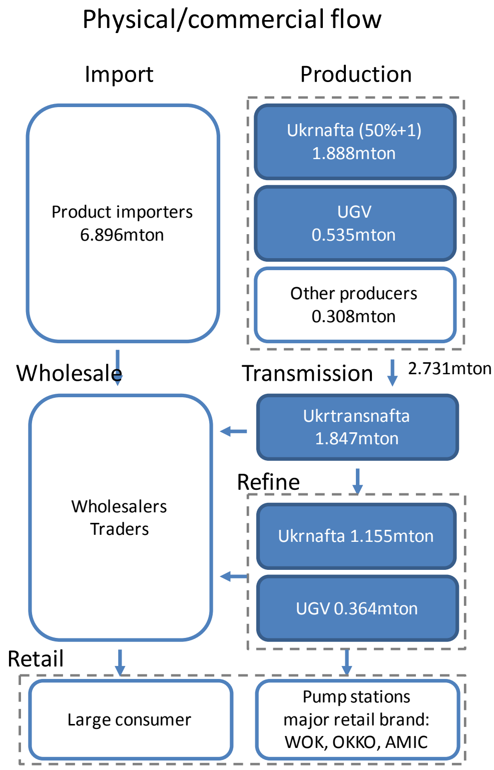
The companies that conduct domestic oil production are the same as for natural gas. Transportation via pipelines is conducted by Ukrtransnafta, a subsidiary of the state-run Naftogaz. In recent years, a decrease in the transit quantity of Russian crude oil bound for Europe, increasing excess regarding the transportation pipeline capacity, and a reduction in income from transit fees have become issues.

There are 7 oil refineries throughout Ukraine, but as of the end of 2015, only the 2 refineries of Kremenchuk refinery, the largest in Ukraine, and Shebelynka condensate refinery are in operation. The refineries are refining domestic crude oil, but their rates of operation are extremely low, at 6.5% and 40% (2014) respectively[3]. One major factor for the operating downturn is that following the privatization of the oil refineries, capital investment was not conducted. Following the privatization, as a result of each company reducing investments in facility renewal and sophistication in order to

[3] Naftogaz, Annual Report 2014

cut costs, competitiveness in terms of price was lost compared to imported products from the neighboring Belarus, for instance.

In terms of gasoline stations, which take on the retail aspect, the major companies include the domestic companies of WOK and OKKO, as well as AMIC, which is Austrian-company.

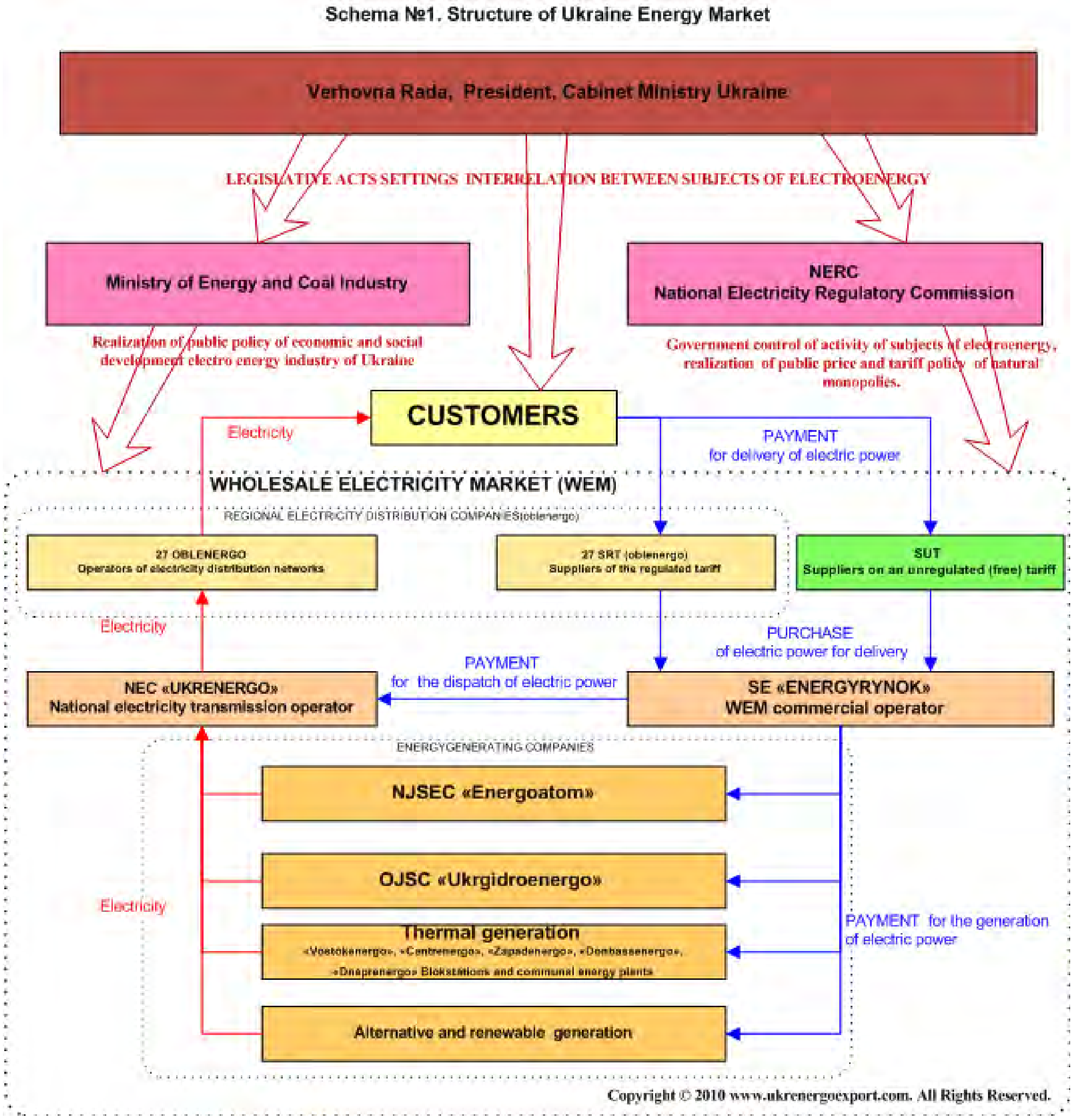


Note: Consistent with the source, methods such as rounding have been used for the numerical values, so the totals are not consistent. The shaded areas represent state-run companies.
Source: Naftogaz Annual Report 2014

Figure 2.1-3 Oil Industry in Ukraine

(4) Electricity Industry

For the power supply in Ukraine, the Wholesale Electricity Market (WEM) was introduced in 1996 by using the pool market of the UK as the reference.



Source： Ukrenergoexportwebsite

Figure 2.1-4 Power supply scheme of Ukraine

Under the scheme, MECI draws and implements power infrastructure development plans while National Energy Regulation Commission (called as “NKREKP”) takes charge of granting permits and approvals and regulating tariff of monopolistic WEM, both based on the policies on the national economy and industry established by the President and cabinet council.

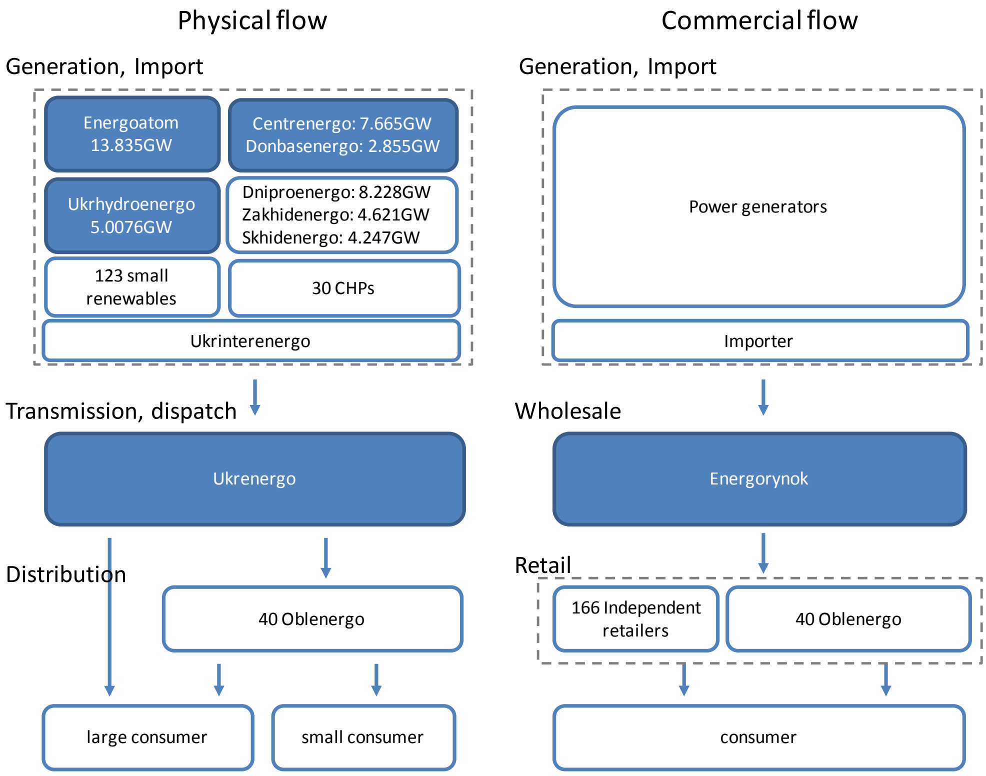
In the monopolistic WEM, state-run Energorynok is the only power purchaser, and Ukrenergo, also a state-run company, solely owns and operates the 220 to 750 kV voltage class trunk transmission systems. Major power producers such as Energoatom (nuclear), Ukrhydroenergo (hydro) and Centrenergo (thermal) as well as small-scale power producers transmit the generated power to Ukrenergo.

As for transmission sector, Ukrenergo monopolizes except for some exceptions, and operates 7 transmission systems except for Crimea district.

Ukrenergo receives the electricity from the power producers and transmits it to the 42 power distributors (Oblenergo) in Ukraine through its distribution systems. Oblenergo then supply electricity to respective customers. Of all the power producers, nuclear and hydroelectric power producers are run by the Government of Ukraine; however, private companies such as DTEK have entered the thermal power field, and the privatization is planned for some state-run companies such as Centrenergo and Donbasenergo.

Meanwhile, as for electricity over 20 MW connecting to high-voltage system and imported electricity, the price of which purchased by Energornok is regulated, under so-called single buyer scheme where Energorynok purchases all of electricity. However, as for electricity from thermal power plant, Energornok purchases through bidding method. Electricity purchased by Energorynok, whose tariff is controlled, is sold to local distribution companies and independent retailers, and then those companies and retailers sells to the end users.

Power distributors conclude contracts with customers and collect power bills based on the pre-approved Service Provisions, as a rule. However, independent businesses (SUT) are allowed to supply power at a tariff different from that set in the Service Provisions for the general population, assuming that the customers meet certain requirements such as that the demand stays even throughout the day, week or month. The distributors and SUT collect power bills from customers, and pay Ukrenergo the cost of using its transmission system as the wheeling charge, and pay the power purchase price to the power producers. Ukrenergoexport, one of the SUT, is allowed to sell electricity to customers abroad in addition to non-regulated customers in Ukraine.



Note: The shaded areas represent state-run companies.
Source: MECI handbook, 2013 data; JEPIC, 2014; Energorynok, MECI

Figure 2.1-5 Electric Power Industry in Ukraine

Due to the privatization of state-run enterprises since the independence of Ukraine, even in the energy sector, except for nuclear power and hydroelectric power, private transfer of state shares has been carried out. Since the current conflict with Russia is making a slight lag, the Government of Ukraine has expressed their policy to increase the further privatization in 2016. However, because the Government also express the elimination of the Russian capital and domestic conglomerates (Oligarchs) in stock transferee, it is opaque whether the sufficient capital partners can find in the future.

Figure 2.1-6 shows the Ukrainian power generation and distributer at the time in 2004, but were all 100 percent state-owned. In Table 2.2-1 the state-owned shares ratio at the time of 2014 is significantly reduced and the privatization is progressing.

It should be noted that the measures of EU request since 2009 for unbundling the producers and transporter have not yet been affected to current Ukrainian laws and regulations.

MINISTRY OF FUEL AND ENERGY

UKRENERGO NATIONAL ENERGY COMPANY

National Dispatch Centre of Ukraine

Regional Power Systems (dispatch centers and high voltage networks)

1. Dniprovska
2. Donbaska Zahidna
3. Krymska Pivdenna
4. Pivdenno-Zahidna
5. Pivnichna
6. TsentralnaRegional

Energorynok
State Enterprise

Other enterprises and institutions

Science, design and technical establishments

POWER DISTRIBUTION COMPANIES

1. Vinnytsaoblenergo
2. Volynoblenergo
3. Dniprooblenergo
4. Donetkoblenergo
5. Zhytomyoblenergo
6. Zakarpattyaoblenergo
7.Zaporizhyaoblenergo
8. Kyivenergo
9. Kyivoblenergo,
10. Kirovogradoblenergo
11. Krymenergo
12. Luganskoblenergo
13. Lvivoblenergo
14. Mykolaivoblenergo
15. Odesaoblenergo
16. Poltavaoblenergo
17.Piykarpatb/aoblenergo
13. Rivneoblenergo
19. Sevastopilenergo
20. Sumyoblenergo
21. Ternopiloblenergo
22. Kharkivobienergo
23. Khersonoblenergo
24. Khmelnitskoblenergo
25. Cherkasyoblenergo
26. Chernivtsioblenergo
27 Chernigivoblenergo

1. UkrInterenergo
2. Ukrinformservice
3. Main data storage and processing center
4. Ukrenergotrud
5. VOHP

ENERGOBUD
State Joint Stock Holding Company

POWER GENERATING COMPANIES

Zakhidenergo
1. Burshtynska TPS
2. Dobrotvirska TPS
3. Ladyzhinska TPS
4. Maintenance and Service enterprises

Donbasenergo
1. Zuyivska TPS.
2. Kurahivska TPS
3. Luganska TPS
4. Slovyanska TPS
5. Starobeshivska TPS
6. Maintenance and Service enterprises

Dniproenergo
1. Zaporizhska TPS
2. Kryvorizhska TPS
3. Prydniprovska TPS
4. Maintenance and service enterprises

Centrenergo
1. Vuglegirska TPS
2. Zmiivska TPS
3. Trypilska TPS
4. Maintenance and service enterprises

Dniesterhydoenergo

Dniprohydoenergo

Energoroatom NNPC

Zaporizhia NPS
Pivden Ukrainska NPS
Khmelnytska NPS
Rivneuska NPS
Chornobylska NPS

Source: JICA Study Team

Figure 2.1-6 Power Generation and Distribution Company in 2004 (All state-run)

Table 2.1-2 Ukraine Power Generation and Distribution Companies in 2014

Sector	Company	Share
Hydro Power	Ukrhydroenergo	100%
	Dniester Pumped Storage Power Station	87.4%
Thermal Power	Centrenergo	78.3%
	DTEK Zakhidenergo	25%
	DTEK Dniproenergo	25%
	Kyivenergo	25%
	DTEK Skhidenergo	0%
	Donbasenergo	25%
Distribution	Vinnytsiaoblenergo	75%
	Volynoblenerho	75%
	Zakarpattiaoblenergo	75%
	Dniprooblenergo	75%
	Khmelnytskoblenergo	70.1%
	Krymenergo	70%
	Mykolaivoblenergo	70%
	Chernivtsioblenergo	70%
	Donetskoblenergo	65.1%
	Kharkivoblenergo	65%
	Zaporizhiaoblenergo	60.3%
	Luhanskoblenergo	60.1%
	Ternopiloblenergo	51%
	Cherkasyoblenergo	46%

Source： Ukraine's Top 100 State-Owned Enterprises by MEDT 2014

(5) District Heating Industry

Local authorities conduct the majority of the district heating business. However, there are also cases such as with Kyiv, a city with special status, where while the facilities are owned by the city, operations are conducted by Kyivenergo, a private entity. As of the end of November, 2015, there are 243 companies that have received business license for regional heat supply, and these comprise approximately 98% of the market.

Heat sources for regional district heating system include sources such as CHP, thermal power station, nuclear power station, and industrial waste heat. Table 2.1-3 indicates Ukraine's heat production capacity.

Table 2.1-3 Heat Production Capacity (2010) in Ukraine

Heat source	Number of unit	Heat production capacity (Thousand Gcal/h)
Thermal power plants	15 (14, as of May 2016)[5]	5.4
CHP	30	8.5
Industry	495	16.1
Nuclear power stations	4	2.6
District heating system	33,312	127.0
Wastes	645	2.5
Total		162.1

Source: Energy Strategy of Ukraine to 2030

Of 33,312 district heat supply systems, 28,563 boilers, comprising 85.7% of the total, are small boilers with heat production capacities of under 3,000 Gcal/hour; 3,839 boilers, or 11.5% of the total, produce between 3,000 and 20,000 Gcal/hour; 708 boilers, or 2.1% of the total, produce between 20,000 and 100,000 Gcal/hour; and 202 boilers, or 0.7% of the total, produce over 100,000 Gcal/hour.

The length of the pipelines for the centralized heat supply system is 37,300 km as of 2010. Of this, the length of the pipelines for the district heat supply system is 33,800 km, with the urban area being 30,900 km and the rural area being 2,900 km. Methods to manage heat losses have not been taken for a large portion of the pipelines, and the situation of 70% of the distribution pipelines has physically deteriorated. It is estimated that the loss when transporting heat is at least 30%, but accurate information is unobtainable. This is due to the fact that meters are not installed for the stage of the transportation, distribution, and end consumption of heat.

[5] Mironovskaya power station of Donbasenergo is now segmented as CHP plant.

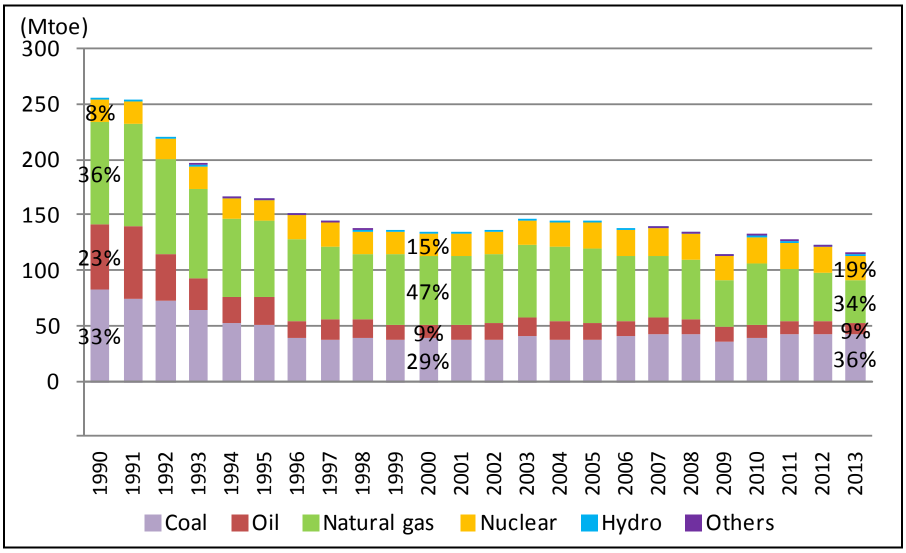
Many district heat supply systems have outdated, and central heating systems have almost no air temperature control system. This leads to additional heat losses, which are estimated at 10 to 15%.

2.2 Present Status and Outlook for the Supply and Demand of Energy

2.2.1 Primary Energy Supply

Changes in the primary energy supply by each energy source are indicated in the below figure. The primary energy supply was 252 million tons of oil equivalent (hereinafter referred to as "Mtoe") in 1990, but it had fallen to 116 Mtoe, half or less of that, in 2013 (an average annual decrease of 3.3%). There are years in which "Others" has a negative value due to net exports of electricity. Looking at the changes in the primary energy supply mix, while the proportion of nuclear power rose from 1990 to 2013, the proportion of oil fell sharply.

The reasons that the primary energy supply fell sharply after 1991 are that the economy was in disorder due to the disintegration of the Soviet Union in 1991 and that Ukraine lost its role as a Soviet energy supply base. Following 2000, there was a gently increasing trend in energy demand due to economic recovery, but factors such as the economic downturn precipitated by the Lehman Brothers bankruptcy in 2008, as well as the conflict in the eastern region of Ukraine in recent years, have weighed down economic growth, and energy demand has decreased.



Source: Energy Balance of Non-OECD Countries 2015, IEA

Figure 2.2-1 Changes in the Primary Energy Supply

With regard to the outlook for the future, the outlook in the "Study of Developing Energy Policy Master Plan for Ukraine" (hereinafter referred to as "Master Plan"), conducted by the Ministry of Economy, Trade and Industry of Japan (METI) was refered to.

3 scenarios are indicated in the future outlook in Table 2.2-1. In the outlook for the Master Plan, the Gross Domestic Product (GDP) growth rate and the speed of improving energy efficiency are given as factors that will greatly influence the image of the future. The GDP growth rate in the “Reference” scenario is 1.3%, set at a value more conservative than the 3.5% growth rate premised in Ukraine's “Draft Energy Strategy of Ukraine through 2035” (hereinafter referred to as “Draft Strategy”). The reasons for this are that the supply of the critical primary energy sources of anthracite and natural gas are being impeded due to the currently ongoing conflict in the eastern region of Ukraine, and that Ukraine's industry is concentrated in that region, yet the conflict is not predicted to be resolved, at least in the short term, and it is predicted that will continue to be a major factor that presses upon the economy. The reason for the other point, energy efficiency, is that Ukraine possesses great potential for efficiency improvement, and it is therefore thought that the degree of efficiency improvement will drastically influence the balance of supply and demand in the future.

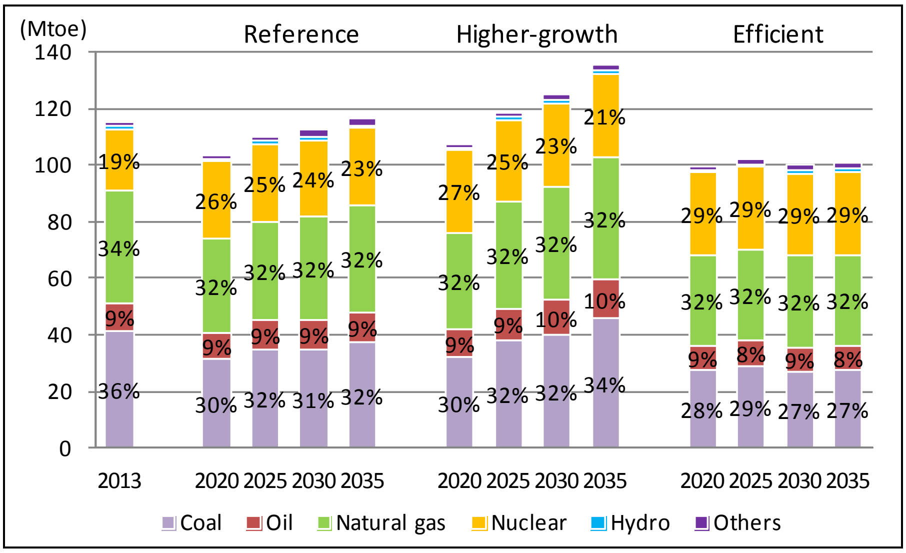
Table 2.2-1 Division of Energy Scenarios in Ukraine

	GDP growth	Efficiency	Energy demand
Reference	1.3%p.a.	Reference	Center
Higher-growth	2.3%p.a.	Same as Reference	Higher
Efficient	Same as Reference	More efficient	Lower

Source: Master Plan, METI

In the “Reference” scenario is shown in Figure 2.2-2, the primary energy demand will slightly increase by an annual rate of 0.1%, and the demand in 2035 will slightly exceed that of 2013. In comparison, in the “Higher-growth” scenario, the demand will increase by an annual rate of 0.8%, and will grow by 1.18 times in the same period. Conversely, in the "Efficient" scenario, in which drastic improvement in energy efficiency is premised, the demand in 2035 will fall 12% below that of 2013.

The GDP growth rate premised in the “Higher-growth” scenario is an annual rate of 2.3%. “Draft Strategy” premised growth that is even higher than this. If that were to become a reality, the total energy demand in the future would increase even more.



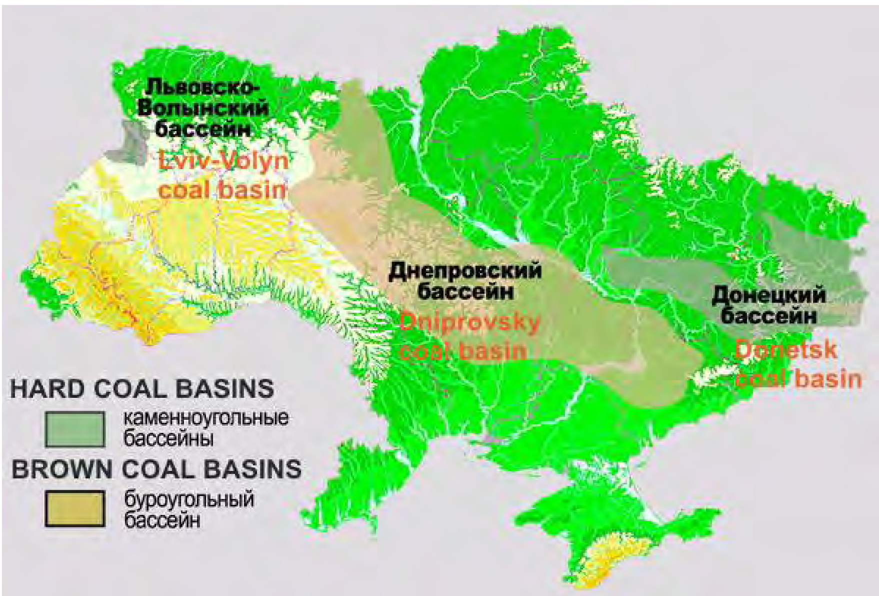
Source: Master Plan, METI

Figure 2.2-2 Outlook for Primary Energy Supply

2.2.2 Coal

(1) Coal Resources

Ukraine's coal and lignite basin is indicated in Figure 2.2-3. Ukraine has anthracite and bituminous coal resources in the eastern and western regions, and lignite resources in the central region.



Source: COAL OF UKRAINE, Dr. Alexabder I. TOPAL, CETI, April 2014

Figure 2.2-3 Ukraine's Coal Basin

The reserves in Ukraine as of January 1, 2000 are indicated by coal basin in Table 2.2-2. In total, there are 117.54 billion tons of reserves in Ukraine. In terms of the proportion by coal basin, 86% of the reserves are in Donetsk, 3% are in Lviv-Volyn, 4% are in Dniprovsky, and 7% are in the Dniprovsko-Donetsk depression area. A large proportion of Ukraine's coal lies in the eastern region, which is undergoing conflict.

Of the reserves, Ukraine's proven reserves for which mineral exploration has been conducted and the details are known amount to a total of 45.54 billion tons, with the Donetsk Basin accounting for 92%.

Table 2.2-2 Coal and Lignite Reserves in Ukraine by Coal Basin (as of Jan.1.2000)

Unit: Billion ton

Coal Basin	Total	Total (4+5+6)	Proven Reserves		Additional
			explored and studied in detail	Other	
1	2	3	4	5	6
Donetsk Basin	**101.47**	**69.43**	**42.07**	**10.66**	**16.70**
Bituminous coal	85.01	57.20	34.95	9.22	13.03
Coking coal	24.96	21.66	12.86	3.84	4.96
Thermal coal	60.05	35.54	22.09	5.38	8.07
Anthracite	14.55	11.60	6.83	1.44	3.33
Brown coal	1.91	0.63	0.29	-	0.34
Lviv-Volyn Basin	**2.98**	**1.87**	**1.17**	**0.26**	**0.44**
Bituminous coal	2.98	1.87	1.17	0.26	0.44
Coking coal	1.77	1.09	0.74	0.19	0.16
Thermal coal	1.21	0.78	0.43	0.07	0.28
Dniprovsky Basin (Brown coal)	**4.16**	**2.41**	**1.86**	**0.32**	**0.23**
Dniprovsko-Donetsk depression area	**8.71**	**0.39**	**0.39**		
Bituminous coal	6.62	-	-		
Brown coal	2.09	0.39	0.39		
Other deposits (Brown coal)	**0.22**	**0.06**	**0.05**	**0.0**	**0.01**
Total	**117.54**	**74.16**	**45.54**	**11.24**	**17.38**
Bituminous coal	94.62	59.08	36.13	9.48	13.47
Coking coal	26.73	22.76	13.60	4.04	5.13
Thermal coal	67.89	36.32	22.53	5.44	8.34
Anthracite	14.55	11.60	6.83	1.44	3.33
Brown coal	8.37	3.48	2.58	0.32	0.58

Source: COAL OF UKRAINE, Dr. Alexabder I. TOPAL, CETI, April 2014

The proven reserves as of January 1, 2012 are indicated by coal type in Table 2.2-3. Mineral exploration has been conducted and the details are known for 80% of the proven reserves. There are 44.639 billion tons of proven reserves for which mineral exploration has been conducted and the details are known. The proportions of the division of Ukraine's coal types are 6% lignite, 14% anthracite, and 80% sub-bituminous coal and bituminous coal. The share of thermal coal used for power generation is 70%.

Table 2.2-3 Proven Reserves in Ukraine by Coal Type (as of Jan.1.2012)

Unit: Million tons

Coal type		Proven reserves		
		explored and studied in detail	Other	Total
B	Brown coal	2,593.3	299.2	2,892.5
D	Long-Flame Bituminous coal	13,000.6	2,825.1	15,825.7
DG	Long-Flame-Gas Bituminous coal (Coking coal)	6,762.8 (1,635.4)	2,073.9 (830.0)	8,836.7 (2,465.4)
G	Gas coal (Coking coal)	7,943.1 (5,593.9)	2,660.7 (1,812.6)	10,603.8 (7,406.5)
F	Fat Bituminous coal (Coking coal)	2,629.2 (2,642.8)	885.0 (884.5)	3,514.2 (3,527.3)
K	Coking Bituminous coal (Coking coal)	1,965.5 (1,931.2)	387.9 (367.5)	2,353.4 (2,298.7)
PS	Coking lean coal (Coking coal)	1,016.5 (947.6)	311.5 (291.7)	(1,328.0) (1,239.3)
P	Lean-coal (Coking coal)	2,586.1 (555.4)	591.2 (150.6)	3,177.3 (706.0)
A	Anthracite	6,142.2	1,440.7	7,582.9
Total **(Thermal coal)**		**44,639.4** **(31,333.1)**	**11,477.5** **(7,140.6)**	**56,116.9** **(38,473.7)**

Source: COAL OF UKRAINE, Dr. Alexabder I. TOPAL, CETI, April 2014

Table 2.2-4 Classification of Coal Types in Ukraine

Coal type		Vitrinite reflectance (R_0, %)	Volatile matter (%)	Thickness of the plastic layer (mm)	Higher calorific value *1 (MJ/kg)
B	Lignite	<0.4	50-70	-	<2.4
D	Long flame	0.4-0.6	35-50	<6	-
DG	Long flame bituminous	0.50-0.80	35-48	6-9	-
G	Bituminous	0.50-1.0	33-46	10-16	-
F	Oily	0.85-1.20	28-36	17-38	-
K	Coking	1.21-1.60	18-28	13-28	-
PS	Lean coking	1.30-1.90	14-22	6-12	-
P	Lean	1.60-2.59	8-18	<6	35.2-36.5
A	Anthracite	2.60-5.60	<8	-	<35.2

Note: *1 Dry ashless state

Source: COAL OF UKRAINE, Dr. Alexabder I. TOPAL, CETI, April 2014

The coal production capacity for Ukraine as a whole reached an annual 89.9 million tons in 2013, with 135 coal mines conducting operations. The coal production for Ukraine as a whole was 83.70 million tons in 2013. By region, the production for Donetsk was the highest, with 37.53 million tons (44.8% of the total). Next were Luhansk, with 26.08 million tons (31.2% of the total); Dnipropetrovsk, with 18.2 million tons (21.7% of the total); Lviv, with 1.51 million tons (1.8% of the total); and Volynska, with 3.8 million tons (0.5% of the total). In this way, Ukraine has rich coal resources overall, but over 70% of the total production is concentrated in Donetsk and Luhansk, which are currently undergoing conflict.

The coal mines in Ukraine mainly conduct underground mining, with the coal seams at around 1.3 m. Compared to major coal-producing countries such as China and Australia, where the coal seams are at around 3 m, this is extremely shallow. Further, the mining locations are extremely deep at 700 m underground, and the mining conditions are harsh. Accordingly, the productivity is rather low, with an average of 23.3 tons per man month for state-run coal mines, an average of 57 tons per man month for private coal mines, and an average of 27.6 tons per man month for Ukraine overall. This is a mere half of the productivity in Poland, a neighboring country; 1/5 of the productivity in Western Europe; and 1/20 of the productivity in the United States.

The long-term coal production outlook for Ukraine’s major coal producers is shown in Table 2.2-5. The private company DTEK is Ukraine's largest coal producer, with state-run coal mines following behind it.

In terms of the coal production share in 2012, DTEK had 45%, and state-run coal mines had 32%. The prediction for coal production in 2030 is 116 million tons, an increase of 30 million tons (+35%) compared to 2012. It is predicted that in 2030 as well, DTEK and state-run coal mines will be the 2 largest coal producers, with DTEK having a 41% share and state-run coal mines having a 39% share.

Table 2.2-5 Long-Term Production Outlook for Major Coal Producers in Ukraine

Unit: Thousand tons

Company name	2012 E	Forecast		
		2015	2020	2030
DTEK	38,600	46,300	50,700	47,680
LLC “METINVEST Holding” (mainly for metallurgical purpose)	5,210	6,674	7,571	6,577
PJSC “Donetsk stal - Metallurgical factory” (mainly for metallurgical purpose)	8,400	7,470	7,500	7,500
PJSC “Shahta named after O.F. Zasyadko”	2,100	2,400	2,550	3,500
State-run mines	26,900	30,100	35,200	45,250
Others	4,100	4,000	5,000	5,000
Total	**85,310**	**96,944**	**108,521**	**115,507**

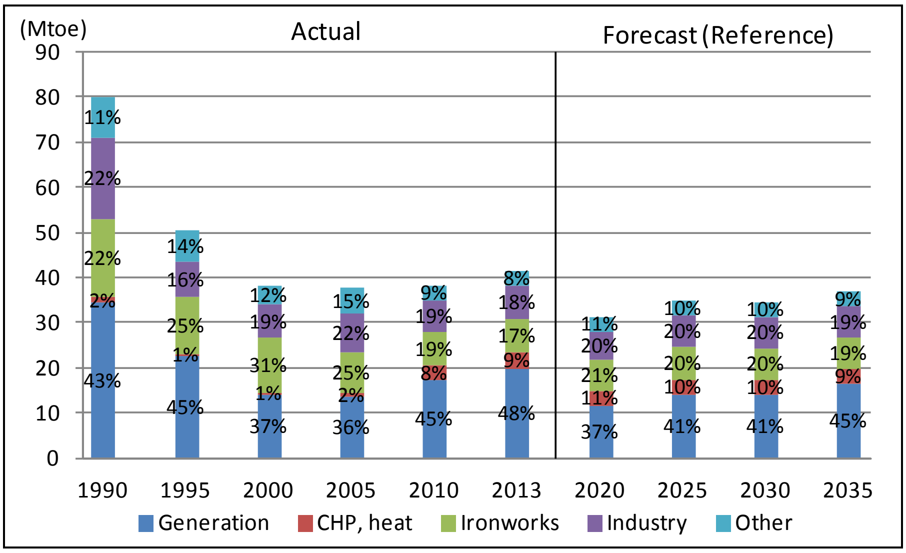
Source: COAL OF UKRAINE, Dr. Alexabder I. TOPAL, CETI, April 2014

The eastern region, which accounts for a large proportion of Ukraine’s coal reserves and production quantity, is in a state of conflict. As this region is outside of the Government’s control, information pertaining to current coal production is unobtainable. The limited information that was able to be obtained is as shown below[6].

- 93 coal mines totally in Donbass;
  - 7 mines destroyed
  - 24 mines in operation
  - 62 mines in maintenance works

- 53 mines on the territory, controlled by pro-Russian separatists.

[6] Energy Component in New Generation Warfare, A. Chubyk, M. Gonchar, O. Ischuk, 10 Sept. 2015



Source: Energy Balance of Non-OECD Countries 2015, IEA、 Master Plan, METI

Figure 2.2-4 Changes and Outlook for the Demand for Coal by Use

(2) Coal Supply Balance

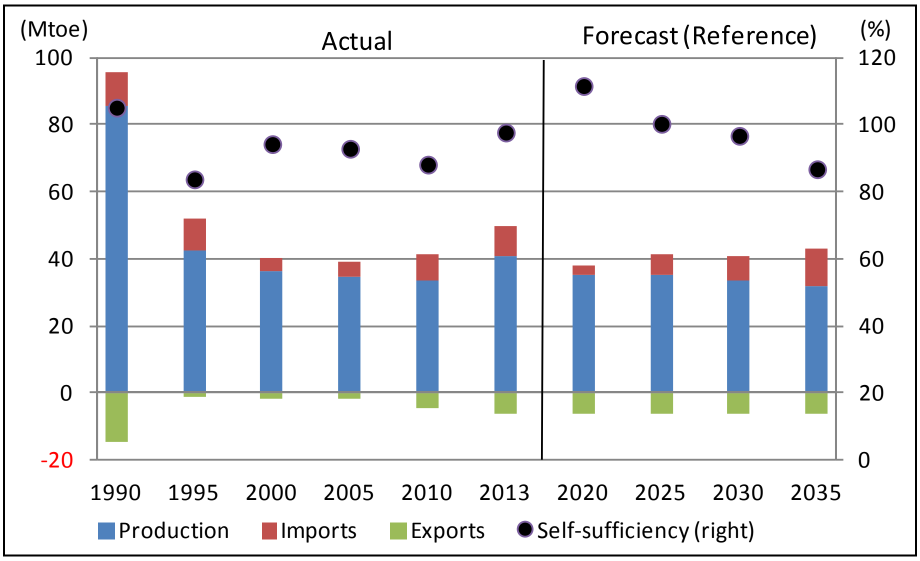
The changes and future outlook for the coal supply balance in Ukraine are shown in Figure 2.2-5 (for the “Reference” scenario).

In 1990, the degree of coal self-sufficiency exceeded 100%, but since then, it has shifted to around 90%. The coal production has decreased by half, from 87 Mtoe in 1990 to 41 Mtoe in 2013. However, as the domestic demand has also decreased by half, from 81 Mtoe in 1990 to 42 Mtoe in 2013, the degree of coal self-sufficiency has not changed greatly.

Until 2013, all of the imported coal was coking coal for iron and steel use. However, since 2014, bituminous coal for power generation has been imported from countries such as South Africa and Russia as a substitute for anthracite, whose supply has stagnated.

The coal production is predicted to decrease from 41 Mtoe in 2013 to 32 Mtoe in 2035. This is an item that was conservatively estimated based upon the aspects that Ukraine is currently moving forward with the incremental abolition of subsidies for coal mines and with coal mine privatization; that the closure of coal mines with low productivity will continue to be unavoidable in the future; and that the future coal supply from the eastern region is unclear. However, some experts are of the viewpoint that although the number of coal mines will decrease due to the privatization process, due to improved productivity, the total production will not greatly change in the future.

Based upon these aspects, a coal imports of 11 Mtoe is predicted for 2035 in Ukraine, an outlook in which imports increase in excess of the record in 2013. In this case, it is thought that it will be necessary to improve the coal import infrastructure.



Source: Energy Balance of Non-OECD Countries 2015, IEA、 Master Plan

Figure 2.2-5 Changes and Outlook for the Coal Supply Balance

2.2.3 Oil

(1) Oil Resources

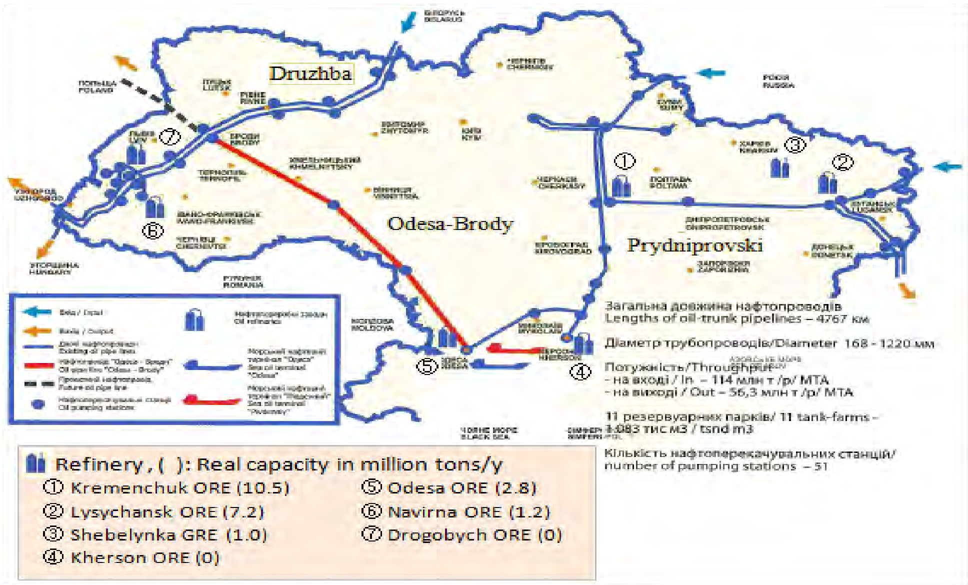
While Ukraine has crude oil (including natural gas liquid: NGL) resources, it does not have sufficient reserves to be specially mentioned in major statistics (BP Statistical Review of World Energy).

(2) Oil Pipelines and Refineries

Ukraine's oil pipelines and major refineries are indicated in the below figure.

The oil pipelines are administered by PJSC Ukrtransnafta (a Naftogaz subsidiary), a state-run company established in 2001. The Druzhba pipeline supplies Russian crude oil to the Drohobych refinery and the Nadvirna refinery, and then becomes a transit pipeline toward European countries. The Prydniprovski pipeline supplies Russian crude oil to the Lysychansk, Kremenchuk, Kherson, and Odessa refineries, and then becomes a transit pipeline that exports oil via the Black Sea. The Odessa-Brody pipeline was completed in 2007, and is a transit pipeline that transports oil unloaded from ships to European countries. There are plans for the Odessa-Brody pipeline to be extended to Poland.

In addition, transit to European countries is also being conducted for Kazakhstan crude oil.



Source: Fuel and energy complex of Ukraine, MECI

Figure 2.2-6 Oil Pipelines and Refineries in Ukraine

With the exception of Shebelynka condensate refinery, there are no refineries for which the Government of Ukraine holds a majority of shares. The refineries currently in operation are only the Kremenchuk refinery, the largest in Ukraine, and the Shebelynka condensate refinery. This is because in terms of price, the oil products, such as gasoline, that are produced by the refineries are not competitive with imported ones.

(3) Oil Supply Balance

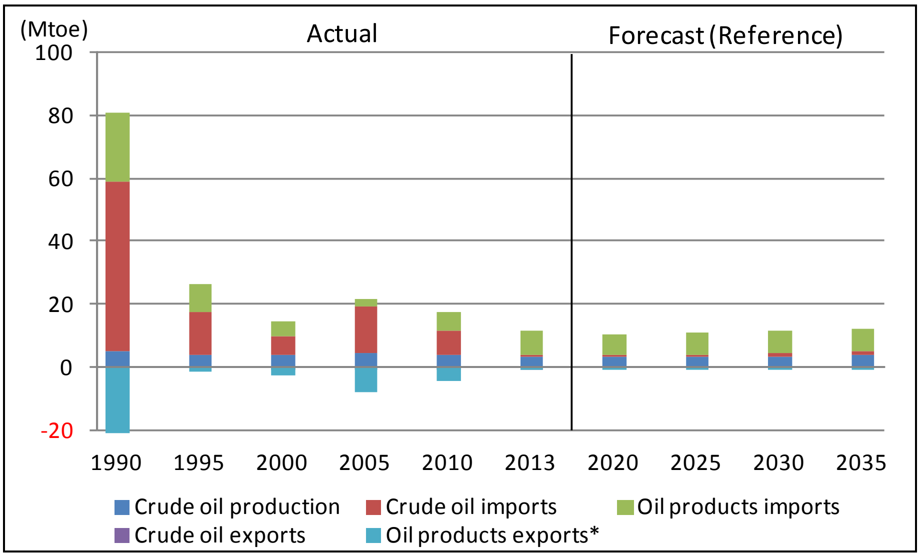
The changes and future outlook for the oil supply balance in Ukraine are indicated in Figure 2.2-7 (for the “Reference” scenario).

Ukraine's oil production is in a decreasing trend. The production was approximately 5 million tons in 1990, but was approximately 3 million tons in 2013. According to MECI statistics, it was approximately 2.7 million tons in 2014, and approximately 2.45 million tons in 2015. The imported oil also fell along with the decline in refinery operations, and according to MECI statistics, the imported oil from November of 2014 to December of 2015 was zero.

Looking at oil products, in 1990, most domestic demand was fulfilled with domestic refining, but afterward there were fluctuations, and from around the middle of 2000s to the present, the country has been a net importer. In 2013, Ukraine relied on imports for approximately 60% of the oil products supply, with Belarus and Russia as its main importing countries.

The main cause for the large decline in Ukraine's refinery operations following independence is in the origin of those refineries. Namely, as the refineries in Ukraine were built in the era of the former Soviet Union with the purpose of processing mainly Russian crude oil and supplying the produced oil products not only to Ukraine, but also within the former Soviet Union, following the country's independence, it came to have excessive oil refining capacities compared to the domestic demand for oil. Further, following independence, Ukraine's refineries were exposed to competition with refineries in countries such as Russia and Belarus. Investment in facility renewal and sophistication were insufficient following the privatization of the refineries, and they lost their competitiveness with the refineries in countries such as Russia and Belarus.

In this way, taking into consideration that large production increases cannot be anticipated from domestic crude oil and that it will take time to realize large-scale investments in refineries, it is predicted that in the future, just as at the current time, a balance in which Ukraine depends on oil product imports for the majority of its oil supply will continue.



Note: "*" includes international bunkers.
Source: Energy Balance of Non-OECD Countries 2015, IEA and Master Plan, METI

Figure 2.2-7 Changes and Outlook for Oil Supply Balance in Ukraine

2.2.4 Natural Gas

(1) Natural Gas Resources

Ukraine's natural gas resources as of the end of 2014 is shown in Table 2.2-6.

Ukraine is 28th in the world in terms of proved natural gas reserves, but in Europe and Eurasia, it is 4th, behind Russia, Norway, and Netherlands. Ukraine's gas fields are located in the eastern region, the mid-eastern region, the Crimean Peninsula, the Black Sea, and the western region.

Table 2.2-6 Natural Gas Resources in Ukraine

Proved reserves (Tcm)	Share of total	Ranking of total	R/P ration
0.6	0.3%	28	34.3 years

Source: BP Statistical Review of World Energy June 2015

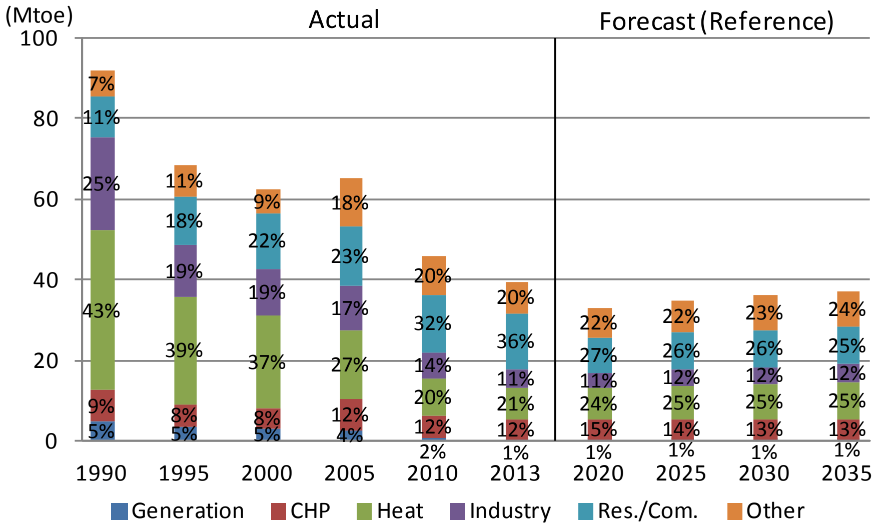
According to the IHS[7], Ukraine's natural gas production costs are in the range of 3.3 to 5.5 USD/MMBtu, depending upon factors such as the region of the deposits and the depth. This figure is 2.7 to 6.6 USD/MMBtu lower than the price of natural gas imported via pipelines from areas such as Europe and Russia from the summer of 2014 to the winter of 2015. In addition, the IEA[8] estimates that the natural gas imports costs for the European market in 2040 will be 12.7 USD/MMBtu, higher than in 2013 (10.6 USD/MMBtu). Naturally, many uncertainties exist with regard to the development costs of new resources, but in general, the cost of domestic natural gas is competitive with imported natural gas, and one could probably situation that it is likely that this competitiveness will continue in the future.

(2) Demand for Natural Gas by Use

The changes and outlook for the demand for natural gas (for "Reference" scenario) by use in Ukraine is shown in Figure 2.2-8. "Other" includes petrochemical feedstock consumption, pipeline fuel consumption, own use, and losses. In Ukraine, natural gas is the main fuel for heat production, including CHP, and is rarely used for power generation. While its demand for industrial use is in a decreasing trend, its demand in the commercial/residential sector is in an increasing trend due to improvement in the standard of living.

Ukraine is earnestly aiming to free itself from dependence on Russia for the supply of natural gas, so the possibility of expanding the use of natural gas in power generation, which would lead to a large increase in its consumption, is unlikely. Accordingly, it is thought that in the future as well, consumption in the commercial/residential sector, including heat supply, will be the focus.

7 Harnessing Production and Revenue: Toward a new fiscal regime for natural gas in Ukraine, 16 June 2015
8 IEA, World Energy Outlook 2014, New Policy Scenario



Source: Energy Balance of Non-OECD Countries 2015, IEA、 Master Plan, METI

Figure 2.2-8 Changes and Outlook for the Demand for Natural Gas by Use

(3) Natural Gas Transportation

Ukraine's domestic gas pipeline network is shown in Figure 2.2-9.

Ukraine is a transit country for Russian natural gas, and sends natural gas it has received from countries such as Russia and Belarus to Europe. The major routes are the Brotherhood pipeline, which runs from Russia to Slovakia, and the Northern Light pipeline, which runs from Belarus to Slovakia.

Source: National Gas Union of Ukraine, East European Gas Analysis

Figure 2.2-9 Natural Gas Pipeline Network in Ukraine

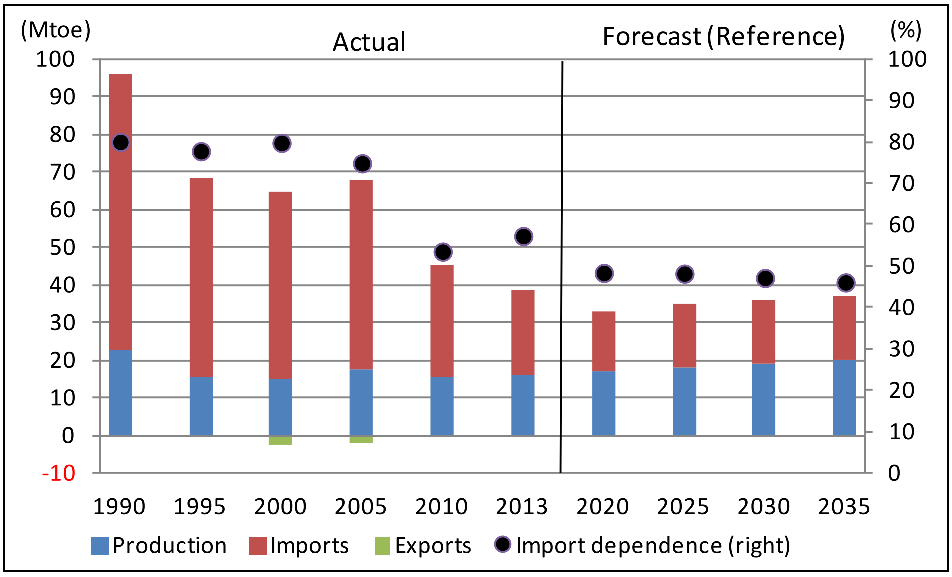
The transit of Russian natural gas bound for Europe peaked at 104.2 Bcm in 2011, and decreased sharply to 62 Bcm in 2014, and 67 Bcm in 2015. The causes for this were that the natural gas consumption in Europe stagnated during that period, and that the Nord Stream pipeline, which bypasses Ukraine, commenced operations in 2011. Even today, Ukraine is the largest transit route for Russian natural gas to Europe, but as part of its political pressure on Ukraine (and Europe), Russia is poised to decrease the natural gas supply routed through Ukraine, and some European countries, companies, and so forth, who dislike the instability of the Ukrainian transit, are aligned with this movement as well. Natural gas transit fees are a major source of income for Naftogaz; if the company were to lose this income source, it is thought that the effects would be great.

(4) Natural Gas Supply Balance

The changes and outlook for the natural gas supply balance in Ukraine is shown in Figure 2.2-10 (for "Reference" scenario).

The natural gas production in Ukraine is 15 to 20 Mtoe, and the country is reliant on imports for the majority of the supply. In the past, nearly all of the imports were from Russia; however, in recent years, Ukraine has rapidly lowered its degree of dependence on Russia by increasing the imports from Europe. According to Naftogaz, the degree of dependence on Russia in recent years was 92% in 2013, 74% in 2014, and 37% in 2015.

With regard to the future, it is predicted that the natural gas production will gradually increase due to improvements in the investing environment. However, in the event of a standard pace of heat supply efficiency improvement, it is predicted that it will be necessary to continue to import around the same amount as at present. Imports are moving in the direction of increasing the natural gas backhauled from Europe, but in order to expand the physical capacity to perform such backhauling, investment in facilities such as pipelines and compressors are necessary on the European side, requiring several years at the least.



Source: Energy Balance of Non-OECD Countries 2015, IEA、 Master Plan, METI

Figure 2.2-10 Changes and Outlook for the Natural Gas Supply Balance

In addition, Ukraine possesses 31 Bcm of natural underground gas storage capacity[9], which exceeds the annual required imports of 20 Bcm. Ukraine's natural gas storage facilities are concentrated in the central and western regions more than in the eastern region, which has become an area of conflict. If a sufficient amount of gas were stored during the summer, when there is no demand for heating, the supply and demand situation for natural gas during winter would be greatly mitigated. It is likely that Ukraine could utilize this fortunate condition to maximum effect and also stabilize the natural gas supply during winter. Further, if the natural gas import prices came to reflect the supply and demand balance for each season in the future, it would be possible for Ukraine to make use of the price difference between summer and winter and supply natural gas at lower prices.

2.2.5 Electricity

(1) Power generation

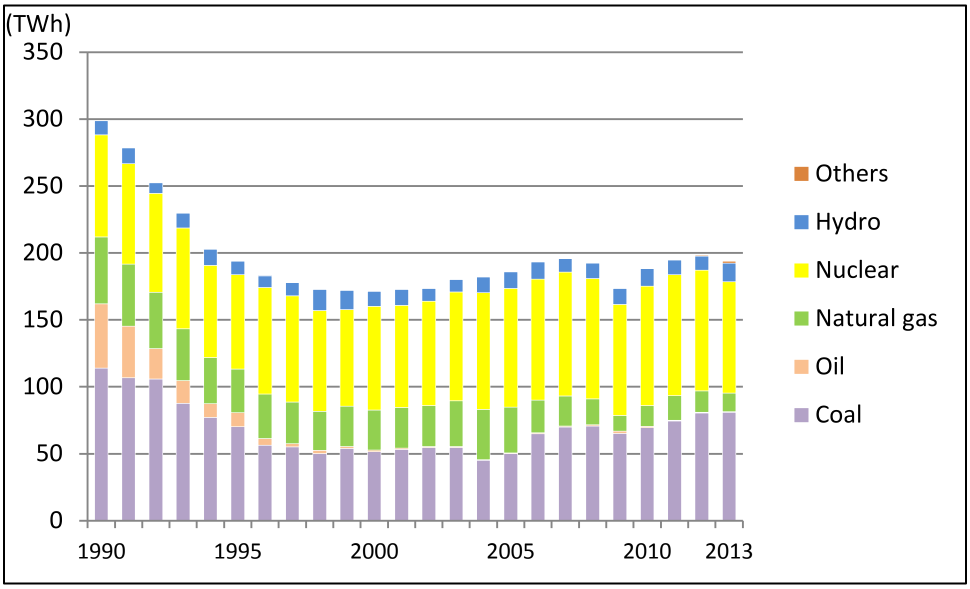
The changes for electricity output is shown in Figure 2.2-11(for the "Reference" scenario).

The electricity output was 300 TWh in 1990, but it sharply decreased following the disintegration of the Soviet Union. In terms of the main factors for the sudden decrease of the electricity output since 1990, one can cite the economic disorder following the disintegration of the Soviet Union, as well as the aspect that the function of being an electricity exporting base, which Ukraine shouldered during the Soviet Union era, became unnecessary. In 2000, it had fallen to 170 TWh, and since then, there has been a gently increasing trend. Although the global recession caused by Bankruptcy of Lehman Brothers affected electricity demand, it was resumed since then. According to MECI

[9] Natural gas is injected and stored in depleted oil and gas fields or aquife.

statistics, electricity output is decreasing, 197 TWh in 2012, 192 TWh in 2013, 182 TWh in 2014, 158 TWh in 2015.

In terms of generation fuel, the share of coal was highest in the past because of abundant coal production. But nuclear power generation was increased because new nuclear power station constructions were continued from 1980s to 1990s. Oil-fired power generation was almost disappeared in 1990s. Natural gas-fired power generation was used in constant relatively in the first half of 2000s, but it was decreased gradually after the natural gas supply war between Ukraine and Russia forced to shift from natural gas to coal for power generation.



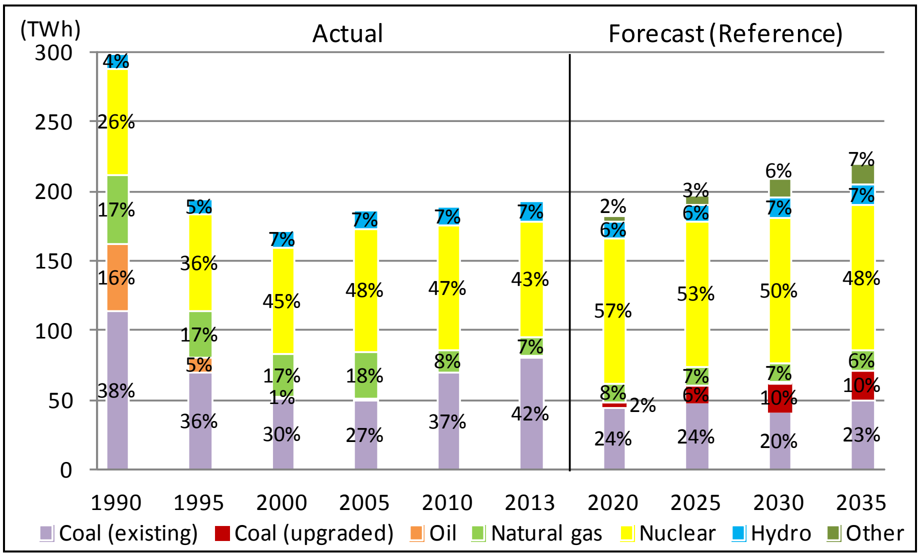
Source： Energy Balance of Non-OECD Countries 2015, IEA

Figure 2.2-11 Changes for Electricity Output

The changes and outlook for Electricity Output is shown in Figure 2.2-12 (for “Reference” scenario). Looking at the generation mix, in 1990, coal was used most often, at 38%. Next was nuclear at 26%, and sources such as natural gas and oil were also utilized in relative abundance. However, in 2013, the proportion of nuclear whose electricity output did not change greatly, became the greatest at 43%, and coal was at 42%, with nearly the same proportion. Conversely, there were sharp drops for oil (which has a high generation cost), which fell to 0%, as well as natural gas (for which Ukraine depends on Russia for the fuel supply), which fell to 7%. In this way, the generation mix has become a structure in which Ukraine currently relies on nuclear and coal for the bulk of its electricity supply.

Ukraine has high self-sufficiency for uranium and coal, which is a rational choice from the perspectives of energy security and economic efficiency. In addition, while coal-fired thermal power station emits substantial air pollutants, nuclear power station, the other source, is zero-emission, so the combination of these 2 sources is suitable from an environmental standpoint.

Accordingly, it is predicted that Ukraine will maintain its generation mix, which positions nuclear and coal as its 2 pillars, in the future as well.



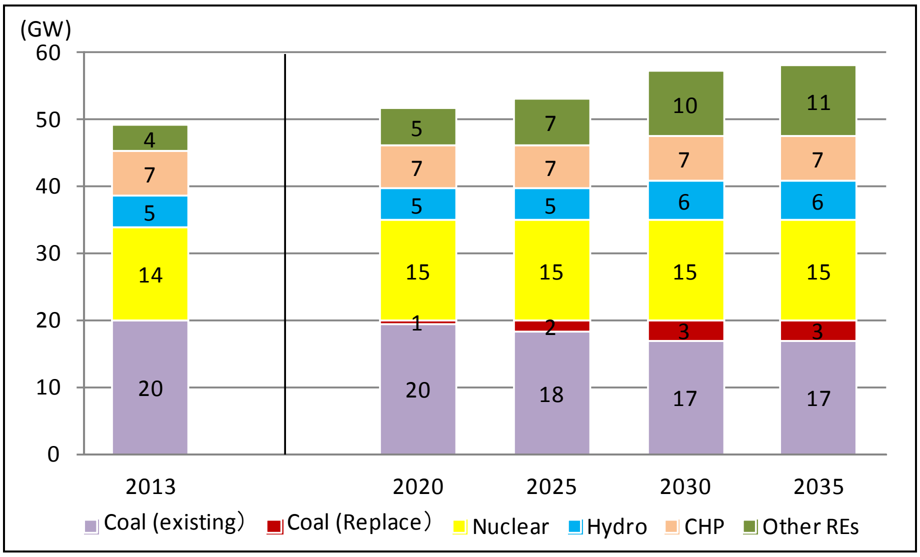
Source: Energy Balance of Non-OECD Countries 2015, IEA、Master Plan, METI

Figure 2.2-12 Changes and Outlook for Electricity Output

(2) Generation Capacity

The current situation regarding the outlook for installed capacity is shown in Figure 2.2-13.

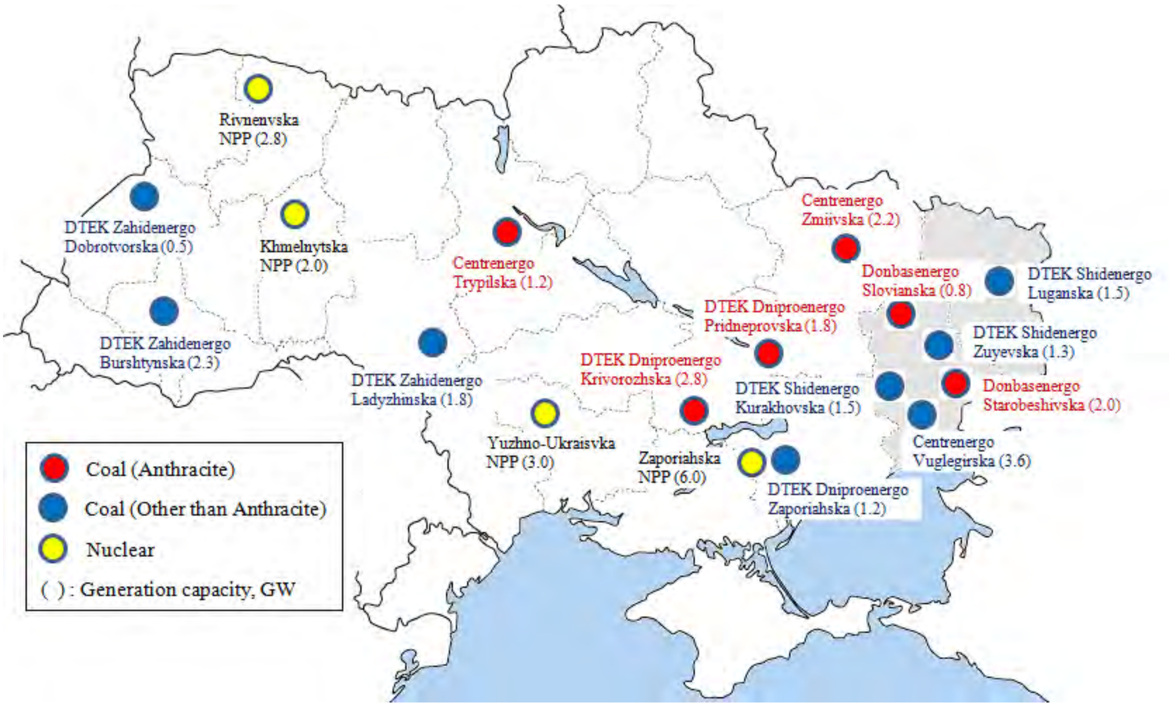
Electric power companies currently have the approximately 20 GW of coal-fired thermal power plants installed capacity. It is predicted that this overall installed capacity will be maintained while incremental replacements and new installations are conducted on deteriorated thermal power plants in the future (1000 MW estimated in each of the years 2020, 2025, and 2030).



Source: Master Plan, METI

Figure 2.2-13 Outlook for Installed Capacity

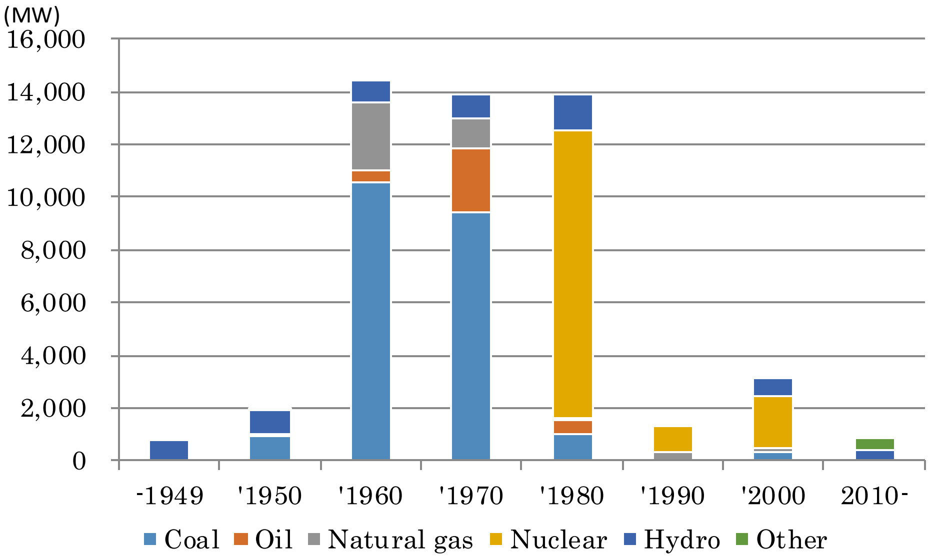
Next, the nuclear power stations installed capacity is 14 GW, but there are many existing nuclear power stations that were built in the 1980s. Around the year 2020, these power plants will reach 40 years since their start of operation. Plans for the additional installation of Khmelnytska Nuclear Power Station No.3 (1,000 MW) and No.4 (1,000 MW) are already being advanced. In the span until these plants commence operation, it is predicted that the generation capacity will be maintained by extending the lifetimes of the existing nuclear power stations. Renewable energy has the effect of Green Tariffs (a name given to feed-in tariffs), and it is predicted that such energy will be gradually expanded.



Source: PREPARED ON THE BASIS OF VARIOUS DOCUMENTATION

Figure 2.2-14 Principal Nuclear and Coal-fired Thermal Power Stations

Figure 2.2-15 shows power generating capacity by period of start of operation of power stations. Many of these power stations were constructed during the former Soviet era, and in particular, for coal-fired thermal power stations many were built in 1960s and 1970s. In Ukraine, as an established common guideline, the operating life of power stations is taken to be 200,000 hours. However, according to the energy strategy up until 2030 created in 2012, as of the end of 2010 84% of thermal power stations had already exceeded 200,000 hours of operation. The construction of a thermal power station, including the period for preparation requires at least 7 to 8 years, therefore taking into consideration the situation of aging deterioration of facilities that have exceeded 200,000 hours of operation, it is necessary to progress with the planning of new and additional facilities.

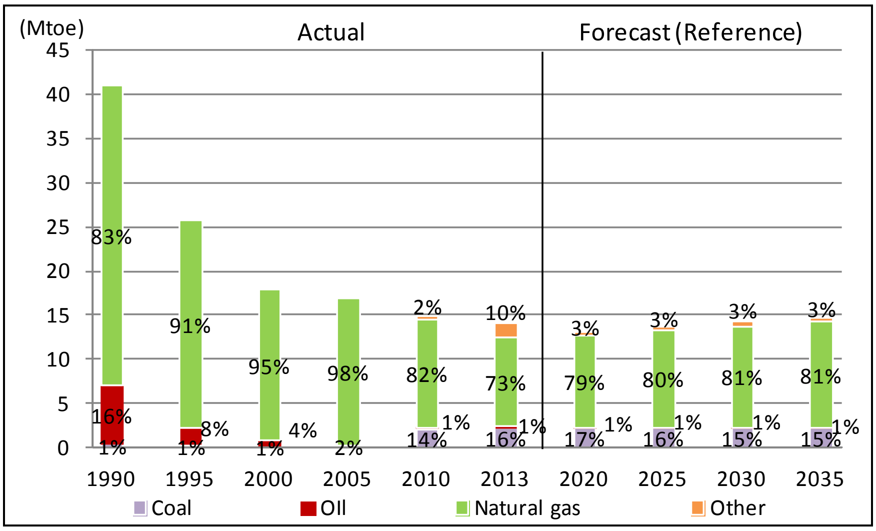


Source: PLATTS UDI WORLD ELECTRIC POWER PLANTS DATA BASE June 2014

Figure 2.2-15 Power Generating Capacity by Period of Start of Operation

2.2.6 Heat

The changes and outlook for the heat supply is shown in Figure 2.2-16 (for "Reference" scenario). The heat supply, centered on industrial use, decreased greatly after 1990, and that trend continues today. Currently, the energy efficiency in the heat supply sector is being proactively advanced from the perspective of curtailing the consumption of natural gas, and it is predicted that future increases in the heat supply will be suppressed.



Source: Energy Balance of Non-OECD Countries 2015, IEA、 Master Plan, METI

Figure 2.2-16 Changes and outlook for the Heat Supply

Looking at the heat production fuel, natural gas has overwhelmingly become the largest. Except for a portion of villages, the natural gas supply infrastructure has been sufficiently prepared, and it is rational to continue with natural gas. The increase of coal since the middle of 2000s is due to the advancement of a fuel substitution with the goal of reducing the natural gas consumption. However, the boilers for district heating system are located in the central areas of cities, and from the perspective of pollution prevention, it is thought that it will not be simple to further advance the fuel substitution to coal in the future. Further, it is predicted that heat sources that utilize biomass will increase in the future due to such factors as the effect of FIT, but it is premised that in terms of the overall heat supply, this will be confined to a limited quantity.

2.3 Policies of the Energy Sector

“Energy Strategy of Ukraine to 2030” was released in 2006 in Ukraine, and it was updated in 2012 (it was approved by cabinet in 2013). In “Energy Strategy of Ukraine to 2030”, the problems facing the energy sector are organized, and a long-term energy infrastructure construction plan is laid out.

However, due to great situational changes resulting from the 2014 Russian annexation of the Crimean Peninsula and the control of eastern Ukraine by pro-Russia factions, a reexamination of “Energy Strategy of Ukraine to 2030” commenced. “Draft Strategy” which MECI published in January of 2015, took factors such as the energy security risks currently being faced, as well as energy market integration with EU, into account. A slightly amended draft (released in July of 2015) was presented for approval at the Cabinet of Ministers, but the instruction was given for reexamination. Reexamination work is currently underway; accordingly, at the current time, there is no official “strategy” that has been approved by the Government. The cause for the reexamination was the credibility of the statistics used in the creation of the supply and demand outlook. The aim is to complete the reexamination work for the statistics and the supply and demand outlook that use them in the first half of 2016.

Accordingly, in this section, we will look at the direction of Ukraine’s future energy policies based on what was able to be acquired of “Draft Strategy” from July of 2015.

2.3.1 Points of “Draft Strategy”

“Draft Strategy” lays out policies, divided into 3 stages for the period until 2035. An outline is shown in Table 2.3-1.

Table 2.3-1 Points of Energy Strategy until year 2035

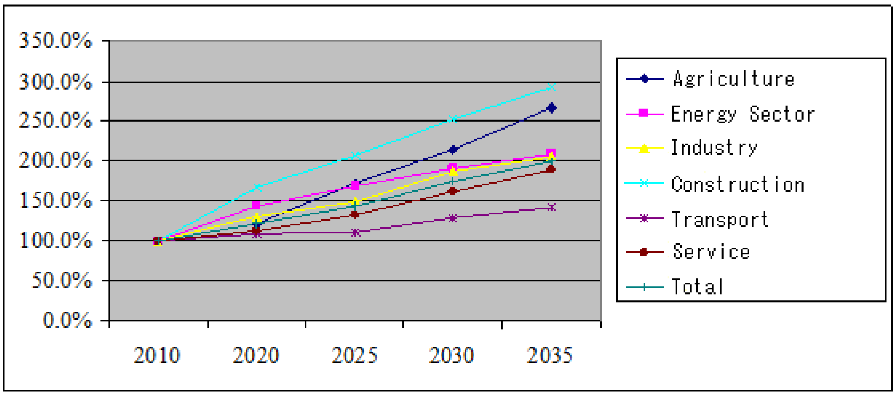
2015-2020 : Reform	➢ Completion of privatization process ➢ Completion of the legal framework for energy market reform, Strengthening the independence of national energy market regulators ➢ decentralization of power and transfer of resources and responsibilities for the housing and utilities sector and electric public utility operations to the local level, substantiated decentralization of power supply systems using local fuels and renewable energy ➢ Introduction of energy management system ➢ Diversification of routes and sources of energy
2021-2025 : Modernization	➢ integration, simultaneously with the submission of the application for Ukraine's accession to the EU, of Ukraine's unified energy system to the ENTSO-E and of Ukraine's gas transport system to the European Network of ENTSO-G ➢ Full implementation of the EU Third Energy Package and other EU Directives ➢ Tax reforms in the mining sector to ensure fair business environment and create an attractive investment climate ➢ Establishment of a comprehensive system of energy and environmental taxes and the concentration of investment resources for implementing large-scale projects to establish financing funds for energy development projects ➢ Stiffening of the requirements to energy consuming equipment and buildings ➢ Introduction of demand management system ➢ Establishment of energy security system
2026-2035 : Integration and Innovation Stage	➢ Providing support for financial market infrastructure ➢ Implementation of targeted programs for the development of technological platforms implementation of targeted programs for the development of technological platforms that would provide the long-term impact on the country's energy mix and economy structure ➢ Protection of consumer rights with regard to access to high-quality power supply ➢ Establishment of the system for support of R&D ➢ Development of the domestic market for GHG trading ➢ Use of Ukraine's financial resources and the opportunities for deeper international cooperation ➢ Development of a support system for pilot projects of advanced energy technologies ➢ Development of the tools to support national energy companies for expanding their participation in European and global markets ➢ Ukraine's full and active participation in international agreements system and international projects in the energy sector in order to develop a common energy security system

Source: Draft Strategy

2.3.2 Outlook for Energy Supply and Demand

(1) Premise for Estimation of Demand

The premise for the estimation of energy demand is that the GDP will increase by an annual rate of 3.5%, with 2010 as the starting point. However, recently, a harsh economic climate, in which there has been negative growth for the 3 consecutive years from 2013 to 2015, has been continuing. GDP growth rate is a critical factor that exerts great influence on energy demand, so it is necessary to take heed of the possibility that the outlook and reality may be vastly separated.



Source: Draft Strategy

Figure 2.3-1 Outlook for GDP Growth Rate by Sector

(2) Outlook for the Primary Energy Supply

In terms of the primary energy supply, the outlook is that there will be an average annual increase of 0.6%, starting at 115.55 Mtoe in 2013 and reaching 132.84 Mtoe in 2035. Comparing 2013 to 2035, the outlook is that coal and natural gas will decrease, and nuclear and renewable energy will increase. It is possible to cite the following 2 points as the major factors that will bring about such changes.

- The consumption of coal will be suppressed by greatly increasing nuclear for the electricity supply.
- The consumption of natural gas will be suppressed by improving efficiency and utilizing renewable energy as heat production fuel.

Table 2.3-2 Outlook for the Primary Energy Supply by Energy

Unit: Mtoe

Energy	2013	(Share)	2020	2025	2030	2035	(Share)
Coal	41.40	(36%)	37.69	38.37	37.27	33.78	(25%)
Oil	9.85	(9%)	13.97	14.86	15.74	16.48	(12%)
Natural gas	39.50	(34%)	37.33	33.57	33.20	34.17	(26%)
Nuclear	21.90	(19%)	25.31	25.38	27.39	32.86	(25%)
Hydro	1.14	(1%)	0.93	1.02	1.21	1.25	(1%)
Biomass, Biofuel, Wastes	1.56	(1%)	6.38	8.91	11.85	13.10	(10%)
Solar	0.07	(0%)	0.37	0.56	0.70	0.84	(1%)
Wind	0.08	(0%)	0.21	0.32	0.43	0.54	(0%)
Environment (water, underground, atmosphere)	0.05	(0%)	0.78	1.42	1.86	2.40	(2%)
Net Exports			-1.03	-1.29	-2.15	-2.58	-(2%)
Total primary energy supply	115.55		121.92	123.12	127.49	132.84	
of which, Non-energy use	4.93		4.72	4.96	5.16	5.31	
of which, energy use	110.62		117.20	118.17	122.33	127.53	
of which, renewables	3.13		8.66	12.23	16.05	18.12	
(Share of REs)	(2.7%)		(7.4%)	(10.3%)	(13.1%)	(14.2%)	
Final energy consumption	69.56		78.89	80.84	85.13	88.91	
(Share of REs)	(4.5%)		(11.0%)	(15.1%)	(18.9%)	(20.4%)	

Source: Draft Strategy

(3) Outlook for the Electricity Supply

The outlook for the generation capacities and electricity output is shown in Table 2.3-3. Looking at the total generation capacity, the outlook is that the capacity will increase by 12.2 GW, from 54.6 GW in 2013 to 66.8 GW in 2035. Looking at this by generation fuel, while the generation capacity of thermal power will decrease, the capacities of other sources, such as nuclear power, will increase. Looking at the electricity output, this trend is even more striking: by maintaining the high operational level of nuclear power generation, it will become the largest electricity supply source by 2035. In this way, one can clearly perceive the policy of shifting from thermal power to sources such as nuclear power and renewable energy.

- Thermal
  - As deteriorated power plants will be retired, generation capacity will decrease.
  - Biomass power plants will increase.
- Nuclear
  - In addition to planned Khmelnytska No. 3 and 4, it seemed to be expected to construct a few new units.

- Renewables
  - Additional hydropower potential can be achieved by the use of mini and micro hydropower plants.
  - Prevention of wind and solar is limited.

Table 2.3-3 Outlook for Generation Capacity and Electricity Output by Fuel

	Unit	2013	(Share)	2020	2025	2030	2035	(Share)
Generation capacity	GW	54.6		52.0	57.5	60.6	66.8	
Thermal (incl. CHP)	GW	34.2	(63%)	27.2	29.8	29.8	31.8	(48%)
of which, REs	GW	0.0	(0%)	0.8	1.8	2.3	2.4	(4%)
Nuclear	GW	13.8	(25%)	14.8	15.0	15.0	18.0	(27%)
Hydro	GW	4.6	(8%)	5.0	5.4	6.2	6.2	(9%)
Pumped storage	GW	0.9	(2%)	2.6	3.6	4.7	4.7	(7%)
Wind	GW	0.3	(1%)	1.4	2.1	2.7	3.4	(5%)
Solar	GW	0.8	(1%)	1.0	1.6	2.2	2.7	(4%)
Generation capacity	TWh	194.4		209.7	233.2	258.3	276.3	
Thermal (incl. CHP)	TWh	95.5	(49%)	93.2	111.5	122.6	117.3	(42%)
of which, REs	TWh			5.5	12.3	16.0	17.1	(6%)
Nuclear	TWh	83.2	(43%)	97.0	97.3	105.0	126.0	(46%)
Hydro	TWh	14.5	(7%)	10.8	11.9	14.0	14.5	(5%)
Pumped storage	TWh			5.1	7.1	9.1	9.1	(3%)
Wind	TWh	0.6	(0%)	2.5	3.7	5.0	6.3	(2%)
Solar	TWh	0.6	(0%)	1.2	1.9	2.6	3.2	(1%)
Fuel consumption	g-ce/kWh	396.0		390.4	373.4	357.9	332.7	

g-ce=gram coal equivalent
Source: Draft Strategy

(4) Outlook for Heat Supply

The outlook for the heat demand and fuel consumption is shown in Table 2.3-4. The outlook is that there will be an average annual increase of 1.9% from 2013 to 2035. Due to aspects such as expansion of the heating area per capita and improvement of the quality of heat supply services, it is predicted that the heat demand will increase mainly in the residential and commercial sectors. On the other hand, it is predicted that by reducing heat losses and introducing highly energy-efficient buildings and new technologies, the heat demand increase will become gradual from 2030.

For fuel, the outlook is that the share of biomass will increase from 2% in 2013 to 41% in 2035. Reducing the natural gas consumption is an important task in Ukraine, and it is thought that there is considerable room to reduce the natural gas demand for heating. One method of doing so is the replacement of natural gas with biomass. Ukraine is one of the world's leading agricultural nations, with particularly abundant grain production yields. Accordingly, there are high hopes for the expansion of biomass use utilizing grain residue.

Table 2.3-4 Outlook for Heat Demand and Fuel Consumption

	Unit	2013	2020	2025	2030	2035
Heat demand	TWh/y	190.24	228.0	242.9	262.2	286.2
	million Gcal	164	196.6	209.4	226.0	246.7
Fuel consumption	million tonnes-ce	14.6	20.5	19.1	19.0	20.0
of which, renewables	million tonnes-ce	0.3	3.6	5.2	7.2	8.1
(Share of REs)		(2.05%)	(17.4%)	(27.3%)	(37.9%)	(40.6%)

Source: Draft Strategy

(5) Production Outlook for Coal, Oil, and Natural Gas

The production goals for coal, oil, and natural gas is shown in Table 2.3-5. Comparing 2013 to 2035, the goals are to increase coal by an average annual rate of 0.2%, to increase oil by an average annual rate of 1.4%, and to increase natural gas by an average annual rate of 3.2%. Ukraine is aiming to improve its degree of natural gas self-sufficiency, so there are particularly high hopes for the expansion of natural gas production.

Table 2.3-5 Production Goals

	Unit	2013	2020	2025	2030	2035
Coal	Mtoe	40.7	37.7	39.9	41.3	42.8
Oil	Million tons	3.1	3.3	3.7	3.9	4.2
Natural gas	Bcm	21.2	22.9	27.5	33.8	42.1

Source: Draft Strategy

The major factors for realizing the production goals are organized as follows.

- Coal
  - Modernization of production facilities and reforms on coal market (pursuing effectiveness) are necessary.
  - Coal market should be open from 2020, after reforms inducing private investment.
  - Strengthen the transport infrastructures for coal import/export and the competiveness of coal industries are necessary.
- Oil
  - Diversity of imported source is an issue because importing as of 2035 is necessary.
  - Modernization of least one of oil refinery is necessary, after building the environment to call for private investment as well as foreign investment.
  - The condition which can bring private and foreign investment to home; the tax system including royalties should be closely set.

- Natural gas
  - Increase in production of natural gas depends on development of new technology which can dig up to fairly deep layers.
  - Establishment of self-supply system in 2025 is possible.
  - Liberalization of natural gas market and integration of EU market finds mobility of natural gas increased, which end up in enhancing reliability of supply even in emergency.

(6) Predicted Energy Balance in 2035

The predicted energy balance in 2035 is shown in Table 2.3-6. The main points are as given below.

- The degree of coal and natural gas self-sufficiency will be 100%, and the degree of oil self-sufficiency will be 28%, nearly the same as in the current situation.
- Only electricity will be exported. 2,582 ktoe (30 TWh), the electricity exports will equate to 11% of the electricity output in 2035.
- In terms of heat supply, while the share of natural gas will decrease compared to the current situation, the share of renewable energy such as biomass will increase.

Table 2.3-6 Table of Predicted Energy Balance in 2035

Unit: ktoe

Supply and consumption	Coal and peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Wind, solar & environment	Biofuels & waste	Electricity	Heat	Total
Production	33,782	4,500	-	34,166	-	1,250	3,775	13,100	-	-	90,572
Import	0	9,500	2,341	0	32,865	-	-	0	0	-	44,706
Export	0	0	0	-	-	-	-	0	-2,582	-	-2,582
Total primary energy supply	**33,782**	**14,000**	**2,341**	**34,166**	**32,865**	**1,250**	**3,775**	**13,100**	**-2,582**	**0**	**132,696**
Electricity production	-18,735	-	-49	-2,820	-32,688	-1,250	-812	-3,042	23,786	-	-35,609
Heat production	-980	-	-31	-13,407	-177	-	-2,964	-5,149	-828	24,632	1,096
Refineries	-	-13,969	13,969	-	-	-	-	-	-	-	0
Energy sector consumption	-62		-477	-540	-	-	-	-	-3,039	-863	-4,981
Transmission & distribution loss	-245	-6	-2	-399	-	-	-	-	-1,674	-1,807	-4,133
Final consumption	**13,760**	**25**	**15,753**	**16,999**	**0**	**0**	**0**	**4,909**	**15,662**	**21,967**	**88,915**
Industry	12,325	-	1,326	3,183	-	-	-	403	7,175	5,208	29,621
Metallurgy	10,954	-	191	371	-	-	-	0	3,045	894	15,455
Chemical Industry	15	-	25	387	-	-	-	0	339	1,143	1,909
Engineering	3	-	33	162	-	-	-	0	1,147	203	1,549
Food Industry	102	-	148	124	-	-	-	343	536	1,669	2,922
Other industries	1,747	-	930	385	-	-	-	60	2,108	1,298	6,528
Construction	2		181	21	-	-	-	0	90	55	350
Transport	27	-	3,508	2,118	-	-	-	223	1,077	0	6,953
Agriculture	16	-	1,978	61	-	-	-	459	606	441	3,561
Services and other consumers	188	-	1,188	589	-	-	-	52	2,298	6,994	11,308
Population	206	-	6,310	9,073	-	-	0	3,772	4,416	9,269	33,046
Non-energy use	498	25	1,261	3,709	-	-	-	-	-	-	5,334

Source: Draft Strategy

2.3.3 Energy Efficiency and Greenhouse Gas Reduction

With regard to energy efficiency, the below policy goals are given.

- By introducing market prices, an awareness of energy efficiency will be implanted into consumers' minds, and consumer behavior will be reformed.
- Meters will be installed.
- The adjustment of electricity consumption in buildings, the installation of heat insulating materials, and the introduction of highly energy efficient heating, air conditioners, and lighting equipment will be promoted. In addition, demand management and the provision of energy-saving services will be carried out.
- In the industry sector, demand management and energy-saving standards will be reformed, and the setting of policy goals, as well as the implanting of energy-saving attitudes, will be carried out through partnerships between the government and private companies.
- Legislation will be created for energy audit, an energy-saving building certification system, and an energy-saving labeling system.
- Distributed generation will be promoted.
- A transition into outsourcing for energy saving, using energy service companies (ESCO) and so forth, will be pursued.
- Greenhouse gases will be reduced through the above methods, the introduction of a carbon tax, and the introduction of a domestic carbon trade system.

2.3.4 Organizational Reforms

As it is thought that corruption in Ukraine is caused market inefficiency and obstructing investments, the improvement of governance has become an urgent task. In “Draft Strategy”, various organizational reforms, detailed as follows, are proposed as shown in Table 2.3-7.

Table 2.3-7 Point of Organization Reform

In the economic sphere	➢ Independence of the legal system, increasing transparency of public governance, implementing effective anti-corruption measures, strengthening the rule of law and effective guarantee of property rights ➢ Setting up and effective functioning of the stock market ➢ efficient and transparent tax system, improving rent relations, introduction of stimulating rates of carbon tax and excise duties, creation of the effective system of penalties for failure to meet the requirements ➢ development of the banking system and health insurance for funding long-term investment projects ➢ Strengthening antimonopoly regulation in limiting the impact of monopolies on functioning of the energy markets, ensuring the independence of national regulators in the energy sector ➢ Introduction of a new model of inter-budget relations, ensuring decentralization and strengthening the financial capacity of local governments, including facilitating the access of local budgets to loan resources (improvement of the legal framework that regulates fundraising by local authorities) ➢ Reforms of housing and public utilities (raising tariffs to economic levels and setting of rates by local authorities) ➢ The latest technologies of generation and use of energy
The social and political sphere	➢ Stability of public governance, consistency and succession of the ruling in passing election cycle ➢ Decentralization of authority and increased responsibility of local governments ➢ Reform of subsidies ➢ Legislative base for consumers' economic responsibility for paying the energy consumption and energy services
The field of science and technology	➢ Ensure renewal of facilities and resources of the research institutions and higher education institutions which provide training of the staff for the energy sector ➢ Establish a program to provide grants for research conducted by Ukrainian scientists ➢ Provide state support for basic science and applied research and technological development ➢ Establish a public-private partnership in science, technology and innovation ➢ Introduce new specialties and training programs to enable the energy sector to operate in a competitive market ➢ Introduce instruments of public support of innovation in the energy sector
The public area and corporate management	➢ introduction of the system of strategic planning in the energy sector, including periodic Strategy revision, preparation and publication of periodic national reports on implementation of the state's energy policy, annual reports on the implementation of the Strategy ➢ Introduction of public-private consultations with representatives of the business community, including foreign investors, to discuss priorities for the development of the energy sector, legislation, coordinated actions to implement the objectives of the Strategy ➢ Getting the energy sector ready to meet the needs of the national economy in energy crisis ➢ Improving corporate culture of the enterprises, introduction of energy and environment management, quality control, etc. ➢ legal definition and implementation of requirements for energy companies to carry out risk analysis and response to threats to energy security, corporate plans for emergencies in the national system of energy security
Clarification of stake holder's role	➢ Following stake holder's roles are clarified. Cabinet of Ministers, MECI, MRDBH, Ministry of Foreign Affairs, National regulators, Local authorities, Civil society

Source: Draft Strategy

2.4 Energy Sector Reforms

2.4.1 Overall of the Reforms

In July of 2014, through Decree No. 614/2014, President Poroshenko established the National Reform Council (NRC) in order to obtain a political consensus regarding reform procedure in Ukraine. Representatives for all interested parties participate in NRC, and the council makes determinations while obtaining agreement. NRC has a Project Office and operates on a special fund from EBRD and the EBRD investors. The operations of the Project Office are carried out in line with the procedures and standards of EBRD.

The overall picture of the reform topics handled by NRC is as shown below. The numbers within the parentheses represent the state of progress as of the end of 2015.

- Anti-Corruption Reform (59%)
- Judicial Reform (70%)
- Decentralization Reform (84%)
- Public Administration Reform (49%)
- Deregulation and Entrepreneurship Reform (68%)
- Law Enforcement Reform (58%)
- National Security and Defense Reform (63%)
- Healthcare Reform (56%)
- Tax Reform (83%)
- Energy Reform (57%)
- Ukraine Promotion Program (92%)
- Agricultural Reform (81%)
- Education Reform (69%)
- State-run Enterprise Governance Reform (83%)
- Financial Reform (76%)
- Constitutional Reform (68%)
- Public Procurement Reform (77%)
- Election Reform (Under development)

The objectives and goals of the energy sector reforms is shown in Table 2.4-1.

Table 2.4-1 Purpose and Goals of the Energy Sector Reforms

Purpose	Strategic Goals	Operational Goals
Building a system with long-term sustainability for the national finances, national security, consumers, businesses and the environment	Energy markets liberalized	Equal access to the market for state-run and private companies is ensured; transparency and competition increased.
		Market-based prices are ensured for all energy resources; tariffs for electricity and gas for all customers (incl. households) are on economically feasible level
		Majority of state-run energy companies are privatized and/or restructured and managed in line with best practices.
	Energy resources supplies diversified and rationally utilized	Diversification of supply sources for all energy resources is ensured.
		Increased production of own energy resources
		National energy consumption is decreased.
	Effective market regulation, safety and environment protection are ensured	Independent and enhanced energy regulator is functioning.
		Enhanced state control of energy safety and environment

Source: National Reform Council

The sector's tasks and the situation of progress as of the end of September, 2015, is shown in Table 2.4-2.

Table 2.4-2 Purpose and Goals of the Energy Sector Reforms (by sector)

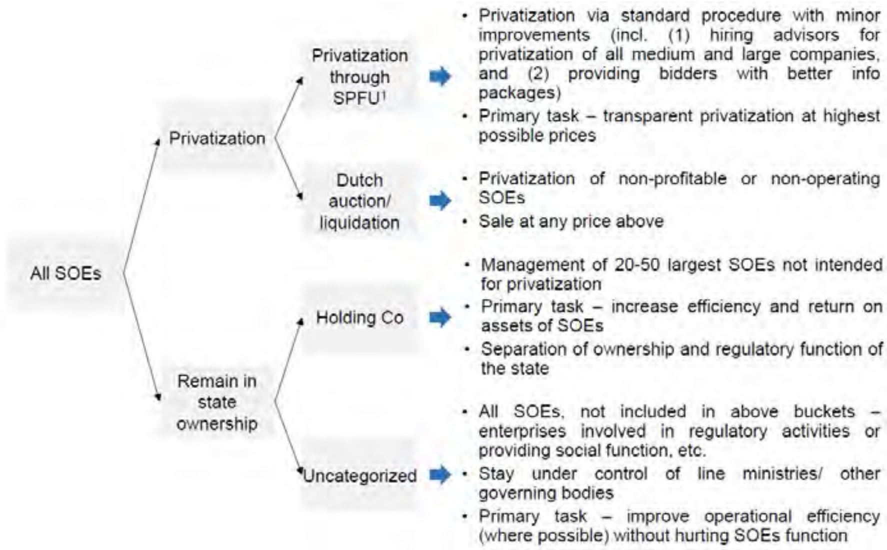
Coal	➢ Implemented mechanism to determine the market price of coal energy through electronic exchange trading (40%) ➢ Approved by the State the Target economic program of reforming the coal industry for the years 2015 to 2020 (30%) ➢ A first phase of a transparent and effective privatization of mines is completed (70%) ➢ Provided organization and infrastructure for an effective system of social support of the coal industry workers and the population of areas with coal and coal-processing enterprises that are under liquidation (50%)
Electricity	➢ Adopted basic legislation for reform of electricity market in accordance with the requirements of the 3rd Energy Package (70%) ➢ Legislative level guarantee of an independent energy regulator according to the requirements of the 3rd Energy Package (20%) ➢ Ensured implementation of normative legal and technological measures to sync the Energy System of Ukraine with the united energy systems of EU countries (40%)
Natural gas	➢ Accepted secondary legislation for the reform and liberalization of the natural gas market in accordance with the Law “On the natural gas market” (85%) ➢ Provided organization and infrastructure for the reorganization of “Naftogaz Ukraine” in accordance with the law “On natural gas market” (60%) ➢ The law contains a provision on creation of economic incentives to build the state hydrocarbon production and to attract private investment in the energy sector (60%)
Electricity/ Natural gas	➢ Conducted gradual elimination of cross-subsidization and alignment of prices for natural gas and electricity for all consumers (40%) ➢ The system of targeted subsidies to vulnerable social groups to pay for gas and electricity is improved (70%)
Energy conservation	➢ Approved the National Action Plan on energy efficiency for the period until 2020 to improve the efficiency of final energy consumption and reduction or substitution of natural gas (100%) ➢ A mechanism of ESCO contracts to attract private investment for energy efficiency measures in budgetary institutions is implemented (100%) ➢ Created Energy Efficiency Fund as an instrument for guaranteed state support and investment in the implementation of energy efficiency measures in homes and institutions of public sector (20%)

Source: National Reform Council

2.4.2 Privatization of State-Run Companies

Ukraine has been going for privatization of state-run companies since independence in 1991 and advancing the work by getting approval on the privatization list from the Parliament nearly every year. However, every company on the list for privatization is not on sale immediately, but there are a lot of companies which stay just on the list for long period.

The financial condition of Ukraine is getting worse every year. The total debt amounts to 90 percent as opposed to GDP as of the end of 2015, which is the background that IMF is requesting Ukraine to prevent corruptions and structural reforms like privatization on energy sector, instead of financial support conducted by International Monetary Fund (IMF) (granting expanded credit of USD 17.5 billion, in March, 2015; targeting from 2015 to 2018). Thus, Ukraine is accelerating the reduction of unrecovered debt and the improvement of productivities. A proposal is being made to distinguish all state-run companies as shown in Figure 2.4-1.



SOEs = State Own Enterprises
SPFU = State Property Fund of Ukraine
Source: Reform of State-owned Enterprises, Ministry of Economic Development and Trade (November 2015)

Figure 2.4-1 State-Run Company Management Framework Proposal

(1) Energy Companies That Will Not Be Privatized

Naftogaz (oil and natural gas), Ukrhydroenergo (hydro power generation), Energoatom (nuclear power generation), and Ukrenergo (transmission) will not be privatized. They will be included under the jurisdiction of a holding company within the Cabinet.

Source: Reform of State-owned Enterprises, Ministry of Economic Development and Trade (November 2015)

Figure 2.4-2 Structure of Management by the Holding Company of the Non-Privatized Companies

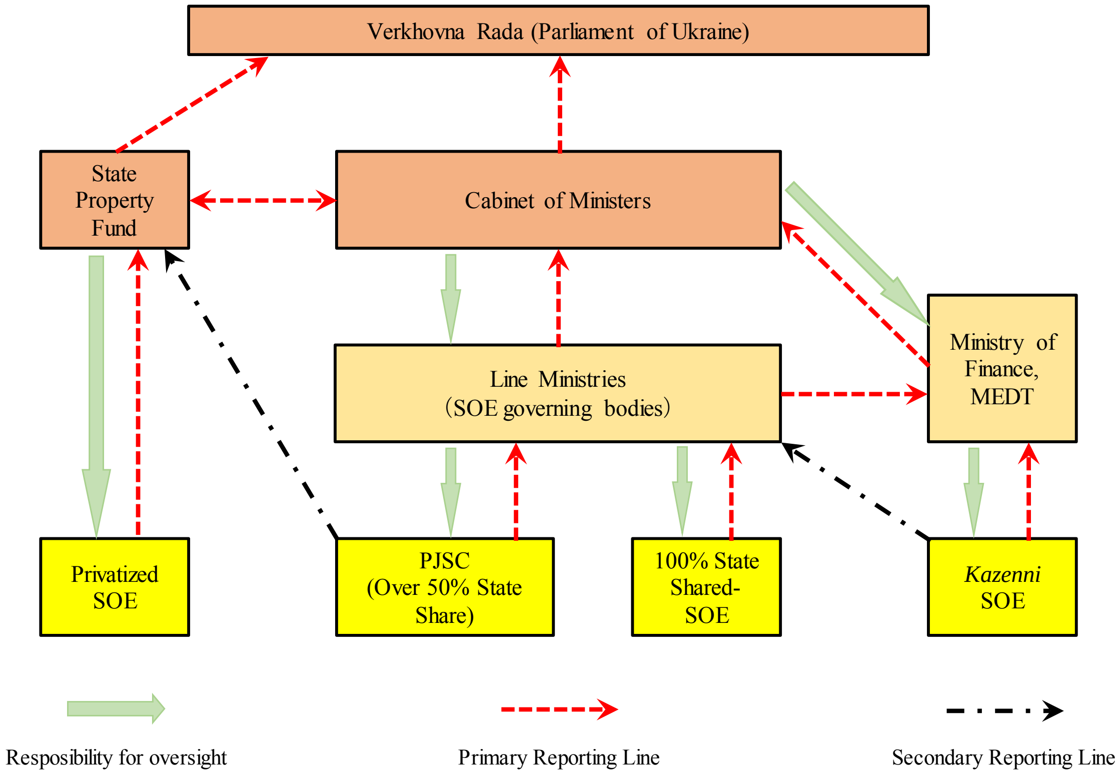
(2) Major Companies Subject to Privatization in the Energy Sector

The state-run enterprises of Ukraine and the control mechanism shown in Table 2.4-3and Figure 2.4-3.

Table 2.4-3 Number of State-Run Enterprise

Year	2005	2006	2007	2008	2009	2014
Total SOE	3,981	4,086	3,209	3,546	3,589	3,340
State Share 100% SOE	3,514	3,636	2,722	3,083	3,126	N/A
Subsidiary of State share 100% SOE (*Kazenni* Enterprise)	48	50	43	43	43	N/A
PJSC (state share more than 50%)	419	400	444	420	420	N/A
Privatized SOE	890	672	403	N/A	N/A	N/A

Source: World Bank Report 599500 Financial Systems and Governance of State Owned Enterprise Feb.22, 2011



**kazenni* enterprises, the lines of responsibilities running from/to the Cabinet of Ministers operate through MEDT

Source: World Bank Report 599500 Financial Systems and Governance of State Owned Enterprise Feb.22.2011

Figure 2.4-3 SOE governance system in Ukraine

Kazenni enterprises are defined as 100% state-run enterprises which sell 50% or more of the production to the country, such as military, science civil engineering center, and medical equipment.

Unitary state-run enterprises are huge capital of the socialist era, such as Railway, nuclear power generation (Energoatom), and power transmission (Ukrenergo) companies.

Corporatized SOE is a company of the public-private joint stock company owned by state 50% or more such as Naftogas, Ukrtelecom, such as Odessa Portside Plant.

The privatized company with national stock of 50 % or less is classified as stock sharing company after its privatization.

345 state-run companies have already been approved for privatization and MEDT released in public the 200 or more companies for privatization (as of July, 2015). Main companies for privatization is listed in Table 2.4-4.

Table 2.4-4 major State-run Companies subject to Privatization

Company Name	Business Type	State share
PJSC Centrenergo	generation	78.3%
PJSC Kyivenergo	CHP, distribution, heat supply	25.0%
PJSC DTEK Dniproenergo	generation	25.0%
JSC Kharkivoblenergo	distribution	65.0%
PJSC DTEK Zakhidenergo	generation	25.0%
PJSC Lysychanskvuhillya (Luhansk)	mine	100%
Krasnolymanska Mine (Donetsk)	mine	100%
JSC «Odesaoblenergo»	distribution	25.0%
PJSC “Donbasenergo”	generation	25.0%
SE Kryvyi Rih District Heating Plant	heat supply	100%
OJSC Zaporizhyaoblenergo	distribution	60.25%
PJSC DTEK Dniprooblenergo	distribution	25.0%
PJSC Mykolaivoblenergo	distribution	70.0%
PJSC Khmelnitskoblenergo	distribution	70.0%
PJSC Zasyadko coal mine (Donetsk)	mine	16.5%
PJSC Dniprodzerzhinska CHP	CHP, heat supply	99.9277%
OJSC Ternopiloblenergo	distribution	51.0%
PJSC Odesa CHP	CHP, heat supply	99.989%
PJSC Cherkasyoblenergo	distribution	46.0%
PJSC Kherson CHP	CHP, heat supply	99.8%
Severodonetsk CHP	CHP, heat supply	100%
PJSC Sumyoblenergo	distribution	25.0%
PJSC Lviv Coal Company (Lviv)	mine	37.58%
PJSC Mykolayiv CHP	CHP, heat supply	100%
Nadiya mine (Lviv)	mine	100%
PJSC DTEK Dobropilska CPP (Donetsk)	coal refinement	38.3%
PJSC DTEK Oktyabrska CPP (Donetsk)	coal refinement	39.1%
#9 Novovolynska mine (Lutsk)	mine	100%
Buzhanska mine (Lutsk)	mine	100%
Velykomostivska mine (Lviv)	mine	100%
Chervonohradska mine (Lviv)	mine	100%

Company Name	Business Type	State share
Vidrodzhennya mine (Lviv)	mine	100%
Lisova mine (Lviv)	mine	100%
Mezhyrichanska mine (Lviv)	mine	100%
Zarichna mine (Lviv)	mine	100%
Stepova mine (Lviv)	mine	100%
Zolote mine (Lviv)	mine	100%
Hirska mine (Luhansk)	mine	100%
Karbonit mine (Donetsk)	mine	100%
Toshkivska mine (Luhansk)	mine	100%
Stakhanov mine (Donetsk)	mine	100%
Rodynska mine (Donetsk)	mine	100%
Kurahivska mine (Donetsk)	mine	100%
Ukrayina mine (Donetsk)	mine	100%
1/3 Novohrodivska mine (Donetsk)	mine	100%
Rosiya mine (Donetsk)	mine	100%
Tsentralna mine (Donetsk)	mine	100%
Dymytrov mine (Donetsk)	mine	100%
#3 Pyvdennodonbaska mine named after Surgay (Donetsk)	mine	100%

Source: Reform of State-owned Enterprises, Ministry of Economic Development and Trade (November 2015)

(3) Method of Privatization

In the procedure for privatization, first of all each governmental ministry and agency prepares a list of state-run companies under its jurisdiction which are to be privatized. These lists are submitted to the State Property Fund (SPF), which then proceeds with privatization using one of the following 6 methods.

- Redemption
- Redemption by equipment loans
- Public auction
- Open bid sale (Commercial Contest)
- Closed bid sale
- Sale of shares

As a priority area for this survey, concerning Centrenergo which has investigated the issues and needs for support, during the 2nd site survey (February 2016) it was decided that execution of the privatization process would follow "open bid sale" above. In an interview with SPF, it was understood that open bid sales would be carried out in accordance with the following procedure.

1) Assets survey (Due diligence)
2) Enterprise value estimates
3) International tender
4) Evaluation of bids (Including Bidder qualification and an impact assessment at the time of privatization transition)
5) Cabinet of Ministries of Ukraine approval
6) Sale

According to SPF, to develop favorable terms and conditions for investor loans, international financial institutions such as EBRD and the European Investment Bank (EIB) are being urged to participate in post-privatization operations through for example the provision of loans, as a result of which efforts are being made to raise appraisal values for 2) "enterprise value estimates" above. Because many of the businesses placed on the privatization list are in an inherently poor condition, state guarantees that would help in arranging international finance are basically unavailable. Further, in cases where state enterprises are to invest more than UAH 4 million, irrespective of whether or not there is a source for the procurement of funds, approval by the Cabinet of Ministers is necessary. Therefore, for privatization candidate enterprises such as Centrenergo, the hurdle to obtaining international finance is considerable.

2.4.3 Reforms of the Electricity and Gas Sectors

Ukraine is seeking to unify with the European energy market, and will introduce to the country a system compliant with the European electricity and gas market framework stipulated in the EU 3rd Energy Package.

Table 2.4-5 EU 3rd Energy Package

What is the EU 3rd Energy Package?

It is a series of directives in order for Europe to uniformly advance the liberalization of the electricity and gas markets. The first directive, which began working toward liberalization through means such as third-party access to networks (power grid and gas pipelines), was issued for electricity in 1996, and for gas in 1998. The second directive, which established such items as the full liberalization of retail by July of 2007, was issued for both electricity and gas in 2003. The main characteristics of the third directive are as follows.

- Creates obligations for the separation of ownership rights or formulate Independent System Operator in the network sector.
- Strengthens the independence and authority of regulatory bodies.
- Establishes the Agency for the Cooperation of Energy Regulators, which handles international issues.

Source: EU 3rd Energy Package

The gas sector has been targeted first in the enactment of the new legislation, with revised gas market laws being approved by the Verkhovna Rada of Ukraine in April of 2015. In the new legislation, the gas market will become as indicated below. Secondary legislation has been established to actualize the reforms determined in the new legislation, but the details have not been made clear.

- State : The state continues to oversee natural monopolies in gas transmission and distribution.
- Regulator : The regulator sets tariff for gas transmission (Ukrtransgaz) and gas distribution (regional gas companies).
  The regulator is responsible for regulating the market, most notably, for safeguarding free competition.
- Transport sector : Unbundling Naftogaz, establishing an independent gas transmission system operator (TSO) and ensuring that all market participants have equal and transparent access to the gas transmission capacities.
- Consumers : All consumers including each family will have the right to choose their gas supplier independently of their gas distribution company.

Meanwhile, for the electricity sector, draft creation and public comments have concluded for the revised electricity market legislation, which will determine the course of the reforms. From now, it will be necessary to gain approval from the Verkhovna Rada of Ukraine and to draw up secondary legislation necessary for the execution.

Separate from the establishment of the new legislation, reforms have already been decided for the wholesale market. Currently, a so-called single-buyer formula, in which the state-run Energorynok purchases all generated electricity or exceeding 20 MW that connects to high-voltage lines, is being taken. However, after reform, in addition to direct transactions between the concerned parties without involvement from Energorynok becoming possible, a day-ahead market will be created, ancillary services will be supplied, and a market that adjusts supply and demand will be provided. As a result of these reforms, the role of Energorynok in the wholesale market will gradually become smaller.

April, 2014	: The establishment of new departments within Energorynok for a day-ahead market and renewable energy purchasing.
January, 2016	: The separation of those departments from Energorynok.
July, 2017	: The start of functionality for organizations for day-ahead market operations and renewable energy purchasing.

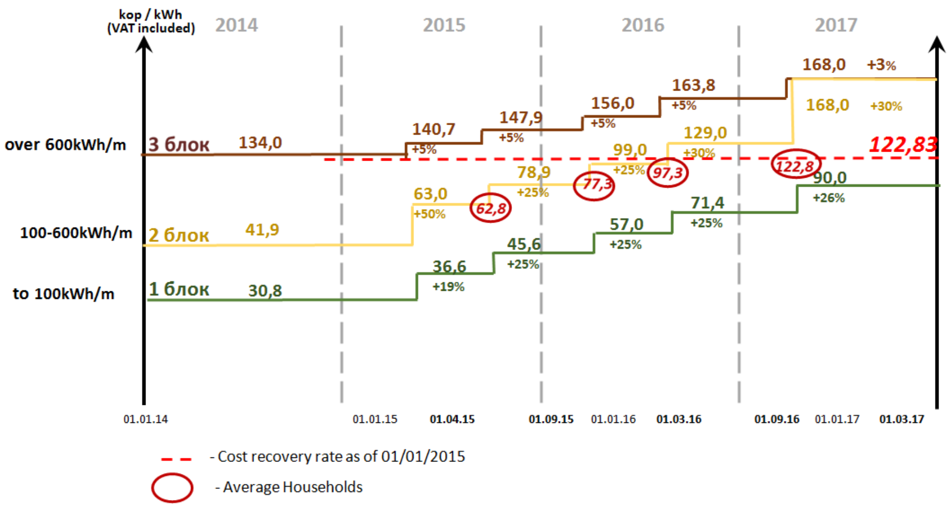
2.4.4 Energy Price Reforms and Meter Installation

To this point, there was a policy for the reform of energy prices, but it was almost never realized. However, From February to March of 2015, NKREKP announced large-scale increases in the prices of household electricity, heat, and natural gas. These increases were realized because international development banks such as the IMF had strongly requested that Ukraine raise various energy prices as a condition for these banks to provide financial support to Ukraine. From now, prices will be incrementally increased so that supply costs are 100% recovered by April of 2017.

If the energy price raises are completed according to plan, it is possible that Ukraine's investing environment will improve greatly. As the companies that shoulder items such as gas supply, power generation, and heat supply will become able to appropriately recover their costs, they will be able to receive capital for new infrastructure investment. In addition, as motivation for consumers to lower energy payments will be created, the environment will lend itself to investment related to energy saving.

(1) Electricity Prices

On February 26, 2015, NKREKP announced the raising of electricity prices in 5 steps in a 2 years period starting on April 1. The schedule for raising the electricity prices is shown in Figure 2.4-4.

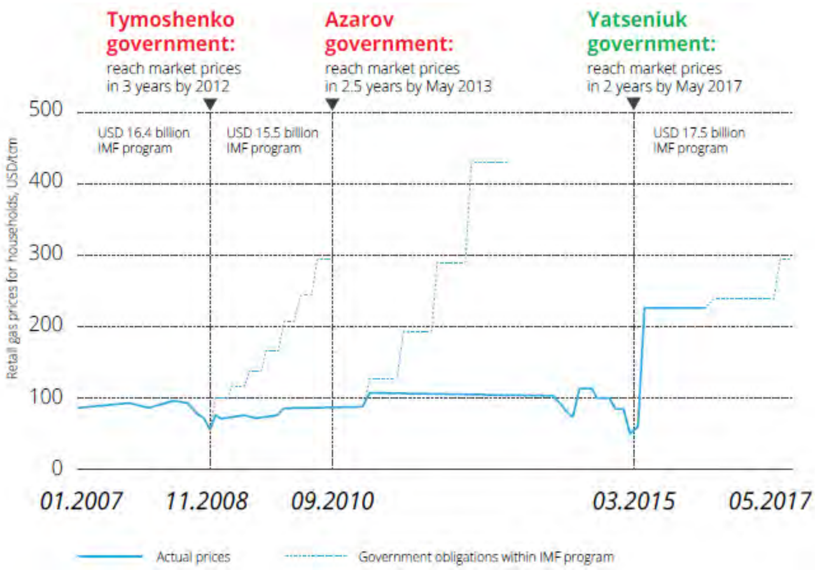


Source: Electricity tariffs Households Ukraine, NKREKP

Figure 2.4-4 Changes and Raising Schedule for Household Electricity Prices

(2) Natural Gas Prices

In a promise to the IMF, gas prices will be raised to a level in which it is possible to recover 100% of costs by April of 2017. Successive administrations promised to raise prices each time they have received funding from the IMF, but all such occasions resulted in failure. However, on this occasion, there has been success in raising prices for households to more than double their payments, starting in April of 2015.



Source: Naftogaz Annual Report 2014

Figure 2.4-5 Changes and Raising Schedule for Household Gas Prices

(3) Heat Prices

On March 4, 2015, NKREKP announced a reform of household heating prices, with a standard natural gas price of UAH 2,495.25/1,000 m^3 for heat production. The changes were applied starting on April 1, and prices have increased by 67%. However, aspects such as CHP and heat supply from power stations are exempt from these increases. In addition, the prices vary by supply company. As with electricity and gas, the plan is to ultimately raise prices to a level in which costs can be 100% recovered by April,2017.

(4) Meter Installation

Along with the adjustment of prices, meter installation is also important. By installing meters, suppliers will become able to suitably grasp energy supply losses, and will become able to aim for further improvement in efficiency. In addition, consumers will become able to ascertain their own energy consumption and, combined with payments for measured rates, aim to save energy.

As of the end of December, 2014, the gas meter installation rate for households is at approximately 70%.

Table 2.4-6 Gas Utilization Purpose Type and Meter Installation Deadlines

Gas Utilization Purpose	Required gas meter installed
Heating, Warming water and Cooking	January, 1, 2012
Warming water and Cooking only	January, 1, 2016
Cooking only	January, 1, 2018

Source: The law on gas meter installation

The meter installation ratio for regional heat supply in units of buildings is at 41% as of the end of November, 2015. The agreement with the IMF entails an installation ratio of 100% by 2017, so Ukraine is rushing to prepare legislation to make installation an obligation. [10]

According to an interview to the W B Group International Finance Corporation (IFC), under the current system, heating prices are set charges per person, and the structure is such that if families grow, their heating charges will increase. For this reason, as payment amounts will decrease if heat meters are installed and charges are switched to measured rates, the installation of heat meters is generally desired. There are many poor people in Ukraine; for people living on pensions of UAH 3,000 half of their pension amount goes toward heating charges. However, if heat meters were installed, the heat charges would be halved.

[10] From a meeting with SAEE

There are 2 ways of installing heat meters.

- Home owners with financial power can create Home Owner's Associations and install heat meters to apartments in groups.
- Home owners without financial power can make an application to their cities and have heat meters installed.

The cost of heat meters ranges from UAH 2,000 to 3,000, and there are no subsidies in Kyiv. At the current time, public charges have risen, and Kyiv has a situation in which the number of applications for heat meter installation is increasing. In localities with no district heating system, there are some cases where replacements to high-efficiency boilers are being performed free of charge.

(5) Energy Saving for General Households

According to the SAEE, there are 220,000 condominiums in Ukraine, and it is necessary to perform insulation work and carry out heat loss reduction for 80% of those. The investment amounts to EUR 300 billion, but donors have not been secured for insulation work or heat meter installation.
All of the devices are made in Ukraine, and the Government can expect revenue from Value Added Taxes (VAT). In terms of household energy saving, employment can be expected for installation work for boilers, windows, and meters, so this would be a beneficial investment for the nation.

Of international organizations, the IFC is supporting energy saving in the heating sector for households, and is promoting the installation of heat meters, the installation of temperature control devices, and the installation of insulating materials. The IFC is performing consulting without providing funding. Its efforts are as detailed below.

- Cooperation with the Ministry of Regional Development, Construction, Housing and Communal Services of Ukraine in the establishment of a legal system
- Cooperation with banks
- Public relations activities

Of these, the background for the IFC's cooperation with banks and undertaking of public relations activities is detailed below.

- In the era of the former Soviet Union, condominiums were the property of the country, but following independence, the rooms in condominiums became the property of individuals. Public service organizations had been shouldering condominium repairs, but their services were of low quality, and better services were able to be obtained by individually using contractors to perform repairs. For this reason, home owners created Home Owner's Associations and consulted with banks concerning loans for repair funds, but the banks did not have experience financing groups such as Home Owner's Associations, and did not understand the method for doing so. Accordingly, the repairs and modernization of condominiums have not been performed. Based on this background, the IFC is cooperating with banks to create a framework to finance Home Owner's Associations.

- While the individuals who have become the owners of rooms in condominiums are aware that their rooms are their property, they do not have a management mindset regarding shared portions such as entrances, stairways, and elevators. Accordingly, the IFC is targeting home owners in condominiums in carrying out public relations activities to communicate that shared areas are also subject to repairs.

2.5 Challenges for the Energy Sector

The largest challenge that Ukraine is currently facing is the supply of natural gas and coal. As has been repeatedly touched on to this point, the cause that actualized the problems on the supply side is Ukraine's worsening relationship with Russia. As there is a context of political confrontation that involves parties such as Europe and the United States, solving these challenges by improving relations with Russia is highly uncertain, and it is likely difficult to hope for this in the short-term. For this reason, the currently ongoing effort to stabilize the supplies of natural gas and coal is a challenge that takes precedence. However, the challenges that Ukraine's energy sector faces are not limited to this. Furthermore, there is a political instability. Prime Minister Yatsenuk, who was contended with President Poroshenko, resigned and was placed to Groysman Yolodymyr, and the Minister of MECI was replaced to Nasalyk Ihor in April, 2016. This kind of political instability potentially affects the progress of Energy Reform.

Here, we will first address the challenges involving natural gas and coal, which have a high priority, as well as heat supply and electricity supply, which are deeply involved with these. Afterward, we will address oil supply and energy efficiency.

2.5.1 Natural Gas

The challenges for the natural gas sector lie in reducing the degree of import dependence and diversifying import countries.

(1) Domestic Natural Gas Production

A portion of Ukraine's resources are located around the Crimean Peninsula, but due to Russia's annexation of Crimea, in reality, it is not possible to develop and utilize these resources.

The resources on the Black Sea coast exist at ultra-deep locations, and the E&P costs are high. In order to tie these resources to production, it is necessary either to improve the management of Naftogaz or to develop an investing environment that invites private investment. The wholesale prices for natural gas produced by companies related to Naftogaz are set low, so it is not possible to earn sufficient profit. In addition, the negative spreads from payments aimed at households have put pressure on the company’s management, and investment funds are lacking. In order to eliminate this problem, it is necessary to raise the wholesale and retail prices of Naftogaz.

In terms of improving the investing environment for private companies, including foreign investment, the reform of taxation related to resource development, including royalties, as well as the improvement of aspects such as the transparency and predictability of systems related to investment, including various regulations, is needed. Taxation related to resource development directly connects to development companies' profits—that is to say, to their investment decision. Ukraine has raised related taxes with the objective of securing tax revenue, and has a dilemma in which this obstructs the desire to invest. In addition, the structure of Ukraine, in which aspects such as policies and organizations change greatly due to shifts in administration, is a large risk for investors, and it is necessary to stabilize this aspect.

(2) Substitution to Alternative Fuels

As natural gas is widely used as fuel for heat production, the reduction of natural gas consumption is being promoted by utilizing alternative fuels such as coal, biomass, and various unused energy. This is an effective policy in terms of reducing the natural gas consumption, but as there is a possibility of causing different problems, related to environment or cost related aspects depending upon the alternative fuel, careful consideration is required.

(3) Improvement of Efficiency

In terms of the natural gas consumption, direct use by households (heating, warming water, and cooking) is the most widespread, and it is critical to improve the energy efficiency in this sector. Gas price increases and meter installation, which are already being addressed, are necessary to save energy, and are prerequisites to accomplishing this challenge according to plan. In addition to these methods, it is necessary to take a multilayered approach to aspects such as public relations, education, and support in order to make an appeal regarding the necessity of saving energy and to incite such behavior.

District heating systems are the sector whose demand for natural gas follows behind direct use, and the improvement of energy efficiency in this sector is needed (mentioned 2.5.2).
Natural gas is mainly consumed for iron and steel and chemical uses (ammonia feedstocks) in the industry sector, and it is consumed as a heat source for heating in the consumer sector. It is thought that it is possible to improve the energy efficiency in the industry sector by modernizing facilities, but it goes without saying that this would require a large amount of investment. The raising of energy prices and the strengthening of regulations would be effective in order to provide incentives to the industrial world for investment toward energy saving.

In addition, Ukraine has a role as a transit country that exports Russian natural gas to Europe, and a large amount of natural gas is consumed for gas compressors for the transportation of natural gas. In total, the compressors have a capacity of at least 1 GW, but the efficiency of the gas turbines, which power the compressors, is quite low, at 30% or below. There is room to improve the efficiency.

(4) Diversification of Natural Gas Import Countries

Ukraine greatly relies on Russia for the natural gas imports, and the diversification of natural gas import countries is a challenge to be addressed. Options include having natural gas backhauled via pipelines from countries such as Slovakia and Poland, importing Liquid Natural Gas (LNG), and so forth.

For pipeline imports, it is necessary not to perform virtual backhauling that pulls out natural gas for transit, but to strengthen the physical backhauling capacity to perform pumping from Europe. For virtual backhauling, in addition to there being cases where the supply is limited due to agreements between Gazprom and European countries, it must be stated that in the context of plans being furthered for export routes that bypass Ukraine, including examples such as the expansion of Nord Stream, it is risky to rely on this.

In terms of LNG imports, in order to receive LNG on the Black Sea coast, it is necessary to pass the Bosporus strait, and it is said that the Government of Turkey is indicating disapproval regarding this matter. In order to avoid this, the only options are to liquefy Central Asian natural gas in Georgia or to import LNG received in countries such as Poland via pipelines.

2.5.2 Heat Supply

The challenges regarding the heat supply sector lie in improving efficiency. MRDBH estimates that natural gas consumption can be reduced 5.0 Bcm per year by improving the efficiency of heat production and consumption sector, and further 11.4 Bcm per year can be reduced if the efficiency of heat production and consumption sector will be reached to EU level.

(1) Raises in Prices and Meter Installation

The raising of heat supply prices and the installation of meters for each building (not each residence) are prerequisites in order to improve efficiency, and efforts toward these tasks have already begun. It is necessary for this to be accomplished according to plan.

(2) Facility Improvement and Modernization

In terms of heat supply facilities, deterioration is advancing both for boilers and for pipelines. It is thought that considerable water leakage is also occurring. The reason that sufficient facility renewal has not been conducted to this point is that investment funds have been lacking. Local authorities shoulder the heat supply business, and due to the nature of public services, prices have been kept low. It is thought that the heat supply price increases that are currently moving forward will break down this situation, and that room for investment toward renewal will be created for the business entities starting in 2017, when the cost recovery rates will be 100%.

When conducting facility renewal, it is important to pay heed to the fact that energy saving is advancing simultaneously. If the heat demand decreases due to energy saving, renewing to facilities that possess the same capacity as today will result in excessive capacity. In order to efficiently utilize heat supply facilities at a high rate of operation, it is thought that it will be necessary to reexamine the overall heat supply method, as mentioned later.

(3) Reexamination of the Heat Supply Method

District heating systems have developed in urban areas. In cases of high geographic density, this method is efficient. On the other hand, there are also aspects including the fact that heat transportation is not suited for supply over a large area, as there are generally large energy losses, as well as the fact that it is difficult to adapt this method to changes in aspects such as the structures and populations of cities. The spread of cities, the thriving of areas, areas in which many people live, business districts, and so forth change with the times. It is conceivable that the situations may be different from when the heat supply infrastructures were established, and it is also possible that the situation is such that the existing infrastructures are not able to be operated efficiently in the first place. For these reasons, it is best to closely investigate the degree of compatibility that the existing heat supply infrastructures have with their cities, and also, depending upon the city, to consider separating from a district heating system and switching to individual heating system. Conversely, it is also an option to systematically raise the densities of cities and to maintain a situation in which district heating systems demonstrate high effectiveness.

2.5.3 Coal

The challenges regarding the coal sector lie in diversifying the coal supply and demand structure and improving the efficiency of domestic coal mines.

(1) Diversification of the Coal Supply and Demand Structure

The most urgent task in Ukraine's coal sector is the presence of obstacles to anthracite supply for power generation. Ukraine is a country with coal resources. To this point, it has had a self-sufficient situation for thermal coal (mainly anthracite for power generation), and has relied on imports for coking coal. However, currently, there is a conflict with pro-Russian factions in the eastern region, the main coal mining area, and the production and supply of anthracite have dropped. Accordingly, Ukraine is getting by with imports from Russia and South Africa.[11] The country must wait for a political resolution to the conflict in the eastern region, and it is unclear when and in what way anthracite production will recover.

In Ukraine, the necessity for renewal regarding deteriorated coal-fired thermal power plants has risen, and a substitution from anthracite-fired thermal power to bituminous coal-fired thermal power is conceivable. For bituminous coal, there are diverse options for import countries, and the price is low. It will become necessary to strengthen the import infrastructure, but considering the stable coal supply in the mid- to long-term, an incremental substitution to bituminous coal is conceivable. In addition, while the resource is somewhat limited, there is lignite, whose use is also conceivable. In this way, it is necessary for Ukraine to diversify its supply and demand structure, which has relied on anthracite and the area of the eastern region, both in terms of coal type and in terms of area.

(2) Making Domestic Coal Mines More Efficient

In terms of structural challenges to be addressed, one can cite the low coal productivity of state-run companies and the reliance on subsidies. Relatively thin coal seams and underground mining are the root causes of the low productivity. In addition to these aspects, the protection of state-run companies through subsidies has spurred on a drop in productivity. In order to reform this structure, at the end of 2014, the Government of Ukraine abolished the subsidies for coal mines. A portion of

[11] From a meeting in July, 2015 with a responsible person at MECI. The imports of anthracite is planned from July to December. The quantity is not great, but the amount necessary for power generation has been secured.

high productive coal mines will likely survive through their efforts to help themselves, but there will likely also be coal mines that cannot avoid closure.

In the past, Ukraine has closed lignite mines. A social issue developed due to the country's failure to provide measures for the unemployed, and that issue has still not been resolved today. For that reason, politics and administrations have been passive with regard to closing coal mines to this point, but the critical situation at hand has spurred on political decisions. In the future, measures for those left unemployed after coal mine closures will be an important issue.

2.5.4 Electricity

Electricity is faced with the following challenges, by area.

(1) Power Generation

In the era of the former Soviet Union, Ukraine functioned as an electricity supply base for the surrounding countries that comprised the union. Accordingly, following its independence, Ukraine came to have excessive generation capacity. The challenge for Ukraine's electricity industry is the consolidation and modernization of its deteriorated and excessive facilities.

In addition, Ukraine's coal-fired thermal power plants are not installed with adequate equipment to prevent air pollutants (PM, SOx, NOx). As a part of its strengthening of the partnership with the European market in the future, it will be necessary to conduct environmental measures, such as exhaust gas treatment, in line with EU standards.

Further, as stated before, there is an unstable supply of anthracite, a fuel for coal-fired thermal power, and it is necessary to address this issue.

In terms of nuclear power generation, it is necessary to select contractors in order to advance the plans to add Units No.3 and No.4 to Khmelnytska. In the beginning, the Russian contractor Rosatom was selected, but that decision was completely revoked. The existing nuclear power plants are all made by Rosatom, and measures are needed in order to newly introduce Western technology.

For renewable energy, green tariffs were introduced in 2009, directed toward promulgation and expansion, but attention must be paid to the fact that purchasing prices are fixed in euros. This is an extremely favorable condition for investors, but depending upon the rate of promulgation and expansion in the future, this may lead to the imposition of an unanticipated economic burden.

(2) Transmission

Deterioration is also advancing in the transmission sector. According to "Energy Strategy of Ukraine to 2030," which was created in 2012, over 40 years have passed since 35% of the 220 to 330 kV overhead power transmission lines were built, and the designed operational period for the equipment on 55% of the substation has elapsed.

In addition, there is an issue in which, due to inadequate transmission capacity, electricity from nuclear power plants cannot be adequately sent to the areas such as the central and eastern regions. Ukraine's policy is to further increase the role of nuclear power generation as a main source of electricity in the future; in order to utilize nuclear power generation to maximum effect, it has become necessary to improve the transmission lines.

(3) Distribution

According to "Energy Strategy of Ukraine to 2030," which was created in 2012, it is necessary to repair or renew 31% of the distribution lines and 32% of the substations. Due to flaws in the low-voltage equipment, the voltage has deviated from the standards and is fluctuating. In addition, there are many cases in which electricity meters are not individually installed, creating a problem in which there are no incentives for consumers to save electricity.

2.5.5 Oil

Domestic resource development and the effective utilization of domestic refineries are challenges for the oil sector.

(1) Domestic Oil Development

In Ukraine, due to the difficulties of the depletion of large-scale oilfields, the absence of new oilfields resulting from lack of investment in hydrocarbon exploration in recent years, and low recovery rates, an increase in oil production cannot be anticipated in the short term. In addition, there were plans for deep-sea hydrocarbon exploration in the Black Sea with Oil Majors, but due to the control by Russia of eastern Ukraine, these plans were scrapped. As the exploration areas targeted for future development have harsh conditions, such as being at extreme depths, if Ukraine is to aim to increase crude oil production in the long term, it will be necessary to improve an investing environment in order to attract technologies and investments from overseas.

(2) Oil Refining

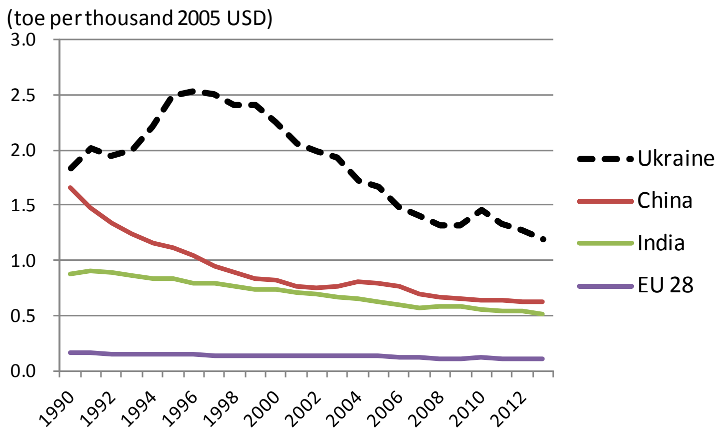
The refineries in Ukraine were constructed in the era of the former Soviet Union, and as there were not sufficient facility renewal investments following privatization, deterioration has advanced, and the oil products produced at these refineries have lost their price competitiveness compared to imported ones. As a result, of the 7 refineries, the only ones currently in operation are the 2 refineries of Kremenchuk refinery (0.36 million barrel/day), which is in the central region, and Shebelynka condensate refinery. The rates of operation for these refineries in 2014 were extremely low, at 6.5% and 40% respectively.[12]

The refineries are facilities in line with the characteristics of Russian crude oil, but currently, the supply of crude oil from Russia has ceased. In addition, in aiming for market unification with Europe, it will be necessary to comply with high standards of product quality, such as Euro-4 and Euro-5. Theoretically, domestic refining is preferable from the perspective of aspects such as the domestic economy and employment, but investment for renewal is necessary in order to operate the refineries.

2.5.6 Energy Efficiency

Compared to other countries, Ukraine's energy efficiency is extremely low, and the country has great potential to save energy.

The Figure 2.5-1 is one index used to depict energy efficiency. It shows a comparison of the primary energy supply per unit of GDP. According to this, looking at the primary energy consumption per unit of GDP (toe per thousand USD at 2005 prices, and the same hereafter), the economy has experienced a gentle recovery, and from the latter half of the 1990s, there has been a trend toward improvement. However, the 2013 primary energy consumption of 1.19 per unit of GDP is at an extremely poor level, even compared to countries such as China and India.



Source: Energy Balance of OECD, Non-OECD Countries 2015, IEA

Figure 2.5-1 Comparison of Energy Efficiency

12 Naftogaz, Annual Report 2014

Ukraine has the SAEE as a governmental agency that promotes energy saving and renewable energy. SAEE was established in April of 2011 through the unification of the National Agency for Efficient Usage of Energy Resources and the State Inspectorate for Energy Saving.

Legislation regarding the improvement of energy efficiency was enacted in 1994, but as the legislation does not fit with the actual conditions, revision work is being undertaken. At the time of writing this report, the revised bill has not been approved.

In November of 2015, the "National Energy Efficiency Action Plan until 2020", which aimed to reduce the final energy consumption by 9% by 2020, created by MRDBH, was approved by the Cabinet. The Action Plan estimates the necessary capital from each sector in order to realize the energy saving to be as shown below.

Table 2.5-1 the Necessary Capital to Realize energy saving

Residential:	UAH 670 billion
Buildings:	UAH 815 billion
Industry:	UAH 9 billion
Transport:	UAH 153 billion

Source: SAEE

In the implementation of energy saving measures, while carrying out aspects such as goal setting and management according to policy, it is important to incite consumers to voluntarily save energy. In this sense, the raising of energy prices and the installation of devices such as gas meters and heat meters are appropriate measures, and it is desirable that these be accomplished according to plan

3. Legal System and International Financing for Energy Sector

3.1 Legal System for Energy Sector

3.1.1 Legislation and Political System of Ukraine

The law and regulatory system of Ukraine extends back to Ius Civile (Roman law) of France and German Civil Code (Bügerliches Gesetzbuch) originated from the Hanseatic League. It also strongly influenced by the jurisprudence of former Soviet Union. In Ukraine, however, since there is no compendium similar to the Corpus Juris of Japan, it is necessary to understand the complicated legislation and administration regime of Ukraine to draft a legislative proposal.

The Constitution of Ukraine inherits the declaration of independence with the disintegration of the Soviet Union on August 24, 1991. The political system, based on the separation of powers of judicature, legislation, and administration, is parliamentary democracy (republican institutions) and is managed by presidential system and parliamentary cabinet system. The term of the president of Ukraine is 5 years and re-election beyond second term is restricted. There is no position for the vice president and the prime minister temporarily fills in for the president if the position is vacant.

Although the presidential system of Ukraine is Semi-presidential system, similar to France and Russia, the president virtually does not have the right of dissolution of the congress referred to as Verkhovna Rada (Supreme Council), unlike the countries. The appointment of the Prime Minister is subject to the concurrence of Verkhovna Rada while the resolution of the resignation of the Cabinet adopted by Verkhovna Rada is compulsory for the President.

Verkhovna Rada is unicameral with 450 seats. All the representatives are elected from nation-wide proportional system and if a political party fails to win at least 3% of the ballot of the precinct, the party cannot win even one seat. The term of the representatives is 5 years. The Congress is qualified for enactment, ratification of a treaty, state budget resolution, and appointment and dismissal of prime minister and cabinet ministers.

The Cabinet of Ukraine is the outstanding governmental administration is responsible to the President and the Congress. The Prime Minister is nominated by the President and appointed with the consent of a majority of Verkhovna Rada. The Cabinet consists of the Prime Minister, the First-Deputy Prime Minister, 3 deputy premiers, and the state ministers.

The state administrative organization of Ukraine is composed of 15 ministries (as of January, 2016) under the prime minister while the state ministers are appointed by the President based on the nomination by the prime minister.

3.1.2 Central administrative agencies of Ukraine

Interior/ Foreign Affairs/ Defense/ Justice/ Finance/ Emergencies/Health Security/ Infrastructure/ Education and Science Youth and Sport/ Economic Development and Trade/ Ecology and Natural Resources/ Energy and Coal Industry/ Agrarian Policy and Food/ Social Policy/ Regional Development, Building and Housing.

3.1.3 Ukrainian law classification

Civil Law (family law, inheritance law, contract law, commercial law, obligation law, asset law, intellectual property law, company law, land law, Civil Procedure law) tax law, criminal law, criminal procedure-administrative law, international law (Ukraine Constitution agrees the international agreement that has been ratified by the Supreme Council to apply as part of the Laws of Ukraine.)

3.1.4 Hierarchy of laws and regulations of Ukraine and decision procedure

[Law of Ukraine] initiated from the Cabinet of Ministers or Council members to be enacted by the approval of the Verkhovna Rada (Supreme Council)

[Decree of President] issued by the instruction of the President in the case of emergency

[Order of Cabinet] instructed by Cabinet to be enforced by the approval of the Prime Minster

[Detailed rules (Regulation/ Instruction)] instructed by Minister or by the approval of the head of the oblast or autonomous region

Local administrative agency can also establish the rules by the recent framework law. The laws and rules promulgated in the official daily newspaper called Holos Ukraine, will enter into force from the next day.

3.1.5 Regulations relevant to infrastructure construction

Apart from the law, following regulations exist in Ukraine and they are applied to facility of energy sector.

[EU Directives and Regulations] Concerning EU directives and regulations, the Energy Community Treaty (EnCT), and the Energy Community's legal framework (3rd Energy Package) concluded between EU and Ukraine in 2011 have not yet been implemented, but were due to be implemented from January 2016.

[DBN (State Building Codes)] Of the building codes applicable to civil engineering and construction, and civil engineering work in Ukraine, strict standards are applied to firefighting, disaster prevention and building strength in particular as compared to other countries, and care is required in energy-sector construction and reconstruction work.

[SOU (Ukraine State Technical Standards) Technical Standards for Industrial Machinery and Facilities] As state technical standards that comply with EU technical standards, care is required with standards for environmental regulation, frequency stability and permissible values for load fluctuation.

[UkrSEPRO (Ukraine State Certification System)] The UkrSEPRO certification system introduced by the Governmant of Ukraine in 1993 was given approval under the Government No. 1585 on October 7, 2003. At first it was operated under "voluntary certification," but products requiring obligatory certification were designated under No. 446 on May 14, 2008. A certificate of conformity is required at the time of obtaining customs clearance when products are exported to the Ukraine domestic market. Under "State Committee of Ukraine January 2, 2005 N28," a list of items for which UkrSEPRO certificates are mandatory was published. However, the items listed are mainly general-use products and products for mass consumption, and many F/S-certified energy-sector-related products are not listed.

[GOST (Former Soviet Union Electrical Equipment Safety Standards)] Since the changeover to UkrSEPRO is incomplete, in the area of electrical safety standards, conformity with former soviet standards is required. In particular, in the energy sector there are no products subject to UkrSEPRO, and in some cases instrumentation and control equipment is subject to GOST, therefore care is required when importing single items of electrical equipment.

3.1.6 Major laws and regulations related to energy and electricity

The most important issues of energy and electricity-related laws and regulations in Ukraine, is to realize the request from the EU. However, some cases to directly apply EU requirements, sometimes it is established with the Ukrainian law and regulations with a slight time lag.
Table 3.1-1 shows principal Ukrainian legislation and the EU request to the energy field such as Thermal power generation, hydroelectric power generation, district heating and biomass and waste energy generation for the purpose of compliance with the EU requirements in Ukraine.
See Appendix, List of Laws and Regulations related to Energy Sector in Ukraine.

Table 3.1-1 Principal laws and regulations related to energy and electricity

Ukrainian Laws and Regulations	EU Directive
➢ The Protocol of joining the Energy community treaty by Ukraine ➢ Order No.733-p of the Cabinet of the Ministries of Ukraine 'On approval of the action plan for implementation the obligations under the Energy Community Treaty establishment', dated 3.08.2011, amended on 7 Oct, 2015 ➢ Order No.1080-p of the Cabinet of the Ministries of Ukraine 'On signing an additional agreement No.1 between Ukraine and the European Union, represented by the European Commission, on amending the Agreement on financing the program "Continue to support the realization of the Energy Strategy of Ukraine", dated 20 Dec, 2013', dated 13 Oct, 2015 ➢ Order No.671-p of the Cabinet of the Ministries of Ukraine 'On the launch of the pilot project "Energy Bridge "Ukraine - European Union", dated 15 Jun, 2015 ➢ Law of Ukraine "On operating principles of the electricity market of Ukraine"	➢ Directive 2001/80/EC of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants ➢ Directive 2006/32/EC of 5 Apr, 2006 on energy end-use efficiency and energy services 407 ➢ Directive 2009/28/EC of 23 Apr, 2009 on the promotion of the use of energy from renewable sources ➢ Directive 2009/73/EC of 12 Jul, 2009 on common rules for the internal market in natural gas and repealing ➢ Regulation (EC) No 715/2009 of 13 Jul, 2009 on conditions for access to the natural gas transmission networks

Source: JICA Study Team

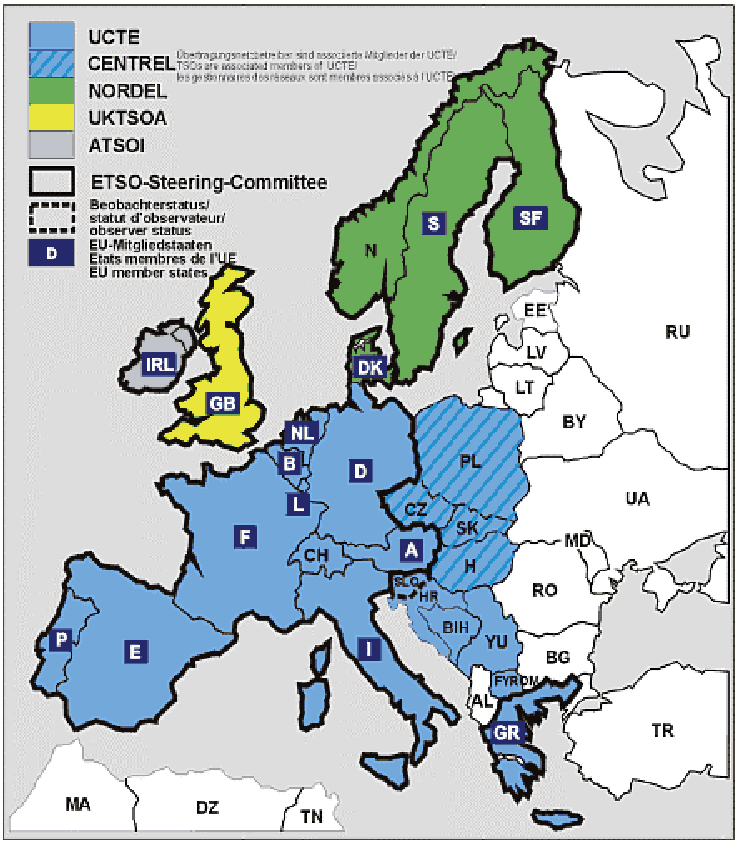
3.2 Laws and Regulations for Renovation and Installation of Electric Power Facilities

As shown in Table 3.1-1 Principal laws and regulations related to energy and electricity, laws and regulations which are applied to rehabilitation and/or new construction of power facilities in Ukraine have been prepared for the purpose of satisfying the EU requests sooner rather than later. Ukraine intends the implementation of measures featuring the modernization of turbines, improved load following capability and the environment to meet the conditions necessary to link to the ENTSO-E which is a pan-European power network. Further details are described later in Table 5.5-1 Major laws and regulations related to thermal power generation and Table 6.3-2 Major laws and regulations related to transmission and distribution equipment.

3.2.1 EU requirements for frequency stability and load tracking capability

European Network of Transmission System Operator for Electricity (ENTSO-E) is established on December 19, 2008 at Brussels by the agreement of the electricity distributing companies (TSO). The purpose is to centralize the power trading and power standards in the EU countries and to control over the whole of power electricity network. However, the network at each location is still managed by a conventional power transmission system shown in Figure 3.2-1. CENRAL adjacent to Ukraine was separated from the former Soviet Union and connected to the European electricity network, but is regulated by the Union for Coordination of Transmission of Electricity (UCTE) standards.

Therefore, frequency stability and load tracking capability of the power system of Ukraine is requested coincide with UCTE standard. Details of requirement is described in “5. Thermal power generation sector”.



NORDEL (Nordic Electricity Conference)

AC Network of Nordic 3 Countries and Denmark

Max. Power : 53,400 GW

UCTE (Union for Coordination of Transmission of Electricity)

AC Network in Central Europe (Currently Isolated Greece)

Max. Power : 276,400 GW

Ukraine Electricity Network

Max. Power: 55,000 GW

(20% of UCTE)

(Ref.) Japan Electricity Network

Max. Power: 287,330 GW

Source: ENTSO-E Electricity in Europe 2014

Figure 3.2-1 Power Electricity Network in Europe

3.2.2 Legal procedures and steps of repair and installation of power facilities

Figure 3.2-2 shows the business flow to obtain the approvals required for the repair and new construction of power facilities in Ukraine. After the stage of the business planning with F/S and design, the examination by the state certification test expert and understanding of design specifications by the Town Master Planning Authority are required.

Following the detailed design, the hearing by the relevant authorities and the approval of the power company are required before start of construction. In addition, the construction permits by the state certified construction qualified personnel is required.

During the construction stages, the permission by application forms and approvals by the respective operators are required before the outside connection of power and other utilities. These certification, licensing construction should be presented to the construction contractors together with the purpose of construction, design, manufacturing, inspection and installation documents showing other business activities that are carried out under contract, before the relevant start of construction. After completion of construction, the permission by the relevant Energy Market Company is required before the connection to the power system together with the construction complete Reports.

- About Expert Examination

  For implementing comprehensive state expertise of construction projects State Enterprise "Ukrderzhbudekspertiza" under the Ministry of Regional Development and Construction of Ukraine is the responsible authority.

  Main activity and target of SE "UkrDerzhBudExpertise" is state complex examination of investment programs and construction projects , and expert conclusion according to specialized areas what are the parts of comprehensive conclusion.

  Official web site of the company is http://ukrbudex.org.ua/ (only Ukrainian)

- About Town Maspter Planning Authority

  This law defines the legal, economic, social and organizational basis for urban development in Ukraine and is aimed at the development of adequate living environment, while ensuring the protection of the natural environment, environmental management and preservation of cultural heritage. Law "On the Principles of Town Planning" No.2780-XII of 16 November 1992

  Town Master Planning Authority is placed in central government or local government, with the following mission.

  - Implementing urban policy of Ukraine
  - The development of national, international urban programs and project
  - Implementation of fundamental and priority of research on urban development, preserve the traditional nature of the environment and human settlements research and restoration work

Exam. and Approval

1. Feasibility Study of Investment (FS)

- Initial Data for Development

2. Design

- Initial Data for Development
- Inititial Data for Designing
- Brief specification of the Construction （Note1)
- General layout and Transport

- Architectural Solutions & Organization
- Cost Estimating Documentation
- Evaluation of Environmental Effect

3. Expert Examination

- Agreement Requires Insertion about Construction in Newspaper
- Expert Opinion of Inspector of the State Emergency Service of Ukraine
- Expert Opinion of Inspector of the Sanitary Preventative Disinfection Department
- Expert Opinion of Inspector of the Ministry of Ecology and Natural Resources of Ukraine
- Expert Opinion of Inspector on Energy Saving
- Mandatory Requirement Specifications for Broadcasting System (if any)
- Agreement of Deesign with Oblenergo (Regional Energy Company)

4. Agreement of Town Master Planning Authority

- Positive decision of the Town Master Planning Authority

5. Detailed Design

- General layout and Transportation
- Architectural Solutions. Main building
- Chimney

- Waste Removal
- Cooling Tower
- Recycling Water Supply

- Fuel Supply
- Fire-Safety Measures
- Cost-Estimation Documentation
- Automatic Control System

6. Approval of Detailed Design

- Obtaining Opinion of the State Emergency Service of Ukraine
- Obtaining Opinion of the Expert-technical Center
- Agreement of Oblenergo (Regional Energy Company)

7. Permitssion for Construction

- Obtaining permit for construction in the State Architectural and Construction Committee (GASK)

8. Construction Works

9. Permission of Connection for Outside Utility Lines

- Obtaining Permission for Outside Utility Lines (Power, Gas, Water)

10. Commisioning & Adjustment

- Commissioning and Adjusting Works
- Construction Completion Reports

11. Permission for Power Transfer

- Obtaining Permission of Energy Market Company

Note1: Contents of Brief specification of the Construction

Source: JICA Study Team

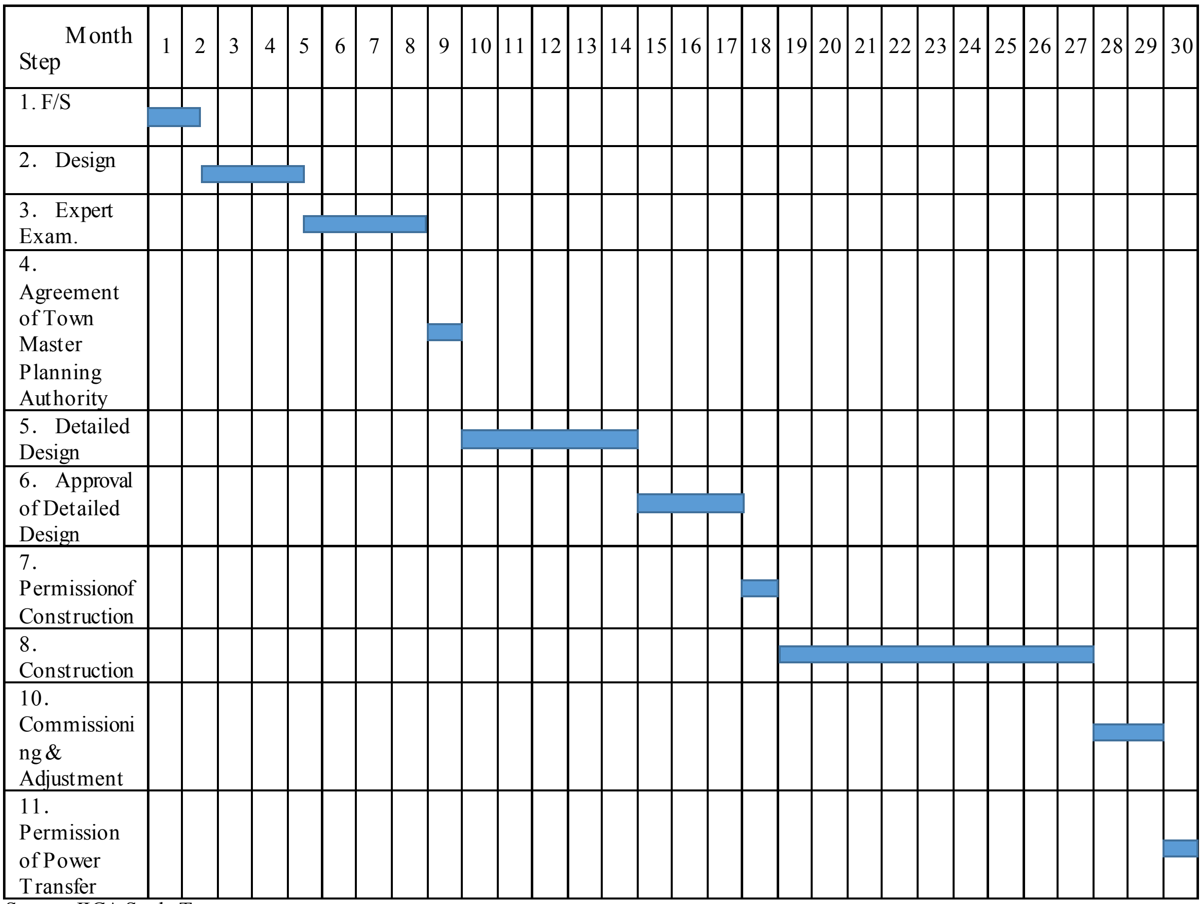
Figure 3.2-2 Flow of the approvals for renovation/installation of power facilities

Following materials are used to outline the project the flow of the approvals as above.

- Brief specification of the construction object and its composition
- Data of engineering surveys
- Result of F/S
- Information on need in resources
- Information about phases of construction
- Solutions and indicators on General layout, utilities
- Information about engineering protection of territories
- Labor protection
- Civil defense measures
- Provision of reliability and security
- Identification and declaration of safety of high-risk sites
- Estimate of economization of implementation of energy saving technologies
- Work scope bill
- Estimation of consequences class and difficulty category

3.2.3 Legal procedures and steps of repair and installation of power facilities

Figure 3.2-3 shows the business flow to obtain the approvals required for the repair and new construction of power facilities in Ukraine. After the stage of the business planning with F/S and design, construction period for around 18 months or more should be considered. (Due to the significance and priority order, construction period could be shortened)



Source: JICA Study Team

Note: Period of "8. Construction" is dependent of project schedule (9 months as above for exemplification)

Figure 3.2-3 Expected period for licensing for renovation/installation of power facilities

3.3 International Financing for Energy Sector

3.3.1 Scheme of the international financing for repair and new construction of power facilities

Repair and new construction of electric power facilities using the financing of donors, including the EBRD for the purpose of energy conservation and modernization will simplify Figure 3.2-3 in some cases.

Sovereign guarantee acquisition procedure for international financing will be applied after "STEP 4. Agreement of Town Master Planning Authority" in Figure 3.2-2 and the loan application will be submitted to the Cabinet of Ministers through the related Ministry from involved state-run enterprises. The loan becomes enable by approval of Supreme Council consequent from the Cabinet of Ministers decision and Ministry of Finance will sign the loan agreement.

In the case of the national loan, the Minister of Finance of Ukraine is the official representative of the borrower (Ukraine), Ministry of Energy and Coal Industries (MECI) are both responsible for payment and execution.

The sub-loan agreement will be signed by Ministry of Finance, MECI and the National Commission for Regulation of the Electric Power Sector (NCRE) to promises the specific performance for the implementation and success of the project.

In addition, in the case of financingto local cities, MRDBH will propose to the Cabinet of Ministers of Ukraine as a responsible Ministry.

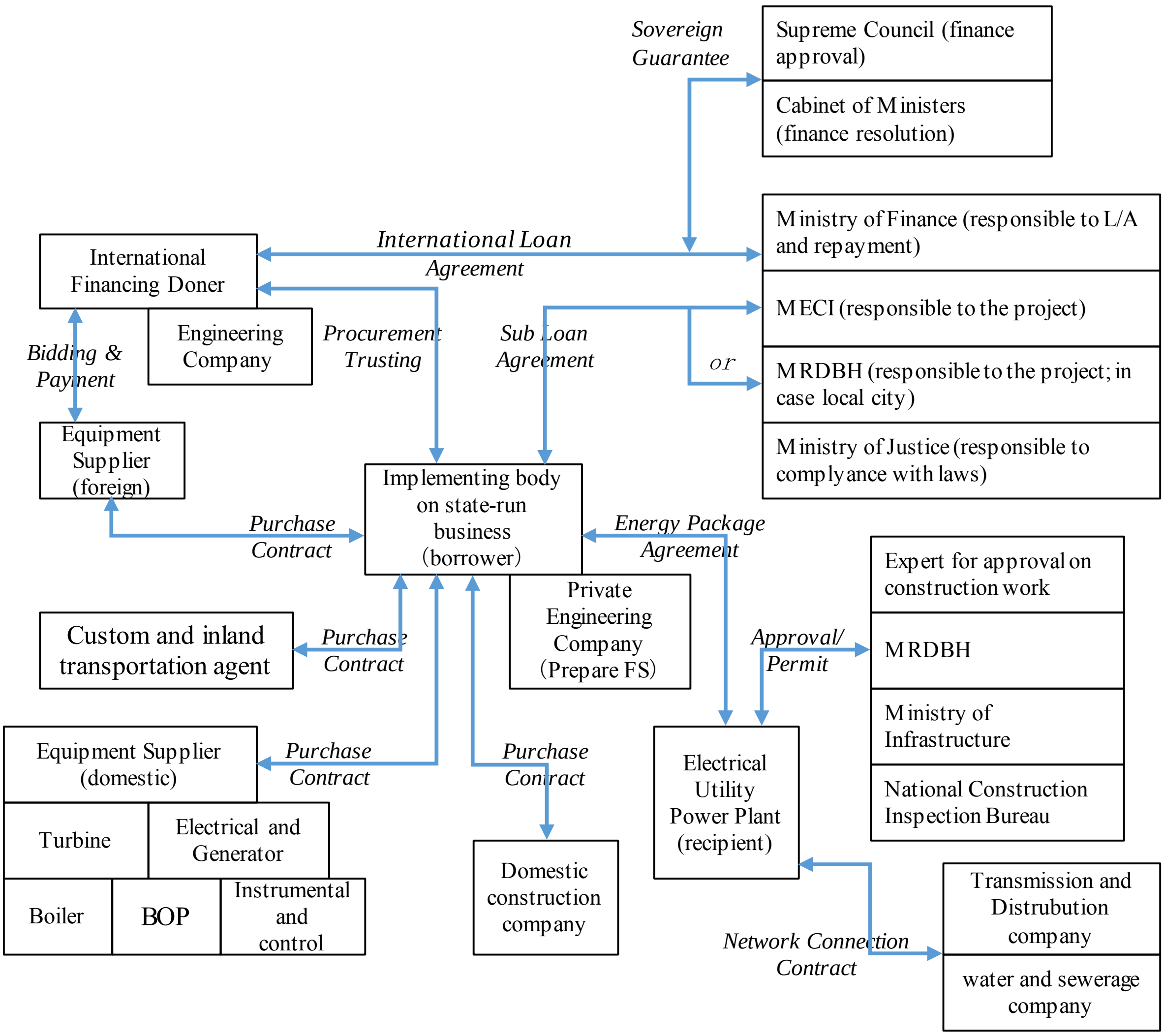
Ukraine Ministry of Justice must give legal status by public notice for the sub-loan agreement ratified between the official borrower (the Government of Ukraine) and the promoter to impose the obligation such as financial audit and legal binding such as specified money usages.

In addition, the promoter must submit detailed reports such as implementation plan of the project and schedule to Ministry of Finance, MECI and NCRE.
It should be noted, these national investment projects should be required by the inspection and approval by the national inspection Institute (Ukrderzhbudekpertiza) at the STEP of 3. and 7. in Figure 3.2-2. There is a possibility that the examination period extends further, therefore a preferential guideline from the higher-level ministries and agencies is recommended.

In order to execute a national loan, the borrowers or the promoter should be a state-run enterprise. However, currently Ukraine has reached to the loan amount limit from IMF, and IMF requests the reduction of national assets (liabilities) by the privatization of state-run enterprises to accept more loans.

Therefore, it must be kept fully grasp the privatization trend of state-run enterprises of Ukraine to plan the international financing. (See “2.4.2 Privatization of State-Run Companies”)

Figure 3.3-1 shows the scheme of the governmental guarantee financing to the repair and new construction of power facilities in Ukraine.
If the promoter is state-run 99% or more, the agreement of relevant ministries and SPF is necessary before the sovereign guarantee application to the Cabinet of Ministers. In addition, it is also possible that the power company itself becomes a promoter.



Source: JICA Study Team

Figure 3.3-1 International Financing Scheme for Renovation/Installation of Power Facilities

3.3.2 Procedure to authorize as national project in Ukraine

(1) Procedure

The procedure necessary for the project funded by International donors mentioned as below.

1) F/S application from the drafter
2) Approval of related ministries who controls the implementer or recipient and agreement by relevant ministries
   (The relevant ministries including the MEDT, MRDBH, Ministry of Finance and the Ministry of Justice)
3) Inquiry to International donors from Ministry of Finance
4) Confirmation of availability of financing from International donors
5) Application to and approval by the Cabinet of Ministers of Ukraine
   (All investment UAH 4 million or more requires the approval of the Cabinet of Ministers.
6) Deliberation proposals to the Supreme Council from the Cabinet of Ministers and resolution of Supreme Council
7) Presidential approval

(2) Eligibility requirements

The following law indicates the conditions for international financing to a national investment project in Ukraine. "The Law of Ukraine On the Regime of Foreign Investments, as amended according to Laws of Ukraine, N 997-XIV of July 16, 1999, N 1807-III of June 08, 2000, N 762-IV of May 15, 2003." The projects must satisfy one of the following.

- Meeting the International Technical Aid (ITA)
- Meeting separately approved bilateral government agreement
- Project for State-run enterprises or the local government approved as a state budget

(3) ITA compliance

According to the agreement between the United States and Ukraine the materials and goods for the international technical aid are exempt the customs tax, import VAT. Reference laws and regulations: "The Intergovernmental Agreement On Technical Assistance and Grant Aid" (Intergovernmental Agreement) concluded on 10 June 2004 (ratified by Ukraine on 1 July 2004).

Under this agreement, the following information in "Registration Card" can make resolution of the Supreme Council as the annual state budget by application from MEDT.

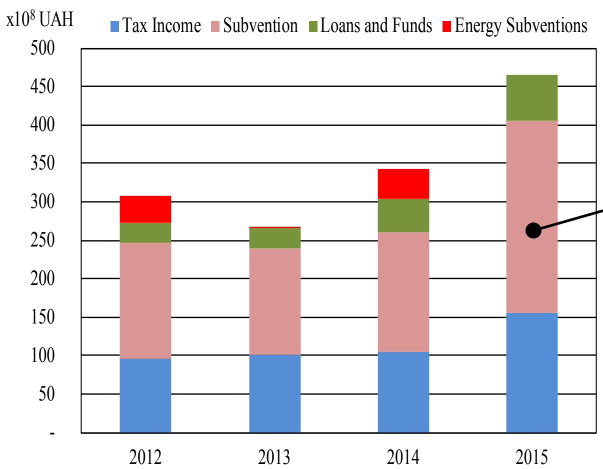
- Donor name, borrowers name, practitioner name, recipient name and beneficiary name
- Memorandum of Understanding (MOU)
- Partnership agreement among donor, borrowers and practitioner

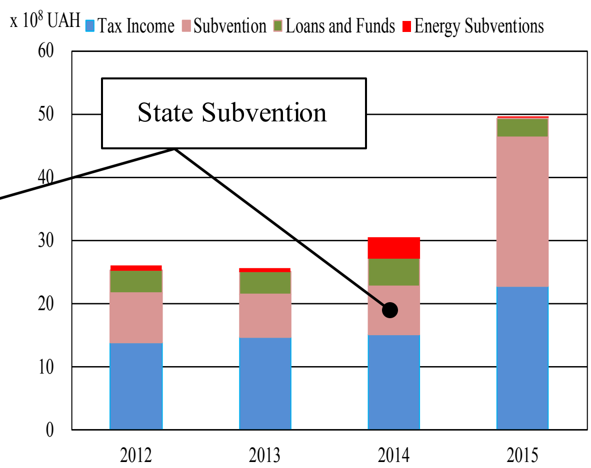
- Business sharing table (TOR)
- Products list subjected to Project and services list (Procurement Plan)

3.3.3 Sovereign guarantee acquisition for local government project

In recent years EBRD and WB are doing the financing to the local government as a recipient of international loans with the local governmental guarantee.
However, if they meet the conditions of sovereign guarantee, there is a case in which obtained a sovereign guarantee. In this case lending money is allocated to the local government from the state in the name of state subventions.

For example, the revenue breakdown of local government, the capital Kyiv and a typical provincial city Lviv city, shown below Figure 3.3-2 and 3.3-3.





Source : JICA Study Team

Figure 3.3-2 Revenue of Kyiv city

Figure 3.3-3 Revenue of Lviv city

Both cities have considerably large portion of State subvention in the city revenue. In addition, there is also income from the loan by local governmental guarantee.

While the bank financing of Ukraine applies 16 to 18% of the loan annual interest rates in 2015, and also expected 30% future policy interest rates, the bank loan cannot be used in such public works. The state subvention is paid in the year depending on the specific purpose which is accepted as the state budget of sovereign guarantee. MRDBH as a related Ministry of the local government will proceed to obtain the sovereign guarantee. (For example, Bortnichi sewerage treatment station renovation project)

Following Table 3.3-1 shows the process to obtain the sovereign guarantee on the project of the local government for International Finance Institutes (IFI) which was suggested by Dnipropetrovsk city. The city obtained the sovereign guarantee for the elongation of Metro from EBRD and EIB. It was taking, however, 2 years since the first experience.

Table 3.3-1 Preparation for Sovereign Guarantee of the investment project supported by the international financial institution
(Refer to Order of the Cabinet of Ministers of Ukraine from January 27, 2016 No.70)

No.	Item	Period (Days)
1	The initiator (City Council) provides the project proposal to the Ministry of Finance	-
2	The Ministry of Finance estimates the correspondence of the proposal (2 days) and the financial position of the beneficiary (20 days)	22
3	The Ministry of Finance refers to IFI	3
4	IFI provides the confirmation of the project support	-
5	The Ministry of Finance decides on the feasibility of the project and informs the Cabinet of Ministers, the initiator, the executive officer and MEDT	3
6	The executive officer defines the project coordinator, prepares the action plan and submits the expenditures proposals to the Ministry of Finance that will be made at the expense of IFI	14
7	IFI sends the draft agreement between Ukraine and IFI	-
8	MEDT prepares and approves the documents necessary for negotiations, including the financial and economic assessment with the Ministry of Finance, the Ministry of Foreign Affairs.	10
9	IFI sends the invitation for negotiations	-
10	The executive officer sends the documents required for negotiations on approval to the Cabinet of Ministers.	-
11	The Cabinet of Ministers of Ukraine takes an act of attracting financial resources the IFI, brings the proposals on the negotiation and signing of the contract to the President of Ukraine	-
12	President of Ukraine adopted the act of negotiating with the IFI	-
13	Negotiations with the IFI	-
14	Provision the protocol and the report of negotiations and to the President of Ukraine, copies to the Cabinet fo Ministers of Ukraine, copies to the Ministry of Finance, the Ministry of Foreign Affairs by the delegation	10
15	The IFI sends notification of the project approval and loaning	-

No.	Item	Period (Days)
16	The signing of the agreement between Ukraine and the IFI, the beneficiary and the IFI	-
17	The executive officer concludes a sub-loan agreement with the Ministry of Finance	14
18	The executive officer submits the copy of the agreement and the translation to the Cabinet of Ministers of Ukraine, the Ministry of Justice, the Ministry of Finance and MEDT	7
19	The Ministry of Finance informs the Ministry of Justice about the state budget anticipation loans	7
20	The Ministry of Justice prepares the conclusion on the procedure of entry into force of the agreement and sends it to the executive officer and the IFI	-
21	The executive officer submits the agreed proposal on agreement ratification with the Ministry of Finance and Ministry of Justice to the Ministry of Foreign Affairs to the Cabinet of Ministers	14
22	The Cabinet of Ministers submits proposals for ratification to the Supreme Council and ask President of Ukraine signing.	-
23	After ratification, the Ministry of Justice directs the legal conclusion on the ratification of the agreement to the IFI, a copies to the Cabinet of Ministers, the Ministry of Finance, the Ministry of Foreign Affairs and the executive officer	10
24	The IFI sends notification of entry into force of the agreement	-
25	The Ministry of Finance informs about the entry into force by the agreement of the Cabinet of Ministers and the executive officer	7
26	The executive officer directs the original agreement with the notification of entry into force of the agreement enactment to the Ministry of Foreign Affairs (2 weeks) and prepares an action plan	14
27	The beginning of the project	-
Required Period (Except for unknown period “-”)		135

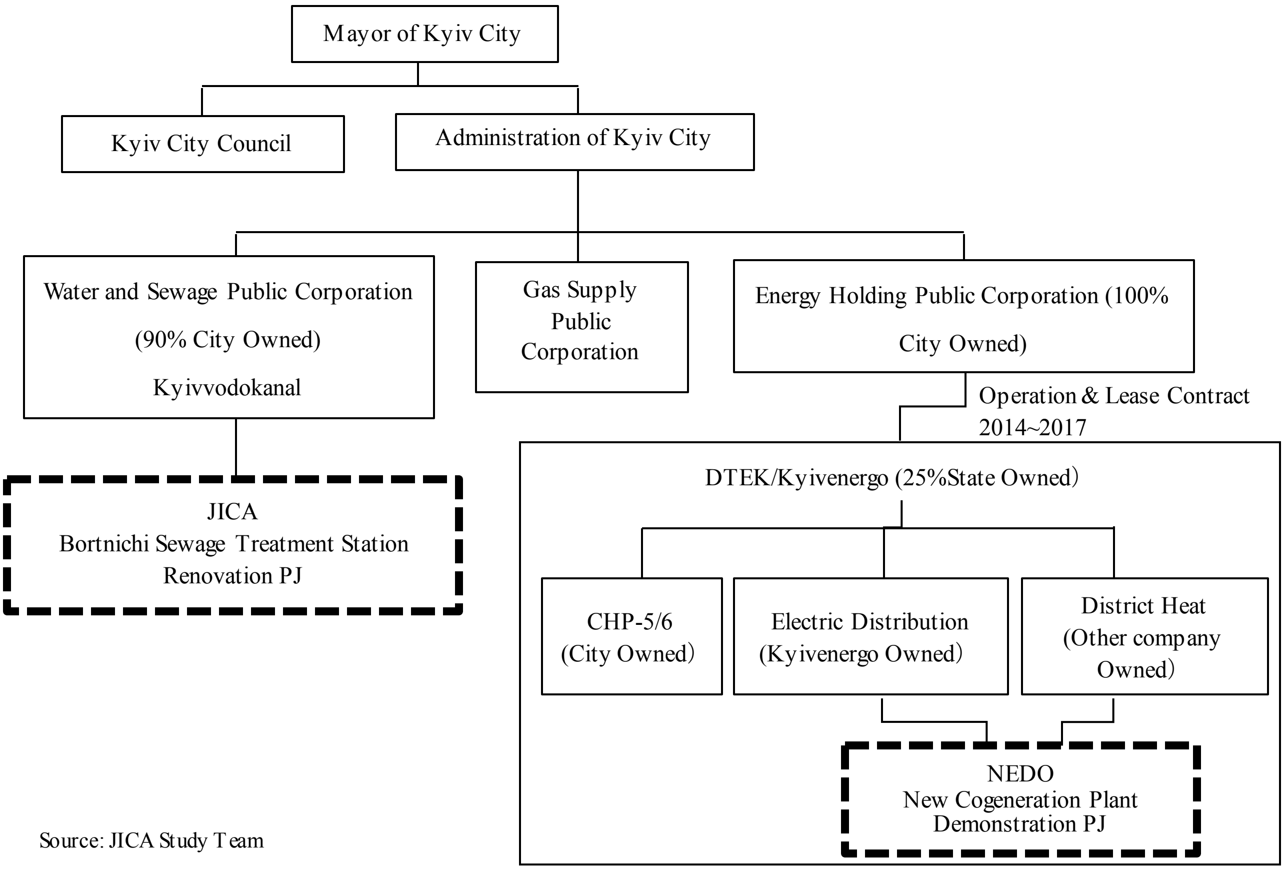
Source: JICA Study Team based on information from Dnipropetrovsk

3.3.4 Organization of Kyiv city and projects funding from Japan

In both Kyiv city and Sevastopol city, which are treated with special status, state subvention has been a large number of budget.

In Kyiv city currently following projects (1) and (2) are in progress as Japan support. Considerations on these cases are good benchmark in planning the financial support from Japan to the provincial cities in the future.

Figure 3.3-4 shows a relationship between business structure of the Kyiv City in 2 projects.



Source: JICA Study Team

Figure 3.3-4 Kyiv city business system (energy and sewer relationship only)

(1) Bortnichi sewage treatment station renovation project

JICA and Ukraine signed a yen-loan agreement totaling up to JPY 108.193 billion on June 15, 2015. It has been certified as a sovereign guarantee.

By carrying out the new construction and renovation of Bortnichi sewage treatment station, Kyiv city aims to improve the health and living environment improvement of the citizen. Project is scheduled to be completed in September 2022.

(2) New cogeneration plant demonstration project

In 2015 to 2016, New Energy Development and Industry Technologies Organization (NEDO) has proceeded the Project which improve the efficiency and environmental load by the Japanese technology in the district heating plant to the Kyiv city which is operated by Kyivenergo.

The major difference in the 2 projects Bortnichi sewage treatment plant is the asset of Kyiv city, and the new cogeneration plant demonstration project is NOT the asset of Kyiv city.

In addition, the new cogeneration plant demonstration project has privatized DTEK / Kyivenergo to the contract partner, while Bortnichi sewage treatment plant renovation project has the Kyiv Public Corporation. Therefore, the new cogeneration plant demonstration projects will be difficult to obtain a sovereign guarantee, and the tax exemption, including the transfer at the time of the completion of the project have to say difficult to accomplish.

In addition, the operation and lease contract between DTEK / Kyivenergo and Kyiv Public Corporation becomes mature in the end of 2017 and in order to suppress the involvement of Oligarchs to the public business is likely not to be extended which will increase the difficulty of the project promotion.

(3) Modification project at Energia waste incineration plant financed by Green Investment Scheme

Through Green Investment Scheme executed between the Government of Ukraine and the Government of Japan under the Kyoto Protocol in 2009, F/S regarding modification at Energia waste incineration plant in Kyiv had been conducted since 2012. The past Yanukovych Administration requested a consortium leader, ITOCHU Corporation to conclude the possibility that 2 new treatment lines would be constructed after the demolition of 2 out of existing 4 treatment lines. However, after the kicking-off, the new cabinet organized after change of power in Ukraine concluded that this project should not be treated as Green Investment Scheme project. This project is still left undiscussed.

3.3.5 Other projects supported by Japan

Technical assistance from Japan toward Ukraine is/was being conducted as follows.

(1) Grobal Environmet Centre, “Ministry of Environment offerred project, “CDM/JI survey” ”

F/S looking for future potential CDM/JI project under the Kyoto Protocol was conducted to gain CO_2 credit.

- F/S on recycling an organic waste discharged from livestock, Japan PFI Association (NGO), 2001

- F/S on methan utilization generated from Lugansk City landfill disposal, SIMIZU Corporation, 2004
- F/S on recovered methane generation collected from sewage treatment in Kyiv, SIMIZU Corporation, 2005
- F/S on methan utilization generated from Zhytomyr city landfill disposal, SIMIZU Corporation, 2006
- F/S on methan utilization generated from Bila Tserkva city landfill disposal, SIMIZU Corporation, 2007

(2) METI, F/S on Ultra-Super Critical Coal-Fired Thermal Power Project at Dobrotvirska TPS in 2013

ITOCHU Corporation and Tokyo Electric Power Services Co., ltd. conducted F/S to construct an ultra-super critical plant (1 x 600 MW) on the exisiting premises of Dobrotvirska PS in Lviv oblast, offerred by Ministry of Economy, Trade and Industry, Japan (METI) . This project was targetting for the introduction of the said proven technology to have already established in Japan and the entry of Japanese companies into Ukraine, as well as the reduction of green house gas like CO_2.
DTEK, who is the owner of this power station, is still looking for an investor for this project when the Study Team visited the company to collect information though this survey.

(3) JCOAL, the diagnosis project for Coal-fired thermal power plant in 2014

JCOAL, who was offered by JCOAL, had conducted the diagnosis work for efficiency improvement at deteroriated coal-fired power stations, Trypilska and Burshtynska. The Study Team suggested effective proposal for efficiency improvement and reduction of environmental load. In addition, turbine inspection was also conducted during removal of upper shell of turbine rotor at its periodical inspection. This is a pre-acitivity for following demonstration project on steam turbine modification.

<Activities>

- General Diagnosis and Inspection after removing the turbine shell
  - Pre-survey at Centrenergo/ Zmiivksa PS (June, 2015)
  - Inspection after removing the turbine shell at Centrenergo/ Trypilska PS (October, 2015)
- Examination on Fuel Conversion
  - Collaboration and Opinions exchange with CETI

(4) JICA “Demonstraion Project on biomass pellet production plant and its boler in Ukrane”

The heat supply,especially in winter, through heat pipelines has been well-developed across the country. The local administration generally supplies the heat generated gas-firing to public facility and households via municipal utility company. However, the price impoted natural gas is very expensive and affected by the poiltical condition. The national policy of Ukraine requests the local bodies to make an effort to lower the dependence of natural gas. Under the circumstance, Asuka Green Investment Co., Ltd. took a lead and demonstrated the effective business to introduce biomass-derived pellet production and its boiler granting for Kharkiv heat supply municipal company in eastern Ukraine, targeting for fuel conversion from natural gas to biomass fuel. This project was conducted from November 2003 to September 2015.

(5) NEDO “The demonstration project in enhancing the efficiency of Steam Turbine”

To reduce emission of carbon dioxides at obsolete power plants in Ukraine, by installing well-experienced and technically-proven Steam Tubine manufactured by Japanese company. This project was conducted from November 2015 to March 2016.

<Activities>

- Pre-survey
  - Steam turbines at Centrenergo/ Trypilska Power Station was designed about 40 years ago. This plant is going for aging even now. The pre-survey was conducted to replace the aged turbine with the steam turbine equipped the latest technology.

3.4 Outline of supports provided by other donors

3.4.1 EBRD

EBRD is one of the largest donors to support Ukraine and have invested in or financed 363 projects and EUR 11.64 billion in total (the figure is based on commitments and actual amount put in is EUR 8 billion) as of April 1, 2016. The basic policies of EBRD with regard to support for Ukraine include the nation’s reform for better transparency and improvement of the business environment. With such notion, EBRD promotes projects that improve energy efficiency, or help achieve low carbon energy and energy security.

The energy efficiency improvement and low carbon energy are pursued through the rehabilitation/reinforcement of the District Heating (DH) facilities and the introduction of wind power and biogas. For the energy security improvement, EBRD actively assists the transmission field with the view to integrate the energy markets of Europe and that of Ukraine. EBRD’s support also includes the modernization of Ukraine’s gas transportation and distribution system as well as the

reorganization of Naftogaz. The latest support offered by EBRD in the transmission field is explained in "6.1.4 (3) Supports of Donners related to the Development Plan for 10 years."
One of the characteristics of EBRD's support framework is that the govenemtal guarantee from Ukraine is not always requested for loans. For example, the governmetal guarantee was obtained through MECI for the support in the transmission field since the facilities belong to Ukrenergo under the supervision by MECI. However, it offers support in the DH field by financing the projects based only on the guarantee by the province or city, or so-called sub sovereign guarantee.
EBRD also offers financing to private companies in addition to public project companies managed by the Government or the City. So far, 53% of the investment and loan to Ukraine was for the private sector. It offered a USD 60 million loan to a private company in 2014, to modernize the export facilities in the port of Odessa which facilitate 95% of Ukraine's grain export, which became the subject of the talk. According to SPF, it welcomes the private loans from EBRD as a force to promote the healthy privatization of state-run companies. As a step towards privatization, Centrenergo's share has been transferred to SPF. SPF is willing to actively utilize the support from international financial institutes including EBRD to cover the fund needed after Centrenergo is privatized.

EBRD also offers long-term loans and equity funds along with technological support to the banking sector in order to enhance the stability of the financial sector. It works with other donors to improve governance and to diversify the financing sources including the local currency on a long-term basis. Table 3.4-1 lists the major support activities by EBRD in the energy field.

Table 3.4-1 Major support projects by EBRD in the energy field

Unit: Million

Date	Project ID	Project Title	Topic	EBRD Finance		Public/ Private	Status
Oct.9, 2015	47355	Karpatskyi Wind Farm	Electricity	8	EUR	Private	Passed concept review, Pending final review
Aug.13, 2015	47359	Chernivtsi District Heating Project	District heating	7	EUR	Public	Passed concept review, Pending final review
Jul.16, 2015	47283	Naftogaz Gas Purchase Facility	Natural gas	300	USD	Public	Board approved, Pending signing
Nov.11, 2014	42608	NAK Naftogaz Emergency Pipeline Upgrade and Modernization	Natural gas	150	EUR	Public	Signed
Oct.16, 2014	45779	Lviv Wastewater Biogas Project	Renewables	15	EUR	Public	Passed concept review, Pending final review
Aug.29, 2014	45346	Poltava District Heating	District heating	15	EUR	Public	
Aug.7, 2014	46798	Ukrainian Residential EE Financing Facility	Energy Efficiency	75	EUR	Private	Board approved
Jul.15, 2014	40858	Lutsk District Heating Project	District heating	7	EUR	Public	Signed
Aug.30, 2013	45462	Galnaftogaz Loan III	Natural gas	80	USD	Private	Signed
Jul.23, 2013	44256	Luhansk District Heating	District heating	20	EUR	Public	Cancelled
Jul.16, 2013	44093	Donetsk District Heating Project	District heating	15	EUR	Public	Cancelled
Jan.23, 2013	42524	Ternopil' District Heating modernization	District heating	10	EUR	Public	Signed
Oct.17, 2012	43684	Coal Energy	Coal	70	USD	Private	Signed
Jun.8, 2012	43660	Ukraine Sustainable Energy Financing Facility (USEFF)	Energy Efficiency	100	USD	Private	Board approved
Feb.8, 2012	42988	Novoazovsky Wind Project	Electricity	33	EUR	Private	Signed
Jan.23, 2012	39300	Lviv District Heating	District heating	20	EUR	Public	Signed
Dec.15, 2011	42086	Nuclear Power Plant Safety Upgrade Program	Nuclear	300	EUR	Public	Signed

Date	Project ID	Project Title	Topic	EBRD Finance		Public/ Private	Status
Dec.7, 2011	42241	Zaporizhzhia Energy Efficiency Project	Energy Efficiency	13	EUR	Public	-
Sep.14, 2011	42621	Sadovaya Coal Recycling	Coal	36	USD	Private	Signed
Jun.9, 2011	42552	Ukreximbank SME EE Loan	Energy Efficiency	50	USD	Private	Signed
May 6, 2011	42470	Galnaftogaz Corporate Loan Phase II	Natural gas	80	USD	Private	Signed
May 6, 2011	42529	Galnaftogaz Equity Phase II	Natural gas	30	USD	Private	Signed
Feb.25, 2011	42159	KUBGAS Project	Natural gas	40	USD	Private	Signed
Apr.9, 2010	40518	Hydro Power Plant Rehabilitation Project	Electricity	200	EUR	Public	Signed
Jan.15, 2010	40263	EMSS Energy Efficiency and Modernization Programme	Energy Efficiency	79	EUR	Private	Completed
Jan.13, 2010	39094	Polska Wind	Electricity	75	EUR	Public	Cancelled
Oct.22, 2009	39850	Ukraine Renewable Energy Direct Lending facility	Res	100	EUR	Private	Board approved
Oct.2, 2009	40147	South Ukraine Transmission Project	Electricity	175	EUR	Public	Signed
Dec.19, 2008	39778	Galnaftogas Equity	Natural gas	50	EUR	Private	Completed
Oct.9, 2008	39091	Energodar District Heating	District heating	8	EUR	Public	-
Sep.4, 2008	39004	Ivano-Frankivsk District Heating Project	District heating	11	EUR	Public	Signed
Oct.10, 2007	37745	Galnaftogaz Corporate Loan	Natural gas	100	USD	Private	Signed
Jul.13, 2007	37598	Rivne Kyiv High Voltage Line Project	Electricity	150	EUR	Public	Signed
Jan.19, 2007	37753	Cadogan Petroleum	Natural gas	18	EUR	Private	Completed
Nov.21, 2006	37511	Cherkasy Energy Efficiency Project	Energy Efficiency	11	EUR	Public	Signed
Sep.15, 2006	37001	UKEEP - Energy Efficiency Programme for Banks in Ukraine	Energy Efficiency	100	EUR	Private	Board approved
Aug.25, 2005	35320	Galnaftogaz	Natural gas	25	USD	Private	Completed
Jul.14, 2005	33896	Odesa High Voltage Grid Upgrade	Electricity	26	EUR	Public	Signed
May 6, 2004	34838	K2R4 POST-START-UP SAFETY AND MODERNISATION PROGRAMME	Nuclear	50	USD	Public	Signed

Date	Project ID	Project Title	Topic	EBRD Finance		Public/ Private	Status
Oct.10, 2003	32108	ENERGY ALLIANCE	Energy Efficiency	10	USD	Private	Completed
Oct.10, 2003	33832	UKRESCO II	Energy Efficiency	20	USD	Public	Completed
Aug.3, 2001	5836	BALKAN GASTRANSIT PROJECT	Natural gas	97	USD	Private	Completed
Sep.4, 2000	14561	Ukraine Fuel Purchase Loan Facility	Electricity	100	USD	Public	Completed
Oct.1, 1997	3136	KYIVENERGO - DISTRICT HEATING REHABILITATION	District heating	45	USD	Public	Cancelled
Aug.28, 1997	2085	LVIV DISTRICT HEATING PROJECT	District heating	37	USD	Public	Cancelled
Aug.11, 1997	4243	DNIPROPETROVS'K OIL EXTRACTION PLANT II (DOEPII)	Oil	15	USD	Private	Completed
Apr.16, 1997	3663	UKRAINE ENERGY SERVICE COMPANY - UKRESCO	Energy Efficiency	30	USD	Public	Completed
Oct.15, 1996	1314	Starobeshevo Power modernization Project	Electricity	113	USD	Public	Completed

Source: JICA Study Team based on information published by EBRD

3.4.2 World Bank

On January 20, 2012, WB has announced the partnership strategy for 2012 to 2016 in an effort to support Ukraine. In the announcement, the bank listed its policies for supporting Ukraine such as the sector reform for better transparency and governance, and the improvement of energy efficiency and energy security, similar to the policies of EBRD. The bank plans to work with IMF, EBRD, EIB and European Commission concerning the promotion of financial support and European integration.

WB has carried out a wide range of support projects in the energy field from hydropower, transmission and substation to energy efficiency improvement. The large-scale projects in recent years include USD 330 million 2nd power transmission project (described in 6.1.4(3) "Supports of Donners related to the Development Plan for 10 years") and support for the smart grid creation.

The highlight of the current energy efficiency improvement projects is a DH project approved in May 2014. In February 2016, the Study Team was able to interview Mr. Fabrice Bertholet (Senior Financial Analyst, Energy group) and Mr. Pedzi Makumbe (Energy Specialist, Energy and

Extractives Global Practice). They came to Kyiv from WB headquarters to handle the bidding for the procurement for the Vinnytsiamiskteploenergo Project ((iii) in the location map in Figure. 3.4-1). The Study Team was able to confirm the status of WB's DH projects in Ukraine. Table 3.4-2 shows the support projects in the energy field.

Table 3.4-2 Major support projects by the World Bank in the energy field

Unit: Million USD

Project Title	Sector	Commitment Amount	Status	Approval Date
Second Power Transmission Project (P146788)	Electricity	330	Active	Dec.22, 2014
Advisory services and technical assistance to Naftogaz and the Government of Ukraine on the reform of the natural gas sector (P151927)	Oil & gas	1.16	Active	Oct.2, 2014
Assistance to the National Commission for Regulation of Communal Services: District Heating Regulatory Reform Support Program (P151321)	Energy Efficiency	2.23	Active	Jun.23, 2014
District Heating Energy Efficiency (P132741)	Energy Efficiency	332	Active	May.22, 2014
Ukraine - Smart Grid Project – PPG (P145138)	Electricity	0.5	Active	Sep.9, 2013
Partnership for Market Readiness in Ukraine (P128551)	General Energy sector	5.35	Closed	Oct.19, 2012
Ukraine - ENERGY EFFICIENCY (P096586)	Energy Efficiency	200	Active	May.17, 2011
HYDROPOWER - ADDITIONAL FINANCING (P115515)	Electricity	60	Active	Nov.19, 2009
Development Policy Lending 3 (DPL 3) (P107365)	Electricity	500	Closed	Dec.22, 2008
Development Policy Loan 2 (DPL 2) (P096389)	Energy Efficiency	300	Closed	Dec.20, 2007
Urban Infrastructure Project (P095337)	Energy Efficiency	140	Closed	Aug.28, 2007
Power Transmission Project in Support of the Energy Sector Reform & Development Program (P096207)	Electricity	200	Active	Aug.2, 2007
Hydropower Rehabilitation Proto-Carbon Finance Project (P094945)	Electricity	5.5	Closed	Sep.15, 2006
Development Policy Loan (formerly PAL 3) (P079316)	General Energy sector	251.26	Closed	Jul.5, 2005
Hydropower Rehabilitation Project (P083702)	Electricity	106	Active	Jun.21, 2005
Programmatic Adjustment Loan (P070693)	General energy sector	250	Closed	Sep.20, 2001
Sevastopol Heat Supply Improvement Project (P055738)	Energy Efficiency	28.2	Closed	Mar 22, 2001

Project Title	Sector	Commitment Amount	Status	Approval Date
Kyiv Public Buildings Energy Efficiency Project (P055739)	Energy Efficiency	18.29	Closed	Jan.27, 2000
Kyiv District Heating Improvement Project (P044832)	Energy Efficiency	200	Closed	May 21, 1998
Coal Sector Adjustment Loan Project (P040564)	Mining	300	Closed	Dec.11, 1996
Electricity Market Development Project (P044444)	Electricity	317	Closed	Oct.10, 1996
Coal Pilot Project (P044110)	Mining	15.8	Closed	May 16, 1996
Housing Project (P034581)	General Energy sector	17	Closed	Mar 14, 1996
Hydropower Rehabilitation and System Control Project (P038820)	Electricity	114	Closed	Apr.11, 1995
Rehabilitation Loan (P009108)	Electricity	500	Closed	Dec.22, 1994

Source: JICA Study Team based on the information published by World Bank

(1) Status of the World Bank's DH projects

WB has only made a commitment regarding the sector loan amount for DH projects. Due to disruption caused by the conflict in eastern Ukraine, the project formation has been behind the original schedule, with no individual project created or actual loan provided.

WB only offered the sector loan, and the specific projects will be selected based on the discussion by WB and MRDBH. The discussion will cover the 10 pre-selected heat supply companies with an aim to implement a wide range of projects such as the CHP facility rehabilitation, thermal piping repair, and Supervisory Control and Data Acquisition (SCADA) replacement. The total project cost will be USD 382 million, with the International Bank for Reconstruction and Development (IBRD) contributing USD 332 million and the Clean Technology Fund (CTF) USD 50 million, toward the comprehensive support including facility renewal and technological support.

WB is in line with the policy of IMF and EIB not to allow Ukraine to be burdened with excess liabilities from now on until 2018, and thus has no plan to start new, large-scale, DH-related projects in the country.

In the framework of this support, the DH utilities will implement the projects, and the country of Ukraine will borrow funds from WB. Ukraine will receive funding from WB through accounts that will be established by the Ministry of Finance and dedicated to the DH projects for which MRDBH will have the supervisory responsibility. WB will obtain the sovereign guarantee from the ministry. Afterwards, the funds will be distributed to the DH utilities of the cities covered by the projects from these accounts set up in the Ministry of Finance. With regard to the actual allocation of the funds to the projects, MRDBH will make the budgetary decisions including that for the governmental fund by

comprehensively considering the feasibility and profitability of the respective projects as well as the financial status of the DH utilities. It then will distribute the fund from the dedicated accounts set up within the Ministry of Finance to the DH utilities in the form of loans. There will be no financial contract between the WB and the local governments or the DH utilities. The WB's attitude is different from the financing approach of EBRD in that WB insists on negotiating financing with MRDBH, a national administrative agency, and requests the sovereign guarantee, while EBRD offers financing based only on the sub-sovereign guarantee subject to the creditworthiness of the local governments.
Also, since WB staff in change of the DH projects will not station in Ukraine.
Therefore, WB will not visit potential cities on its own to conduct a study like EBRD that has a base of operation in Ukraine. Instead, the bank waits for MRDBH to screen the projects before starting negotiation. Once the individual projects start, they will be managed by temporary staff, or by WB staff stationed in neighboring Moldova in the case of the Vinnytsiamiskteploenergo project.

The Team asked why WB does not manage the projects by stationing the DH staff in Ukraine, but sends staff to work with MRDBH on occasion. The answer was that "since it is unclear if the projects will be realized, the staff cannot carry out the work efficiently even if stationed in Ukraine. It is safer to trust MRDBH to find the projects on the assumption that the governmental guarantee will be obtained, even if it takes time. If the situation improves in the future, the bank might station its staff in the country, but it is not clear at this point."

They also stated that compared to EBRD which has a base in Ukraine, WB might be at a disadvantage in the time it takes to find projects. However, the bank makes sure that its projects will not overlap or conflict with EBRD's support projects. For example, the bank has no project that covers Lviv or its heat supply company Livivteploenergo since EBRD has been actively supporting the city and the company in recent years.

Since JICA does not have a base of operation in Ukraine and requires the governmental guarantee for its loans, WB's approach in finding projects might serve as a useful reference. Figure. 3.4-1 shows the locations of WB's DH projects in Ukraine (P132741).

(2) Outline of the Vinnytsiamiskteploenergo Project

Vinnytsiamiskteploenergo is a public heat supply company affiliated with Vinnytsia, a city with 300,000 people located southwest of Kyiv. WB has already finished the study and preparatory consultation with the company, and plans to carry out the support activities below:

・F/S for improving the transportation pipelines of the DH system
・Switching of the heat supply system from centralized system to distributed system

・The city has 2 major CHPs which use natural gas as fuel. It is impossible to switch fuel to coal as coal cannot be imported due to geopolitical issues. Instead, 15 to 30% improvement in thermal efficiency will be pursued while using gas. The priority is given to facilities in urgent need of attention (high-efficiency CHP introduction, rehabilitation of thermal piping and electric power network, modern SCADA introduction and heat boiler rehabilitation).

(i) Public-Power Generating Utility "Chernihivska Teploelektrotcentral" LLC Agency "Tehnova", August 21, 2014
(ii) State Municipal Utility "Ivano-Frankivskteplokomunenerho", August 21, 2014
(iii) Public Utility of Vinnytsya City Council "Vinnytsiamiskteploenergo", August 18, 2014
(iv) Subsidiary Enterprise "Kirovohradteplo", August 18, 2014
(v) Municipal Public Utility "Khersonteploenerho", August 18, 2014
(vi) "Kharkivski Teplovi Mererzhi", August 18, 2014
(vii) Oblast' Public Utility "Mykolaivoblteploenerho", August 18, 2014
(viii) Public Utility "Miskteplovodenerhia" of Kamianets-Podilskyi City Council, August 18, 2014
(ix) Public Utility "Dniproteploenerho" of Dnipropetrovsk oblast Council, August 18, 2014
(x) Public Commercial Utility "Donetskmiskteplomerezha", May 22, 2014

Source: JICA Study Team based on the published information

Figure 3.4-1 Locations of the World Bank's DH projects in Ukraine (P132741)

4. Environmental and Social Considerations

4.1 Environmental Administration in Ukraine

4.1.1 Central Government

MENR is the central executive authority in the area of environmental protection. The key tasks of MENR are the development of state policy in the area of environmental protection and state control of the implementation of environmental legislative requirements, as well as realization of the state policy in the area of environmental protection. The key functions of MENR are as follows:

- Development of legislative acts,
- Development and putting into force standards for hazardous impact of physical and biological factors on the environment,
- Issuing licenses for operations in the area of waste management, collection and gathering of secondary raw materials,
- Issuing, voiding, and renewing duplicate permits for hazardous materials transportation,
- Issuing permits for special use of natural resources,
- Issuing air emissions permits for the stationary sources of emissions,
- Registering the enterprises of high environmental risk.

The structure of MENR also includes 4 state executive bodies. These are the State Ecological Inspection of Ukraine, the State Service of Ukraine on Geology and Subsurface, the State Agency of Water Resources of Ukraine, and the State Agency of Ukraine on Exclusion Zone Management (Chornobyl).

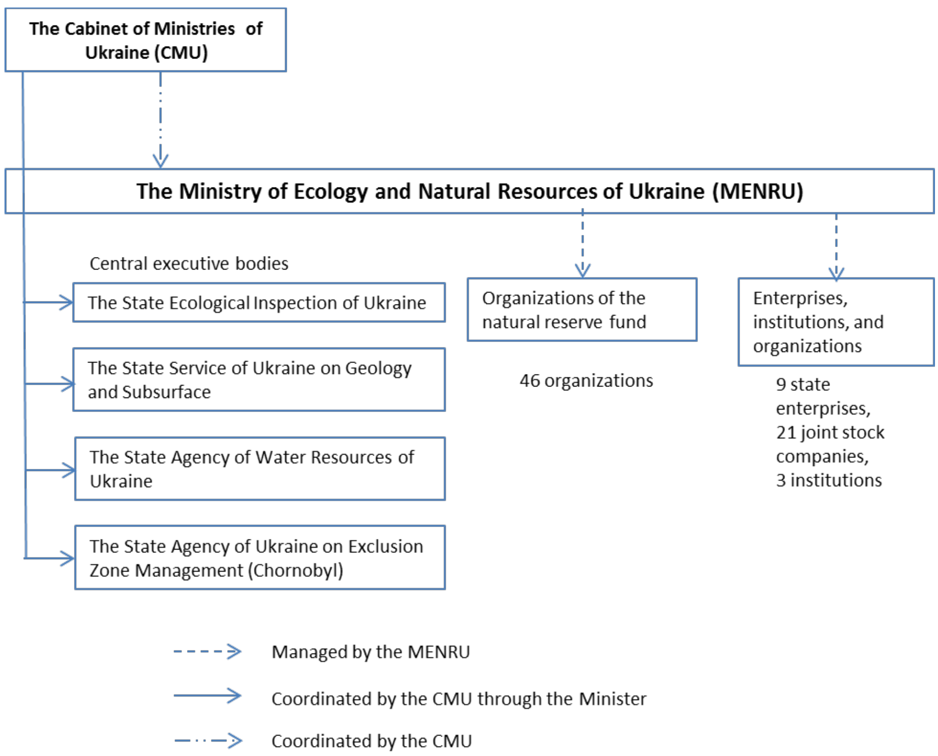
4.1.2 Local Level

Local functions of MENR are performed by the departments of ecology and natural resources in regional state administrations, and in Kyiv and Sevastopol city state administrations. Departments are subordinated to the head of the regional Kyiv and Sevastopol state administrations, and accountable to MENR. The main responsibilities of the departments in areas of permitting are as follows:

- Issuing permits for special use of natural resources,
- Issuing air emission permits for stationary emission sources

- Issuing permits for special water use – for using water from water bodies of national importance,
- Approval of the standards of maximum allowable discharge of pollutants to the water bodies,
- Negotiation on current individual technological standards for drinking water use by household sector,
- Negotiation on limits for drinking water use for industrial needs taken from drinking water supply networks,
- Issuing permits for operations in the area of waste management,
- Registering the declarations on waste.

Figure 4.1-1 shows the structure of the state executive bodies in the area of environmental protection and management.



Source: JICA Study Team

Figure 4.1-1 State executive bodies in the area of environmental protection and management

4.2 Environmental Laws and Regulations in Ukraine

The Constitution of Ukraine, No.254к/96-В, dated June 28, 1996, Article 50 guarantees the rights for a safe environment for life and health of all citizens, and compensation for damages resulting from the violation of these rights. In addition, Article 50 guarantees the right of free access to information about the condition of the environment.

The main legislative acts that regulate the areas of environmental management, environmental protection and safety are included in Table 4.2-1 below.

Table 4.2-1 Main Legislative Act for environmental Management

Name	Year (latest revision)	Content
The Law of Ukraine 'On Environmental Protection', No.1264-XII, dated Jun.25, 1991	1991 (Jan 1, 2015)	This Law stipulates legal, economic and social fundamentals for the organization of environmental protection in the best interests of the current and future generations. It includes the following issues: ecological rights and responsibilities of the citizens, responsibilities of the authorities, monitoring of the environment and cadaster of the natural resources, state and civil ecological examination, standardization and regulation in the area of environmental protection, economical mechanisms for environmental protection, actions for provision of ecological safety (includes requirements for EIA development), regulation of protective areas, and penalties for violating the law.
The Law of Ukraine 'On ensuring sanitary and epidemic safety of the population', No.4004-XII, dated Feb.24, 1994	1994 (Sep.20, 2015)	The Law regulates social relations arising in the field of sanitary and epidemiological welfare, determines relevant rights and obligations of the state bodies, enterprises, institutions, organizations and citizens, and establishes way of the State Sanitary and Epidemiological Service management and implementation of the State Sanitary and Epidemiological Control in Ukraine.
The Law of Ukraine "On atmospheric air protection', No.2707-XII, dated Oct.16, 1992	1992 (Apr.26, 2014)	The law stipulates the legal and organizational basis and ecological requirements in the field of protection and use of ambient air.
Land Code of Ukraine, No.2768-III, dated Oct.25, 2001	2001 (Jul.1, 2015)	The Land Code of Ukraine regulates management in the area of land use, the creation of conditions for the rational use and protection of lands, the equitable development of all forms of land property and the economic activity, environmental protection, and the protection of land rights of citizens, enterprises, organizations and institutions.
The Subsurface Resources Code of Ukraine, No.132/94-BP, dated Jun.27, 1994	1994 (Jul.12, 2015)	The Subsurface Resources Code of Ukraine regulates the legal basis for creating conditions for the rational use and protection of subsurface resources. It ensures the safety of people, property, the natural environment, and protection of the rights and legal interests of enterprises, organizations, institutions, and citizens.

Name	Year (latest revision)	Content
Water Code of Ukraine, No.213/95-BP, dated Jun.6, 1995	1995 (Jan.1, 2015)	The Water Code of Ukraine regulates rational water use, water conservation and water use for the needs of the population and various other economic branches, the recovery of water resources, water protection from pollution, improvement of the condition of water supply and sanitation facilities, as well as the protection of the rights of enterprises, organizations, institutions and citizens in terms of water use.
The Law of Ukraine 'On waste', No. 187/98-BP, dated Mar.5, 1998	1998 (Sep.1, 2015)	The Law regulates the legal, organizational and economic activity related to the prevention of and decrease in the generated waste volumes, its collection, transportation, storage, treatment, utilization and removal, neutralization and burial, as well as elimination of the adverse effects of waste on the environment and people's health on the territory of Ukraine.
Forest Code of Ukraine, No.3852-XII, dated Jan.21,.1994	1994 (Jan.1, 2015)	The Law regulates the management of forest resources in terms of the rights for ownership and use, forest protection, and the prevention of negative impacts on forests as a result of economic activity.
The Law of Ukraine 'On Ecological Examination', No.45/95-BP, dated Feb.9, 1995	1995 (Nov.18, 2012)	The Law stipulates the legal, organizational basis, and requirements regarding ecological assessments in Ukraine in order to prevent negative impacts of human activity on the environment and human health, and assesses the degree of ecological safety of various economic activities and ecological condition of territories and facilities.
The Law of Ukraine 'On Ecological Audit', No.1862-IV, dated Jun.24, 2004	2004 (Nov.18, 2012)	The Law regulates the terms and conditions of ecological audits, stipulates the forms of the audits (mandatory or optional), and details described through the audit procedure.
The Law of Ukraine 'On Highly Hazardous Facilities', No. 2245-III, dated Jan.18,2001	2001 (Apr.26, 2014)	This Law addresses the legal, economic, social and organizational issues of activities connected with highly hazardous facilities. This includes health and environmental protection against the adverse effects of emergencies at such facilities through prevention of their occurrence, limitation (localization) of their expansion and liquidation of consequences (remediation).
The Order of the design projects approval and their evaluation, approved by the Regulation of the Cabinet of the Ministers of Ukraine No.560, dated Sep.11, 2011	2011 (Sep.9, 2015)	The Order regulates the approval of design documentation for construction of new infrastructure based on the degree of complexity, and the terms of such evaluations.
The State Construction Norms DBN A.2.2-1-2003 'Structure and content of the Environmental Impact Assessment (EIA) materials during the design and construction of enterprises, buildings and installations', approved by the Order No.214 of the Derzhbud of Ukraine on Dec.15, 2003. Put into force in 2004.	2004 (Jul.1, 2010)	The DBN describes the requirements to and content of the Environmental Impact Assessment (EIA) for construction objects of enterprises.

Name	Year (latest revision)	Content
The Law of Ukraine 'On Ratification of the Convention on Access to Information, Public Involvement in Decision-Making Process and Access to Justice on Environmental Issues', No.832-XIV, dated Jul.6,1999.	1999	This Convention was signed on behalf of Ukraine on Jun.25, 1998 in Orhous (Denmark).
The Law of Ukraine 'On the animal world', No.2894-III, dated Dec.13, 2001	2001 (May 9, 2015)	The Law regulates the relations in the area of protection, use and reproduction of animal habitats.
The Law of Ukraine 'On the plant world', No.591-XIV, dated Apr.9, 1999.	1999 (Apr.26, 2014)	The Law regulates the relations in the area of protection, use and reproduction of non-agricultural plants.

Source: JICA Study Team

The following section of the report clarifies the requirements of the mentioned above legislation in the area of EIA.

4.2.1 The Law 'On Environmental Protection（No.1264-XII, dated June 25,1991）

Article 51 of the Law requires all design projects of business (economic) activity to carry out EIA, including also an assessment of the impact on human health. This assessment should be done in accordance with the requirements of the legislation in the area of environmental management, environmental capacity and environmental conditions of the construction territory, the ecological forecasts, perspective of the socio-economic development of the region, and the capacity and types of cumulative impacts of hazards and objects on the environment. Enterprises, institutions and organizations that engaged in designing, construction, reconstruction, technically re-equipment, and/or commissioning of the enterprises, facilities and other objects that could adversely affect the environment based on their assessment, are required to submit to MENR a special statement about the impact (Statement of environmental impacts of the activity).

It is forbidden to put into operation enterprises, buildings or other facilities that are not in full compliance with all environmental requirements.

4.2.2 The Law "On atmospheric air protection" (No.2707-XII, dated October 16, 1992)

Article 23 of the Law requires the implementation of measures for air protection during the design, construction or reconstruction of new facilities. The approval of projects for design, construction or reconstruction of enterprises and other objects that may impact air quality is performed by MRDBH, taking into account the conclusion of MENR, and the central executive body that implements the state policy in the field of sanitary and epidemiological safety of the population (Sanitary epidemiological service: SES).

Article 11 regulates the emissions to the air by stationary sources. A business entity should receive an air emissions permit from the regional, Kyiv or Sevastopol city state administration[13] through a negotiation with SES and MENR[14] with the agreement of SES.

4.2.3 Water Code（No.213/95-BP, dated June 6,1995）

Article 96 of the Water Code prohibits the implementation of projects of business activities without assessment of their impact on the water resources.
Article 35 defines the following standards in the area of water use, water protection and restoration of water resources;

- Standards of ecological safety of water use
- Ecological standard of water quality in water bodies
- Standards of maximum allowable discharge of pollutants
- Sectoral technological standards for substances discharged into the water bodies
- Technological standards of water use

Article 36 determines the following standards of ecological safety for water use;

- Maximum allowable concentrations of substances in water used for drinking, household purposes and other needs of the population
- Maximum allowable concentrations of substances in water used for fishing
- Allowable concentrations of radioactive substances in water used for drinking, household purposes and other needs of the population

Article 37 details the ecological standard of water quality, specifically the general physical, biological, chemical, and radiation indexes of the water quality. The categories of water quality are established on the basis of the level of water pollution.
The standards of maximum allowable discharge of pollutants (Article 38) are established with the aim of gradually achieve the ecological standards of water quality in the water bodies. The procedure for the development and approval of the standards for maximum allowable discharge and the list of pollutants that are limited is established by the Cabinet of Ministers.

[13] in case the enterprise is defined as a facility of the Group 2 (the objects included into the governmental register without production lines or technological equipment, for which the best available technologies and management practices should be implemented)or 3 group(the objects that are not included into groups 1 or 2)

[14] in case the enterprise is defined as a facility of the Group 1 (the objects included into the governmental register that have production lines or technological equipment, for which the best available technologies and management practices should be implemented)

Sectoral technological standards (Article 39) for substances discharged into water bodies and those discharged into treatment facilities (i.e. standards of maximum allowable concentrations of substances in wastewater generated in the process of one type of product manufacturing, using the same raw material) are established in order to assess the ecological safety of production standards.
Technological standards of water use (Article 40) are set in order to assess and ensure the rational use of water in different economic sectors. Among them are current technological standards of water use – for the existing level of technology; and future technological standards of water use – based on the best world technologies.
Discharge of substances into the water bodies for which the standards of ecological safety of water use and standards of maximum allowable discharge are not established is forbidden by Article 41.

Article 49 of the Water Code requires enterprises to apply for special water use permits in the event an enterprise will make use of water resources (which includes water intake from water bodies using the technical devices or equipment, other aspects of water usage, and wastewaters discharge into water bodies). Special water use permits are issued by the regional and Kyiv and Sevastopol city state administrations in cases of water use from water bodies of national importance, and by regional and Kyiv and Sevastopol city councils with the agreement of the respective regional administrations in cases of water use from water bodies of local importance.

4.2.4 Law on Waste（No. 187/98-BP, dated March 5, 1998）

According to Article 32 of this Law, it is forbidden to commission new enterprises without providing them with technologies and equipment for safe waste management. It is also forbidden to commission new enterprises without an impact assessment on the environment and human health based on data related to the waste produced.

According to Article 17, each business entity should receive a permit for operations in the area of waste management in case its activity leads to waste generation in the amount for which the calculated rate of total waste generation is more than 1,000[15].

[15] 5000 x M1 + 500 x M2 + 50 x M3 + 1 x M4,

Where M1, M2, M3, M4 - weight in tones of waste of the 1st, 2nd, 3d, and 4th class of hazard respectively that was generated during the previous year.

4.2.5 Coal Ash Management

The only legislative act that regulates coal ash management (more specifically, the transboundary transportation of it) in Ukraine is Regulation No. 1120 of the CMU “On approval of the provision for controlling transboundary transportation of hazardous waste and its utilization/disposal, and Yellow and Green lists of waste”, dated July 13, 2000. This regulation was developed to ensure the implementation of the international obligation of Ukraine with respect to the Basel Convention. Coal ash is included into the Yellow list of waste, as “fly ash from power plants operating with coal that contain compounds listed in Annex 2 of The Regulation (waste subject to regulation) in the amount sufficient to present the hazardous properties described in the list”; and to the Green list as “fly ash from power plants operating with coal that is not included into the Yellow list of waste.”

4.3 Environmental Standards in Ukraine

4.3.1 Ambient Air Standard

The ambient air quality standards are regulated by the State Sanitary rules for Air Protection from Pollution (with Chemical and Biological Agents) in Human Settlements, approved by the Order of the Ministry of Health of Ukraine No. 201, dated July 9, 1997. The operation of Order No. 201 was stopped due to the Notice of the State Service of Ukraine for Regulatory Policy and Entrepreneurship Development, dated August 7, 2014. However, Ministry of Health web-site claims that the Regulation is active, and no other list of ambient air standards is adopted in Ukraine.

The list of the 201 regulation includes 24-hour average concentration values, maximum allowable concentrations, and risk classification for 509 materials. The standard value for dust is regulated by Ministry of Health based on dust types and the content ratio of silicon dioxide compounds, not on particle sizes.

Table 4.3-1 Ambient Air Quality Standards for some substances

Substances		**Maximum allowable concentrations (mg/Nm^3)**		**Class of hazard**
		Max one-time	**Average daily**	
SOx		0.5	0.05	3
NO_2		0.085	0.04	2
NO		0.4	0.06	3
Dust non-organic with SiO_2	70% or more	0.15	0.05	3
	20 to 70%	0.3	0.1	3
	20% or less	0.5	0.15	3

Source: JICA Study Team

4.3.2 Emission standards of the enterprises in the power generating sector

Order No. 541 of the Ministry of Environmental Protection of Ukraine "On approval of the technological standards of permissible emissions of pollutants from thermal power-generating units with nominal capacity exceeding 50 MW", dated October 22, 2008 (amended on October 30, 2015), install current and future technological standards of emissions from stationary thermal power plants designed for energy production by means of solid, liquid, and gaseous fuels and waste coal combustion. The current technological standards are valid till December 31, 2017 for existing installations. The standard value for dust emissions is not based on particle sizes, but instead regulates dust in general as "suspended particles in the air." The permitted value of the technological standards depends on the type of fuel. The following Table 4.3-2 and 4.3-3 stipulate the emission standards for power facilities.

Table 4.3-2 Emission standards for suspended particles (Dust) (mg/Nm^3)

<table>
<tr><th>No.</th><th>Fuel type</th><th>Current standard for existing installations (till Dec.31, 2017)</th><th>Future standard for modernized installation (since Jan.1, 2018)</th><th>Future standard (for new installations)</th></tr>
<tr><td>1</td><td colspan="2">Solid:</td><td rowspan="9">50 (P≥500)
100 (P<500)</td><td rowspan="9">50 (50<P≤100)
30 (P>100)</td></tr>
<tr><td rowspan="3">1.1</td><td colspan="2">with liquid removal of the residue</td></tr>
<tr><td>1.1.1 electro filter with 12 m electrodes or more</td><td>400</td></tr>
<tr><td>1.1.2 electro filter with 12 m electrodes or less</td><td>1,000</td></tr>
<tr><td rowspan="2">1.2</td><td colspan="2">with solid removal of the residue</td></tr>
<tr><td>1.2.1 electro filter</td><td>1,000</td></tr>
<tr><td rowspan="3">1.3</td><td colspan="2">for all types</td></tr>
<tr><td>1.3.1 wet ash collectors</td><td>1,300</td></tr>
<tr><td>1.3.2 multi cyclone</td><td>2,000</td></tr>
<tr><td>2.</td><td colspan="3">Liquid:</td><td rowspan="3">50 (50<P≤100)
30 (P>100)</td></tr>
<tr><td>2.1</td><td>with not more than 0.06% ash content</td><td>50</td><td>50</td></tr>
<tr><td>2.2</td><td>with 0.06% or more ash content</td><td>100</td><td>100</td></tr>
<tr><td>3.</td><td colspan="4">Gaseous:</td></tr>
<tr><td>3.1</td><td>General case</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>3.2</td><td>Blast furnace gas</td><td>50</td><td>10</td><td>10</td></tr>
<tr><td>3.3</td><td>Gases generated in steel production and used as fuel</td><td>50</td><td>50</td><td>30</td></tr>
</table>

Source: JICA: Study Team

Table 4.3-3 SO_2 emission standard (mg/Nm[3])

<table>
<tr><th>No.</th><th>Fuel type</th><th>Current standard for existing installations (till Dec.31, 2017)</th><th>Future standard for modernized installation (since Jan.1, 2018)</th><th>Future standard (for new installations)</th></tr>
<tr><td>1.</td><td colspan="2">Solid:</td><td rowspan="7">2,000
(50<P≤100)
400 to 2,000
(100<P≤500)
400
(P>500)</td><td rowspan="7">850
(50<P≤100)
200
(P>100)</td></tr>
<tr><td rowspan="3">1.1</td><td colspan="2">anthracite and poor coal</td></tr>
<tr><td>1.1.1 combustion in circulating fluidized bed</td><td>400</td></tr>
<tr><td>1.1.2 flame combustion</td><td>3,400</td></tr>
<tr><td>1.2</td><td>Poor coal</td><td>4,500</td></tr>
<tr><td>1.3</td><td>Black coal</td><td>5,100</td></tr>
<tr><td>1.4</td><td>Brown coal</td><td>5,100</td></tr>
<tr><td>1.5</td><td>Biomass</td><td>—</td><td>—</td><td>200 (P>50)</td></tr>
<tr><td>2.</td><td>Liquid fuel:</td><td>3,100</td><td>1,700
(50<P≤300)
400 to 1,700
(300<P≤500)
400
(P>500)</td><td>850
(50<P≤100)
200 to 400
(100<P≤300)
200
(P>300)</td></tr>
<tr><td>3.</td><td colspan="4">Gaseous:</td></tr>
<tr><td>3.1</td><td>General case</td><td>35</td><td>35 (P>500)</td><td>35</td></tr>
<tr><td>3.2</td><td>Sour gas</td><td>800</td><td>800 (P>500)</td><td></td></tr>
<tr><td>3.3</td><td>Condensed gas</td><td></td><td>5 (P>500)</td><td>5</td></tr>
<tr><td>3.4</td><td>Low heating value coke oven gas</td><td></td><td></td><td>400</td></tr>
<tr><td>3.5</td><td>Blast furnace gas</td><td></td><td></td><td>200</td></tr>
</table>

Source: JICA Study Team

Table 4.3-4 NOx(NO_2)emission standard (mg/Nm³)

<table>
<tr><th>No.</th><th>Fuel type</th><th>Current standard for existing installations (till Dec. 31, 2017)</th><th>Future standard for modernized installation (since Jan.1, 2018)</th><th>Future standard (for new installations)</th></tr>
<tr><td>1.</td><td>Solid:</td><td></td><td rowspan="11">Till Jan.1,2016:
600 (50<P≤500)
500 (P>500)

After Jan.1,2016:
600 (50<P≤500)
200 (P>500)</td><td rowspan="11">400 (50<P≤100)
200 (P>100)</td></tr>
<tr><td rowspan="5">1.1</td><td>black and brown coal</td><td></td></tr>
<tr><td>1.1.1 liquid residue removal</td><td>700</td></tr>
<tr><td>1.1.2 liquid residue removal, steam generation 950 t/hour or more</td><td>1,300</td></tr>
<tr><td>1.1.3 solid residue removal</td><td>700</td></tr>
<tr><td>1.1.4 cyclone furnace</td><td>2,000</td></tr>
<tr><td rowspan="4">1.2</td><td>anthracite and poor coal</td><td></td></tr>
<tr><td>1.2.1 liquid residue removal</td><td>1,300</td></tr>
<tr><td>1.2.2 liquid residue removal, steam generation 2650 t/hour or more</td><td>1,800</td></tr>
<tr><td>1.2.3 circulating fluidized bed furnace</td><td>400</td></tr>
<tr><td>1.3</td><td>Biomass</td><td>—</td><td>—</td><td>400 (50<P≤100)
300(100<P≤300)
200 (P>300)</td></tr>
<tr><td>2.</td><td colspan="2">Liquid:</td><td rowspan="3">450 (50<P≤500)
400 (P>500)</td><td rowspan="3">400 (50<P≤100)
200 (P>100)</td></tr>
<tr><td>2.1</td><td>steam boiler</td><td>500</td></tr>
<tr><td>2.2</td><td>water heating boiler</td><td>500</td></tr>
<tr><td>3.</td><td colspan="2">Gaseous</td><td rowspan="3">300 (50<P≤500)
200 (P>500)</td><td rowspan="3">Natural Gas:
150 (50<P≤300)
100 (P>300)

Other:
200 (P>50)</td></tr>
<tr><td>3.1</td><td>steam boiler</td><td>500</td></tr>
<tr><td>3.2</td><td>water heating boiler</td><td>500</td></tr>
</table>

Source: JICA Study Team

Table 4.3-5 CO emission standard (mg/Nm^3)

No.	Fuel type	Current standard for existing installations (till Jan.31, 2017)	Future standard for modernized installation (since Jan 1, 2018)	Future standard (for new installations)
1.	Solid (boiler)	250	250	250
2.	Liquid			
2.1	Boiler	250	250	250
2.2	Gas turbine	—	—	100
3.	Gaseous			
3.1	Boiler	250	250	250
3.2	Gas turbine	—	—	100

Source: JICA Study Team

4.3.3 Noise Standard

According to the State Building Norms (DBN 360-92 Urban development. Planning and development of urban and rural areas), approved by Order No. 44 issued by the State Committee of Urban Development, dated April 17, 1992, the applicable noise levels at the nearest sensitive areas are as follows:

Table 4.3-6 Environmental noise standard

Area specification (location of receptor point)	Equivalent Sound Level, LAeq,T (dB(A))		Max Acceptable Equivalent Sound Level, LAmax (dB(A))	
	Day time 7am – 11pm	Night time 11pm – 7 am	Daytime 7am – 11pm	Night time 11pm – 7 am
Residential area	55	45	70	60
Residential area under reconstruction	60	50	70	60
Residential area near the airports and airdromes	65	55	75	65
Area of public recreation and tourism	50	35-40	85	75
Sanatorium and health resort area	40-45	30-35	60	50
Nature conservation area	< 25	< 20	50	45

Source: JICA Study Team

4.3.4 Effluent Standard

The regulation of wastewater discharges in Ukraine covers all economic sectors irrespective to the type of enterprise or sector.
Drinking water quality is regulated by Order No. 400 of the Ministry of Health of Ukraine 'On approval of the state sanitary standards and rules "hygienic requirements to drinking water intended for human consumption"', dated May 12, 2010. It includes standards for (i) city main water, city well rooms, and bottling points; (ii) water from wells and damming; (iii) packaged water.

The sanitary rules and standards of surface water protection from pollution, SanPiN 4630-88, approved by the Ministry of health of the USSR, July 4, 1988 are used for regulation of substance content in the water of surface water bodies. It contains the following standards:

- Hygienic requirements regarding the content and properties of water in water bodies used for drinking and domestic purposes, and also cultural and household water use purposes;
- Maximum allowable concentrations of pollutants in the water of water bodies used for drinking and domestic purposes, and also cultural and household water use purposes (contains 1,345 substances).

SanPiN 4630-88 contains also the general sanitary requirements for wastewater discharged into surface water bodies. The requirements of wastewater discharge into water bodies should be determined taking into account:

- Degree of possible mixing and dilution of sewage water in the water body;
- Background water quality in the water body, above the release point;
- Water quality standards installed for specific water bodies, (SanPiN 4630-88) with regard to the type of water use.

Table 4.3-7 Hygienic requirements and maximum allowable concentrations of pollutants in water of water bodies

Substance/index	Content in water bodies, used for drinking and domestic purposes (mg/l)	Content in water bodies, used for bathing, sport, etc. (mg/l)
Suspended solids	0.25	0.75
pH	6.5-8.5	6.5-8.5
Salinity	1,000 or less chlorides : 350 or less sulfates : 500 or less	
Dissolved oxygen	4 or less	-
BOD (Biological Oxygen	3 mg O_2/l	6 mg O_2/l

Substance/index	Content in water bodies, used for drinking and domestic purposes (mg/l)	Content in water bodies, used for bathing, sport, etc. (mg/l)
Demand)		
COD (Chemical Oxygen Demand)	15 mg O_2/l	30 mg O_2/l
Nitrogen ammonium	2	
Nitrates	45	
Nitrites	3.3	
Sulfates	500	
Polyphosphates	3.5	
Cadmium	0.0013	
Copper	1.03	
Arsenic	0.053	
Lead	0.03	
Zinc	1.03	
Nickel	0.13	
Mercury	0.00053	
Iron	0.33	
Cobalt	0.13	
Chromium (3+)	0.5	
Chromium (6+)	0.05	

Source: JICA Study Team

The rules of surface water protection, approved by the State Committee of the USSR for Nature Protection, dated February 21, 1991, regulate wastewater discharge into water bodies, and are obligatory for designers of all types of enterprises or organizations that will impact the water condition. The measures outlined in these rules include the standardization of the water quality in the water body, regulation of discharges of substances, regulation of the economic activities that affect the water condition, planning the measures for water protection, organization of water protective areas, as well as other functions. The document contains the general requirements as to the content and characteristics of the water for drinking and domestic purposes, household purposes, and fishery purposes.

Regulation No. 1100 of the Cabinet of the Ministries of Ukraine ‘On the order of development and approval of the maximum allowable discharge standards and the list of pollutants, the discharge of which should be limited’, dated September 11, 1996, contains a list of substances divided into 4 parts:

- List A – pollutants that are limited in all cases (dissolved oxygen, suspended particles, salinity, sulfates, chlorides, nitrogen ammonium, nitrates, nitrites, phosphates, mineral oil products, BOD5, COD, bacteriological indexes, toxic level of water, water radioactivity, pH, and temperature);
- List B – pollutants, the discharge of which should be stopped shortly, and limited in case of the presence in waste water (contains 132 substances);
- List C – pollutants, the discharge of which should be decreased, and limited in case of the presence in the waste water (contains 155 substances);
- List D – pollutants that are listed in the sanitary rules and standards of surface water protection from pollution, SanPiN 4630-88, but not included in the Lists B and C.

Order No. 37 of the State Committee of Construction, Architecture and Housing Policy of Ukraine 'On approval of the instruction for installation of fees for industrial and other waste water discharge to the sewage system of settlements, and rules of enterprises' wastewater acceptance in municipal and departmental sewage systems', dated February 19, 2002, contains the mentioned instruction, which requires enterprises to discharge wastewater into the municipal system and pay for these services in accordance a contract to be concluded with the relevant municipal enterprise of water supply and wastewater treatment. Such contracts should be concluded on the basis of the local rules of wastewater acceptance into the municipal sewage system, and the usage rules for centralized municipal water supply and discharge in settlements of Ukraine, approved by the Order No. 190 of the Ministry of Housing and Utilities Infrastructure of Ukraine, dated June 27, 2008.

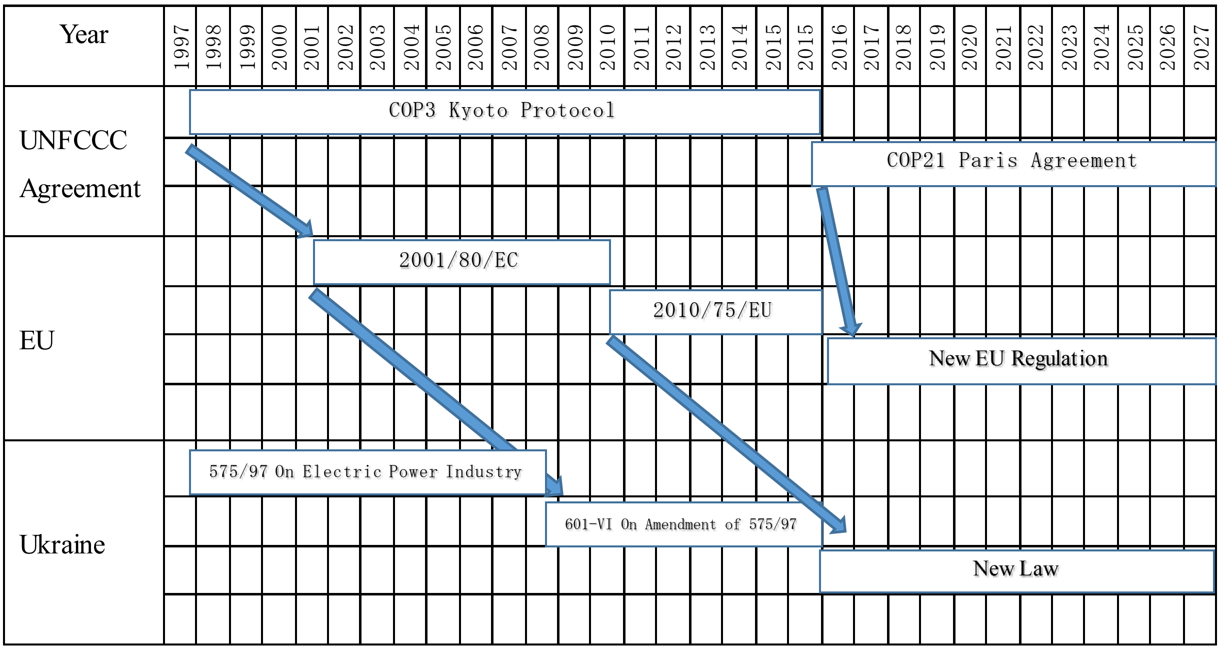
4.4 Legal procedures and steps of repair and installation of power facilities

Figure 4.4-1 shows historical flow of the status on the environmental laws and regulations to the energy sector in Ukraine. After the disintegration of the Soviet Union in 1991 and before the Orange Revolution in 2004, the capitalistic power industry law (Electric Power Industry) was enacted in October 1997. This original law did not have the provision of the environment pollution prevention, since the revision in September 2008, environmental pollution prevention and the Green Tariff had been introduced. Environmental pollution control values were coincident with 2001/80 / EC in October 2001 which was instructed by the European Parliament (EC) based on the COP3 Kyoto Protocol of December 1997.
EU enacted severely environmental regulations value by 2010/75 / EU, however Ukraine has been no legal changes that conform to this regulation value of current Europe until December 2015 so far.

For this reason, the Ukraine parliament are preparing the amendment law which will conform to 2010/75 / EU in 2016.

However, because Ukraine has the large output of aged coal-fired power plants compared to other countries, Ukraine was specially agreed by the EU Cabinet meeting in 2013 Belgrade to postpone the goal on dust and SO_2 until 2028, NOx until 2033 whereas EU has the goal of 2010/75 / EU until December 31, 2027.

COP21 Paris meeting of the United Nations Framework Convention on Climate Change conference (UNFCCC) was held in December 2015 and the new environmental regulations by the end of this century has been agreed. EU will likely enact further regulation law and Ukraine will also be affected by these contents.



Source: JICA Study Team

Figure 4.4-1 Status of the laws and regulations related to environment of Ukraine

4.5 Comparison with EU Standards

EU standard regulating the industrial emissions is 2010/75/EU[17], which stipulates emission from combustion plants of the total rated thermal input off which is equal to or greater than 50 MW. 2010/75/EU was set to integrate and update several individual EU Directives which have regulated pollution regulation. In regarding to air emission, the emission standard was developed based on 2001/80/EC[18] which stipulates the limitation of emission of certain pollutants in to the air from large combustion plants.

The current air emission regulation in Ukraine (Order No. 541) was established in order to comply

[17] DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November, 2010 on industrial emissions (integrated pollution prevention and control)
[18] Directive 2001/80/EC of the European Parliament and of the Council of October 23, 2001 on the limitation of emission of certain pollutants in to the air from large combustion plants

with 2001/80/EC, and currently the Government of Ukraine is working to amend relevant law in order to meet with 2010/75/EU. The Government of Ukraine has prepared action plan (2014 – 2017) for this amendment process which was approved by the cabinet on September 17, 2014. MENR, MEDT and MECI was appointed as responsible authorities to carry out the amendment process. Table 4.5-1 to 4 show the comparison between the Ukraine regulation and EU standard.

Table 4.5-1 Emission standards for suspended particles (mg/Nm^3)

<table>
<tr><th rowspan="2">Fuel type</th><th rowspan="2">Output (MW)</th><th colspan="2">Ukraine standard (No.541)</th><th rowspan="2">EU Directive 2010/75/EU</th></tr>
<tr><th>Future standard for modernized installation (since Jan.1, 2018)</th><th>Future standard (for new installations)</th></tr>
<tr><td rowspan="4">Solid</td><td>50-100</td><td>100</td><td>50</td><td>20</td></tr>
<tr><td>100-300</td><td>100</td><td>30</td><td>20</td></tr>
<tr><td>>300</td><td>100</td><td>30</td><td rowspan="2">10</td></tr>
<tr><td>>500</td><td>50</td><td>30</td></tr>
<tr><td rowspan="3">Biomass and peat</td><td>50-100</td><td>-</td><td>-</td><td>20</td></tr>
<tr><td>100-300</td><td>-</td><td>-</td><td>20</td></tr>
<tr><td>>300</td><td>-</td><td>-</td><td>20</td></tr>
<tr><td rowspan="3">Liquid</td><td>50-100</td><td rowspan="3">100
(with 0.06% or less ash content)
50
(with not 0.06% or more ash content)</td><td>50</td><td>20</td></tr>
<tr><td>100-300</td><td>30</td><td>20</td></tr>
<tr><td>>300</td><td>30</td><td>10</td></tr>
<tr><td rowspan="3">Gaseous</td><td>general case</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>blast furnace gas</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>gases generated in steel production</td><td>50</td><td>30</td><td>30</td></tr>
</table>

Source: JICA Study Team

Table 4.5-2 Emission standards for SO_2 (mg/Nm^3)

Fuel type	Output (MW)	Ukraine standard (No.541)		EU Directive 2010/75/EU
		Future standard for modernized installation (since Jan.1, 2018)	Future standard (for new installations)	
Solid	50-100	2,000	850	400
	100-300	400-2,000	200	200
	>300	400-2,000	200	150-200
	>500	400	200	
Biomass	50-100	-	200	200
	100-300	-	200	200
	>300	-	200	150
Peat	50-100	-	-	300
	100-300	-	-	250-300
	>300	-	-	150-200
Liquid	50-100	1,700	850	350
	100-300	1,700	400-200	200
	>300	400-1,700	200	150
	>500	400		
Gaseous	general case	35 (P>500)	35	35
	sour gas	800 (P>500)	-	-
	condensed/liquefied gas	5 (P>500)	5	5
	coke oven	-	400	400
	blast furnace gas	-	200	200

Source: JICA Study Team

Table 4.5-3 Emission standards for NOx(NO_2) (mg/Nm^3)

<table>
<tr><th rowspan="2">Fuel type</th><th rowspan="2">Output (MW)</th><th colspan="2">Ukraine standard (No.541)</th><th rowspan="2">EU Directive 2010/75/EU</th></tr>
<tr><th>Future standard for modernized installation (since Jan.1, 2018)</th><th>Future standard (for new installations)</th></tr>
<tr><td rowspan="4">Solid</td><td>50-100</td><td>600</td><td>400</td><td>300
400
(in case of pulverized lignite combustion)</td></tr>
<tr><td>100-300</td><td>600</td><td>200</td><td>200</td></tr>
<tr><td>>300</td><td>600</td><td>200</td><td rowspan="2">150
200(in case of pulverized lignite combustion)</td></tr>
<tr><td>>500</td><td>200</td><td>200</td></tr>
<tr><td rowspan="3">Biomass and peat</td><td>50-100</td><td>-</td><td>400</td><td>250</td></tr>
<tr><td>100-300</td><td>-</td><td>300</td><td>200</td></tr>
<tr><td>>300</td><td>-</td><td>200</td><td>150</td></tr>
<tr><td rowspan="4">Liquid</td><td>50-100</td><td>450</td><td>400</td><td>300</td></tr>
<tr><td>100-300</td><td>450</td><td>200</td><td>150</td></tr>
<tr><td>>300</td><td>450</td><td rowspan="2">200</td><td rowspan="2">100</td></tr>
<tr><td>>500</td><td>400</td></tr>
<tr><td rowspan="3">Gaseous</td><td>natural gas</td><td rowspan="3">300 (50<P≤500)
200 (P>500)</td><td>150 (50<P≤300)
100 (P>300)</td><td rowspan="3">100
(except gas turbine and gas engine)</td></tr>
<tr><td>blast furnace gas, coke oven gas</td><td rowspan="2">200 (P>50)</td></tr>
<tr><td>Other gases</td></tr>
</table>

Source: JICA Study Team

Table 4.5-4 Emission standards for NOx and CO (Gas turbine and Gas engine) (mg/Nm^3)

Air Pollutant	System	Ukraine standard(No.541)		EU Directive 2010/75/EU
		Future standard for modernized installation (since Jan .1,2018)	Future standard (for new installations)	
NOx	Gas Turbine	-	50-120	50
	Gas Engine	-	-	75
CO	Gas Turbine	-	100	100
	Gas Engine	-	-	100

Source: JICA Study Team

4.6 Environmental Approval in Ukraine

4.6.1 Environmental Impact Assessment (EIA)

The formal requirements to the procedure and content of the EIA document (OVNS (OBHC) – is a Ukrainian acronym for EIA) is described by DBN A 2.2-1-2003 'Structure and content of the Environmental Impact Assessment (EIA) materials during the design and construction of enterprises, buildings and installations. The procedure of the EIA development is as follows:

- The investor determines the EIA developer;
- The investor and EIA developer agree on and publish a Statement of intention, indicating a list of expected impacts of the proposed activity; perform collection and systematization of the available materials about the environment, living environment of the population, and economic activity in the area; develop the task for EIA development with the grounds for the scope of work based on the environmental impact of the proposed activity, the alternatives to the proposed activity(including the absence of this activity), options for placement and condition of the environment;
- EIA developer performs the assessment according to the task and DBN requirements; on the basis of the EIA conclusions, the investor and developer should then compose the statement of environmental impacts of the proposed activity and ensure its distribution through the media; comments from the population should be considered.
- For activities listed in Annex E of the DBN, the investor or the developer on behalf of the investor during the development of the EIA should (i) inform the population through the local authorities on the planning activities, (ii) define the place and the order of open public meetings and (iii) collect and consider the comments and suggestions from these meetings;

- Investor or on his behalf, General Designer submit the EIA materials with considered comments of the public as part of project documentation for approval and comprehensive state examination.

Table 4.6-1 EIA development in the scheme of the investment construction process

Stage	Content of design and construction stages		Content of the EIA
0	Investor decision for object construction		-
1	Preinvestment study	Preparation of initial data on the object; definition of production program, investment intentions, needs in raw materials, energy and human resources, etc.; pre-development.	Statement of Intention. Preliminary assessment of environmental impact of the proposed activity.
2		Elaboration of the options for object siting taking into account environmental and engineering characteristics of the territory.	Brief EIA in the materials for land allocation
3		Development and approval of the task for F/S, Conceptual Design (CD)	Development of the Task for the EIA development as part of the task for F/S, CD
4		Development of F/S for investments, CD in the volume, required by the regulatory documents	Development of the EIA materials as part of F/S, CD, and public hearings for the objects, listed in Annex E to the DBN A 2.2-1-2003. Development of the Statement on environmental impacts of activity
5		Negotiation and approval of F/S, CD	Complex state examination and negotiation of the EIA as part of F/S or CD. Transfer of the statement of environmental impacts of activity to the local authorities.

Stage	Content of design and construction stages		Content of the EIA
6	Designing	Development and approval of the task for the basic design (BD) or detail design (DD)	Development of the task for EIA as part of BD or DD taking into account the changes of the design decisions comparing to F/S, CD, or changes in urban planning situation
7		Implementation of BD and DD	Development of the EIA in full volume in case it wasn't developed on the previous stages, or clarification of the EIA according to the BD and DD
8		Negotiation and approval of BD and DD	Complex state examination and negotiation of the EIA according to the legislative requirements
9		Making of the DD documentation	Clarification of the EIA in case of changes of the production technology and plan for construction works execution, etc., presenting it for negotiation and state examination.
10	Construction		Receiving the permit for construction. Implementation of measures, foreseen by EIA
11	Operation	Development of design capacity (post-project analysis)	Assessment of the efficiency of environment protective measures, clarification of the EIA, and post-project analysis if needed

Source: Annex B to DBN A2.2-1-2003.

4.6.2 Categories to be included in the EIA report

Development of EIA in full volume is only mandatory for types of activity and/or installations posing a high environmental risk (listed in Annex E to DBN). According to this Regulation (808), the following objects are classified as high environmental risks in the energy sector:

- Thermal power plants
- Equipment for electricity, steam and hot water production with the capacity of 200 kW or higher using fossil fuels
- Transmission line and substations with voltage of 330 kV or more
- Household waste management (treatment, processing, utilization, and disposal)

Full volume of the EIA report should contain the following information:

- Reasons for conducting EIA (information about the documents that are the basis for the development of the EIA as part of the investment program or project construction; the list of sources for potential impacts of the proposed activity on the environment, and considering its alternatives; summary of the impacts of the proposed activity on the environment; data on the attitudes of the public and other stakeholders towards proposed activities and related issues to resolve, etc.)
- Geographical characteristics of the area of construction of the facility design (brief description of the physical and geographical conditions of the terrain data on protected areas, generalized description of the flora and fauna to the extent necessary for environmental, sanitary-epidemiological, social and economic assessments at the regional and local levels, characteristic distribution of all negative factors in the area of project activities, and related cartographic materials, etc.)
- General description of the designed facility (general description of the proposed activity and its alternatives; compliance of the planned activity with planning documentation; description of positive environmental, sanitary-epidemiological, social and economic aspects of the proposed activity, etc.)
- Assessment of environmental impacts of the proposed activity (climate and microclimate, ambient air, geological environment, water environment, soils, flora and fauna reserves - only those components of the environment, that are affected by the planned activities are considered, as well as those, which do not meet regulatory standards)
- Assessment of impacts of the proposed activity on the social environment (brief description of the basic social and living conditions in the area of project activities; assessment of the positive and negative impacts of the proposed activity on local social conditions; assessment of impacts on recreational zones, etc.)

- Assessment of impacts of the proposed activity on the industrial environment (impacts of the proposed activity on the industrial, housing and civilian objects, monuments of architecture, history and culture, surface and underground structures and other elements of man-made environment in the area of influence of the proposed activity; potential impacts of the built environment on the proposed activity, types of impacts, ways and means to eliminate them)
- Integrated measures to assure the standard of ambient environment and its security (Generalization of steps to ensure regulatory environment considered above; list and a brief description of project design decisions, including resource saving measures, protection measures, etc.)
- Assessment of environmental impacts during construction (includes measures on ambient air and noise control, protection of surface and groundwater, soil protection, protection of flora and fauna, protected areas; mitigation of impacts on life conditions of local population; protection of monuments of history and culture; etc.)
- Statement of environmental impacts of the proposed activity (Statement of environmental impacts is a document regarding the scale of these impacts and guarantees environmental protection measures to ensure the safety of the environment for the entire duration of the proposed activity; Statement of environmental impacts is in brief, containing only the final results of the EIA study and the necessary comments, etc.)

For other activities and objects not listed in Annex E, EIA materials are developed in a shortened volume determined by the investor and the general designer in each case during the preparation of the Statement of Intention, under the agreement of the in consultation with the Departments of ecology and natural resources in regional state administrations, and the State Sanitary and Epidemiological Service of MH.

4.6.3 Public Hearing and Disclosure of Information

DBN requires consideration of public opinions in accordance with the legislation of Ukraine. Point 1.9 of the legislation states that the investor of the planning activity ensures.

- Informing the population about the public hearings on the planned activity
- Public discussion of the project (the broadness of discussion should be determined by the extent of the expected impacts)
- Providing project materials to the public members in accordance with the Statement of Intention

The materials for public opinion consideration should include the following.

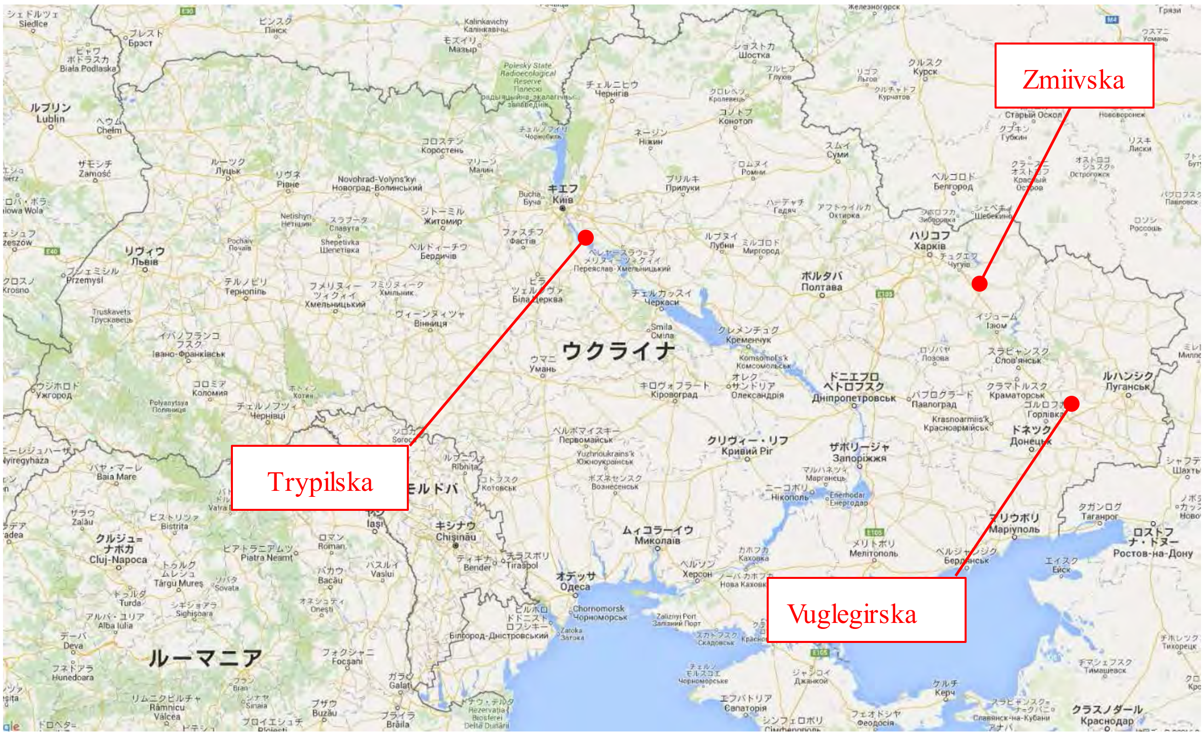
- Information on the publication in the media of Statement of Intention and the schedule of public discussions
- Written and other appeals of citizens
- List of materials submitted for review by the investor and EIA developer to local communities and non-governmental organizations, a list of questions and comments from citizens, convincing answers to the comments
- Generalized solutions based upon the public suggestions, and justification regarding the suggestions or comments not addressed
- The decision of the public examination (if it was held)

Adaptation of the EIA on the basis of the results of public discussion is the decision of the investor and the general designer. Motives for some decisions should be communicated to the public.

5. Thermal Power Generation Sector

5.1 Overview of Centrenergo

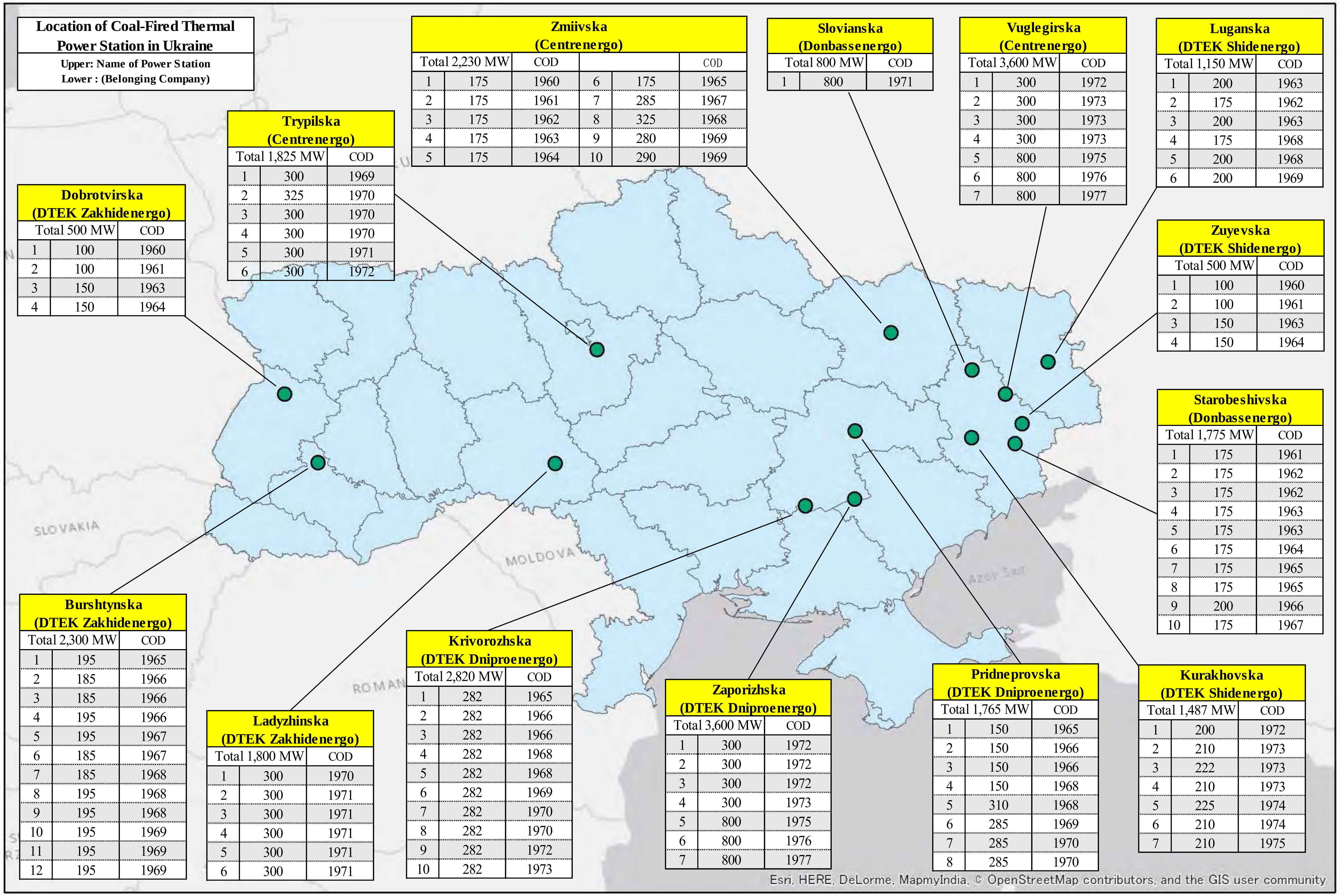
Centrenergo was established by the Decree of the President of Ukraine in 1994, "Reforms on electricity sector of Ukraine", as a unique generation company with 78.3% ownership by ECU. At present, Centrenergo is one of the 5 biggest thermal power companies in Ukraine, which has 3 coal-fired thermal power stations, Trypiliska, Zmiivska and Vuglegirska, and a headquarters in Kyiv. There are 23 power units of thermal power generation, which consist of 18 of anthracite-fired and 5 of gas-fired units (2 in Trypilska, and 3 in Vuglegirska). Those plants supply not only the produced electricity but also the heat to the local district. The total capacity of the power plants Centrenergo owns amounts to 7,655 MW, corresponding to 15% of nationwide capacity of Ukraine.



Source: JICA Study Team

Figure 5.1-1 Location of Power plants owned by Centrenergo

In addition, Figure 5.1-2 shows the Location Map of Coal-Fired Power Plants of Ukraine.



Location of Coal-Fired Thermal Power Station in Ukraine

Upper: Name of Power Station
Lower : (Belonging Company)

Dobrotvirska (DTEK Zakhidenergo)

Total 500 MW		COD
1	100	1960
2	100	1961
3	150	1963
4	150	1964

Trypilska (Centrenergo)

Total 1,825 MW		COD
1	300	1969
2	325	1970
3	300	1970
4	300	1970
5	300	1971
6	300	1972

Zmiivska (Centrenergo)

Total 2,230 MW		COD			COD
1	175	1960	6	175	1965
2	175	1961	7	285	1967
3	175	1962	8	325	1968
4	175	1963	9	280	1969
5	175	1964	10	290	1969

Slovianska (Donbassenergo)

Total 800 MW		COD
1	800	1971

Vuglegirska (Centrenergo)

Total 3,600 MW		COD
1	300	1972
2	300	1973
3	300	1973
4	300	1973
5	800	1975
6	800	1976
7	800	1977

Luganska (DTEK Shidenergo)

Total 1,150 MW		COD
1	200	1963
2	175	1962
3	200	1963
4	175	1968
5	200	1968
6	200	1969

Zuyevska (DTEK Shidenergo)

Total 500 MW		COD
1	100	1960
2	100	1961
3	150	1963
4	150	1964

Starobeshivska (Donbassenergo)

Total 1,775 MW		COD
1	175	1961
2	175	1962
3	175	1962
4	175	1963
5	175	1963
6	175	1964
7	175	1965
8	175	1965
9	200	1966
10	175	1967

Burshtynska (DTEK Zakhidenergo)

Total 2,300 MW		COD
1	195	1965
2	185	1966
3	185	1966
4	195	1966
5	195	1967
6	185	1967
7	185	1968
8	195	1968
9	195	1968
10	195	1969
11	195	1969
12	195	1969

Ladyzhinska (DTEK Zakhidenergo)

Total 1,800 MW		COD
1	300	1970
2	300	1971
3	300	1971
4	300	1971
5	300	1971
6	300	1971

Krivorozhska (DTEK Dniproenergo)

Total 2,820 MW		COD
1	282	1965
2	282	1966
3	282	1966
4	282	1968
5	282	1968
6	282	1969
7	282	1970
8	282	1970
9	282	1972
10	282	1973

Zaporizhska (DTEK Dniproenergo)

Total 3,600 MW		COD
1	300	1972
2	300	1972
3	300	1972
4	300	1973
5	800	1975
6	800	1976
7	800	1977

Pridneprovska (DTEK Dniproenergo)

Total 1,765 MW		COD
1	150	1965
2	150	1966
3	150	1966
4	150	1968
5	310	1968
6	285	1969
7	285	1970
8	285	1970

Kurakhovska (DTEK Shidenergo)

Total 1,487 MW		COD
1	200	1972
2	210	1973
3	222	1973
4	210	1973
5	225	1974
6	210	1974
7	210	1975

Figure 5.1-2 Location Map of Coal-Fired Power Plants of Ukraine

5.1.1 Condition of obsoleteness and background of examing solutions

The majority of the thermal power generation plants in Ukraine were designed in the 1960s or 1970s. They continue in operation to date, now under deteriorating conditions due to aging. The deterioration of power generation plants due to aging causes various problems, such as: (i) difficulties in continuously procuring replacement parts and the consumables required for operation and maintenance; (ii) increased maintenance costs due to the need for frequent maintenance operations; (iii) significant operator overloading and the possibility of erroneous operation due to human error, etc., or (iv) inability to respond to changes in the environments and conditions surrounding these power plants (i.e. tightened environmental regulations, etc.). Further, any problems happening at the infrastructure distributing the electricity produced by these power plants, which is fundamental for economic and social activities, would significantly affect those activities. For example, failure of the supply of affordable electricity could arise or, in the worst case scenario, an outage of power generation and transmission could occur.

As capital investments for power generation facilities typically involve extremely large sums of money, such investments must be implemented in a timely and effective manner from a middle-to-long term perspective, considering the changes in environments surrounding the power plants. This will also prevent convergence of large-scale facility retrofits and modifications during the same period. As regards the 2 power plants visited by the Study Team during the course of the first site survey, namely, Trypilska Power Station and Zmiivska Power Station (of the former state-run Centrenergo), although some units aged over 40 to 50 years in the plants has undertaken large-scale retrofits since their commercial operation dates, others have undertaken no retrofitting like mentioned previously. Thus, the introduction of simultaneous large-scale countermeasures against deterioration due to aging is required for almost all the power generation units, along with upgrading and/or renewal.

In this survey, which is based on the report of the facility diagnosis project on thermal power plant in Ukraine of 2014, which was conducted by JCOAL (See Section 3.3.5), where 4 proposals were observed. The Study Team had discussions with Centrenergo and 2 power plants based on the 4 proposals candidates.

5.1.2 Specifics of 4 proposals for improvement

As mentioned above, 4 proposals for the improvement of aged power plants have been prepared as shown in Table 5.1-1, before having discussions with 2 power plants. These proposals have been prepared and chosen on the premise where that excellent Japanese technology can be utilized to enhance the existing power plants.

Table 5.1-1 4 Proposals for Improvement of Aged Power Plants

	Proposals	Reasons behind proposal
1	Replacement of steam turbines with the turbine of the type provided in the NEDO project	In the 2 surveyed power plants, the Steam Turbine Replacement Project provided by New Energy and Industrial Technology Development Organization (NEDO) is being implemented. Following completion of the NEDO project, Trypilska Power Station will have 3 different types of steam turbines among 4 coal-fired plant units (No. 1 to 4), and Zmiivska Power Station will have 2 different types of steam turbine among 6 old units (No. 1 to 6); therefore, these plants will suffer from inefficiency due to lack of part standardization. In order to eliminate this inconvenience, all the remaining steam turbines should be replaced with turbines of the same type as those used in the NEDO project.
2	Installation/Modernization of Environmental Facilities	Dark-colored smoke emission from a stack was observed in both plants, which was assumed to be coal ash or unburned carbon that could not be collected by an electrostatic precipitator (ESP). As environmental regulations have been tightened in the European Union (EU) zone, a flue gas desulfurization (FGD) plant and a selective catalyst reduction (SCR) plant should be added, together with renewal of ESP to meet the requirement of EU's emission control.
3	Modernization of Plant Control System	The plant control rooms contain a large number of analog instruments, and operators monitor plant conditions of the analog instruments visually. They also operate operation terminal switches by themselves. While some of the monitoring screens and turbine supervisory instrumentation has been replaced with digital devices, the remaining instruments are analog and the operating switches are still old and mechanical. If Distributed Control System (DCS) is applied to these instruments for operation of the local control system, this will reduce the operator workload and improve the operation quality.
4	Modernization with GIS at switchyard	As obsolete outdoor substation designs have exposed charged parts, frequent maintenance is required, which is associated with certain risks. Explosions due to CVT deterioration are likely. Further, as old substation failure may result in outage of the power generation operation itself, the substation reliability is desirably as high as possible. As the charged parts are contained within a vessel in a Gas Insulated Switchgear (GIS), this device can prevent this type of expected failure.

Source: JICA Study Team

5.2 Overview of 2 Power Stations

5.2.1 Trypilska Power Station

(1) Overview of Power Station

Trypilska Power Station is located in the south about 45 km away from the capital of Kyiv. Operation of Unit No. 1 commenced in 1969. Operation of 4 coal-fired plants (Units No.1 to 4) and 2 gas-fired plants (Units No.5 and 6) then commenced sequentially in the period from 1969 to 1972. A supercritical plant with a unit capacity of 300 MW and a total installed capacity of 6 x 300 MW is utilized for this power plant (Note that Unit No. 2 has been already modified and modernized, with its output capacity being increased from 300 MW to the current value of 325 MW). Coal-fired plants using domestic anthracite obtained from the Donbass Region, eastern Ukraine, have been continuing to suffer from an insufficient supply of coal for power generation due to the outbreak of conflict in Ukraine. The Units No. 5 and No. 6 gas-fired plants are rarely operated because of high fuel costs; they are preserved as standby units for emergency use. A facility diagnosis was conducted for Unit No. 3 by JCOAL in 2014, and proposals from various perspectives concerning the facilities and operation were made by Japanese experts. A Steam Turbine Retrofit Project provided by NEDO is in progress, targeting Unit No. 4.

Figure 5.2-1 Trypilska Power Plant

[Steam Turbines]

6 Steam Turbines (K-300-240) was provided by Kharkiv around 1970 under the age of former Soviet Union. The following photo is No.4 Steam Turbine which is under plan of retrofit by NEDO.

Figure 5.2-2 No.4 Steam Turbine

[Condition of ash pond]

As the amount of ash 500,000 tons per year is being disposed off in the current ash pond now in use, the capacity left is getting smaller year by year. This is an urgent issue to be solved. As a countermeasure to suppress ash disposal, the following countermeasures are regarded effective, not only improvement of efficiency of existing power plants but also adoption of ash recovery system in not a wet condition now in use but a dry condition or taking regulations in effect that more utilization of coal ash can be promoted. Such countermeasures on national level review is required. Base on those, aspects of both facility and administrative policy is requested. However, it is found that additional land acquisition for ash pond is very difficult.

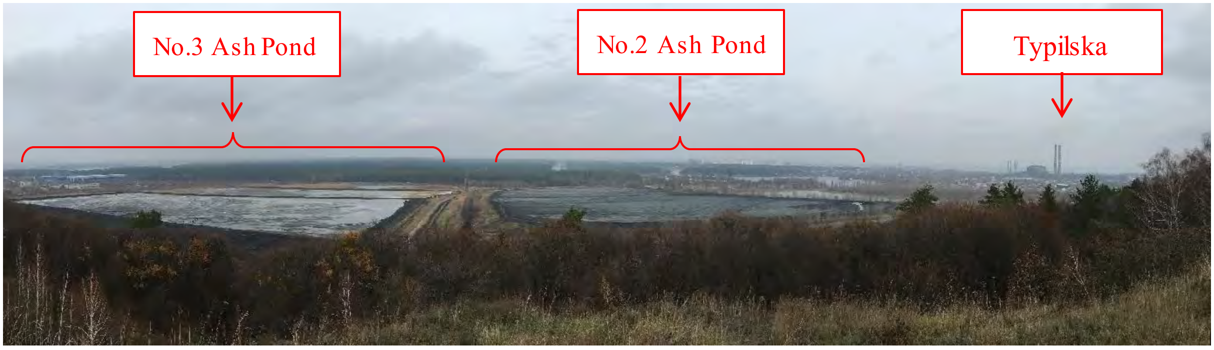


Figure 5.2-3 Distant view of Ash pond from south

Figure 5.2-4 Location of Trypilska Power Plant and its Ash Pond

[Condition of Environmental Facilities]

Units No. 1 to 4 using a coal burning boiler each have only Electrostatic Precipitators and no other environmental systems, including a Selective Calalyst Reduction (SCR) system and a flue-gas desulphurization (FGD) system, are installed. (Following the equipment renewal, a semi-dry type flue-gas desulphurization system is now being installed at Unit No. 2). Even though the flue-gas meets the domestic emission standards, it fails to meet the EU emission standards. Based on the fact that colored smoke from the chimney is observed, the performance of the installed ESPs seems to be poor to the extent that there is information suggesting negative impacts of harmful substances contained in the soot and dust from the chimneys on the surrounding area.

(Flue Gas Duct between boiler and chimney)

(Colored smoke emitting in the sky)

Figure 5.2-5 Condition of Environmental Facilities

[Condition of Control Rooms]

The output of Unit No. 2 has increased from 300 MW to 325 MW and rehabilitation of the plant control system is implemented. In regard to other units, there are many analogue instruments. Because of the general deterioration of the instruments, the plant management hopes to introduce a Distributed Control System (DCS) along with equipment renewal.

(Renewed control room (No. 2))

(Other analogue type control room)

Figure 5.2-6 Condition of Control Rooms

[Condition of Switchyard]

This switchyard was first opened in 1969 and some equipment is beyond its design life, others have spare parts exhausted in stock and cannot obtain in the market spare parts. The plant management hopes to change to a gas insulated switchgear (GIS) in view of the deterioration of the existing system to ensure a stable power supply.

Figure 5.2-7 Condition of Switchyard

Table 5.2-1 List of Trypilska Power Plant Units

Item		Unit	No.1	No.2	No.3	No.4	No.5	No.6
Commercial Operation Date		-	Dec. 1969	Mar. 1970	Nov. 1970	Dec. 1970	Oct. 1971	Sep. 1972
Manufacturer	Boiler	-	TPP-210A fabricated by Taganrog				TGMP-314 fabricated by Taganrog	
	Turbine	-	K-300-240 fabricated by Kharkiv	K-325-240 fabricated by Kharkiv	K-300-240 fabricated by Kharkiv			
	Generator	-	TGV-300, fabricated by Elektroty Azhmash	TGV-300 fabricated by Elektroty Azhmash	TGV-300 fabricated by Elektroty Azhmash			
Type	Boiler	-	Supercritical constant pressure once-through type					
	Turbine	-	Tandem compound 4-flow, reheat and regenerative, condensing type					
	Generator	-	3-phase, rotating field, horizontal and cylindrical type					
Main fuel		-	Anthracite			Natural gas		
Capacity		MW	300	325	300	300	300	300
Steam Pressure	Main steam	kg/cm^2	240	240	240	240	240	240
	Reheat steam	kg/cm^2	39	39	39	39	39	39
Steam Temperature	Main steam	℃	545	545	545	545	545	545
	Reheat steam	℃	545	545	545	545	545	545
Fuel consumption rate		g/kWh	400	350	400	400	360	360
Environmental Equipment	SCR	-	No	No	No	No	No	No
	Dust collector	-	Yes (ESP)	Yes (ESP)	Yes (ESP)	Yes (ESP)	No	No
	FGD	-	No	Under construction (Semi-dry type)	No	No	No	No
Height of chimney		M	Collective 180				Collective 180	
Environmental emission values	NOx	mg/Nm^3	1,300				500	
	Dust (having passed collector)	mg/Nm^3	1,000				5	
	SOx	mg/Nm^3	2,500				35	
Total Operational Time (as of February 2016)		hours	292,192	280,040	295,594	287,824	178,401	172,461

Source: JICA Study Team

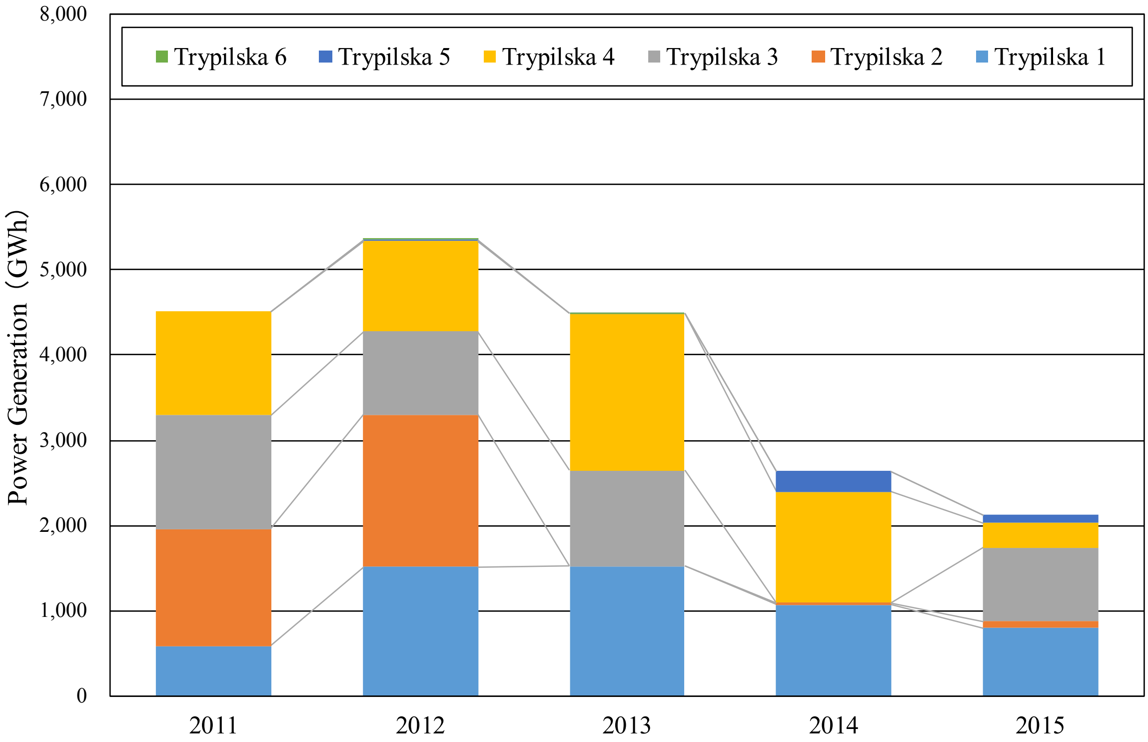
(2) Operational Condition of Trypilska Power Station

Trypilska Units No.1 to 4 have had far less power generation and indication of Plant Load Factor (PLF) in 2014 and 2015 due to difficulty in coal procurement since the conflict occurred in Donbass region on February 2014 (See Figure 5.2-8). Unit No. 2 have kept shutdown long because of lack of anthracite since the year 2013, even though the reconstruction was almost completed, which contains large-scale retrofit like renewal of steam turbine and new installation of FGD. The power plant got coal for generation after that, general test runs was underway when the Study Team visited there on November 2015. Units No. 5 and No.6 have been regarded for emergency purposes, which were constructed as natural gas-fired plants. Unit No.6 in particular have had few operational hours for past 5 years due to high fuel cost (See Figure 5.2-9). In addition, for independence from heavy anthracite use, the power plant is planning to make a retrofit converting anthracite-fired to bituminous-fired on a certain unit based on request from MECI issued on February 2016.

Table 5.2-2 Power Load Factors on Trypilska Power Station Units

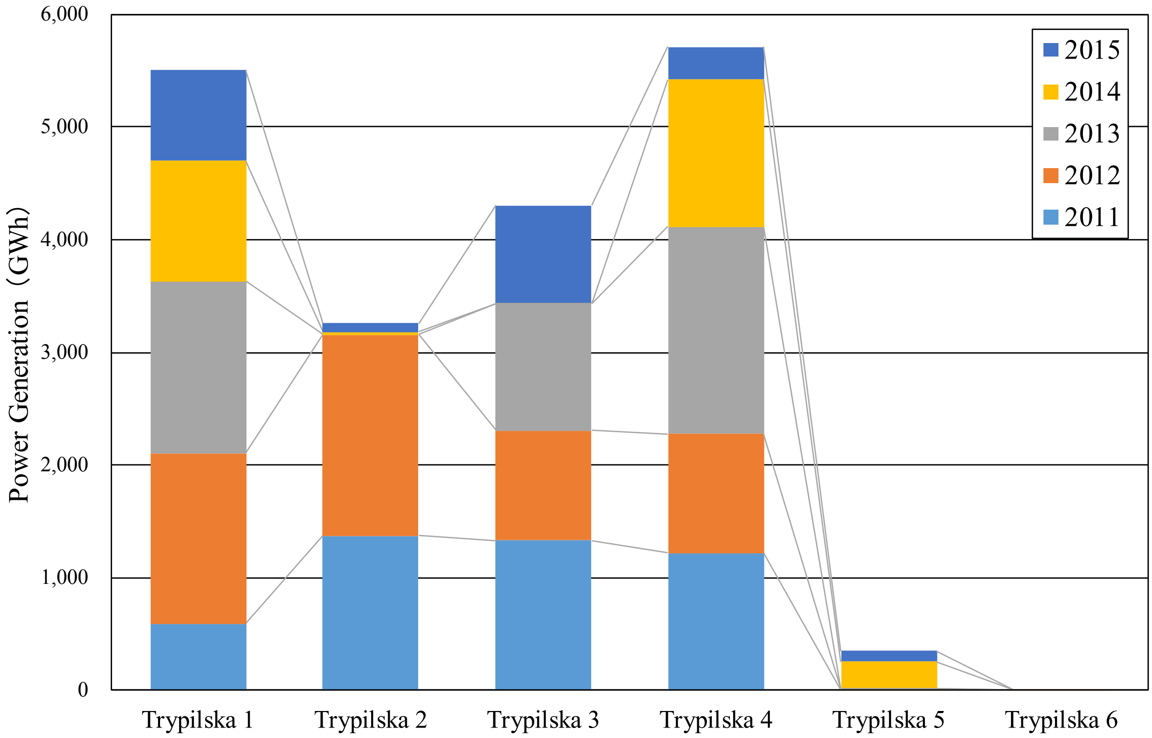
	No.1	No.2	No.3	No.4	No.5	No.6
Fuel	Anthracite				Natural Gas	
2011	22.5%	52.1%	50.7%	46.4%	0.0%	0.0%
2012	57.6%	26.1%	37.1%	40.2%	0.6%	0.1%
2013	58.0%	0.0%	42.8%	70.0%	0.0%	0.0%
2014	40.8%	0.8%	0.0%	49.7%	9.1%	0.0%
2015	30.5%	2.6%	33.1%	11.0%	3.6%	0.0%

Source: JICA Study Team based on the historical data from Centrenergo



Source: JICA Study Team based on the historical data by Centrenergo

Figure 5.2-8 Total power generation of each year in Trypilska Power Plant (2011 to 15)



Source: JICA Study Team based on the historical data by Centrenergo

Figure 5.2-9 Total power generation of each unit in Trypilska Power Plant (2011 to 15)

5.2.2 Zmiivska Power Station

(1) Overview of Power Station

Zmiivska Power Station is the oldest of 3 power plants owned by Centrenergo. Unit No. 1 and No. 10 commenced their operations in 1960 and 1969, respectively. Among these, each of Units No. 1 to 6 has an installed capacity of 175 MW, whereas each of Units No. 7 to 10 units has an installed capacity of 300 MW. (Note that Unit No. 8 was retrofitted with increased output of 325 MW as supply capacity augmentation countermeasure following the accident at Chornobylska Nuclear Power Station.) As fuel, this power station uses anthracite mined in the Donbass region, eastern Ukraine, similar to the Trypilska power station. At present, combustion testing for the extended utilization of mixed burning with bituminous coal is being conducted, so that Zmiivska Power Staion will not be reliant on anthracite alone. A Steam Turbine Retrofit Project provided by NEDO is now in progress, targeting Unit No. 3. For Units No. 9 and 10, the same facilities as those installed in Units No. 1 to 4 of Trypilska power station have been installed.

Figure 5.2-10 Zmiivska Power Station

[Condition of Environmental facilities]

No Units have the SCR or FGD facility. Although the Power Plant meets the emissions control standards of Ukraine, it doesn't meet the EU environmental standards. (However, Unit No. 8 meets the EU dust concentration standard since its thermal efficiency as well as flue-gas treatment ability increased thanks to the improvement that the unit went through as part of the supply measures taken after the meltdown at Chornobylska.) Every Unit are already equipped with scrubbers or ESP; however, with their poor performance (except Unit No.8), colored flue gas emitted from chimney was able to be seen.

Figure 5.2-11 Smoke from chimneys (yellow-colored flue gas was seen)

[Condition of ash disposal area and water pond for cooling]

With the tight capacity of the ash disposal area, it is urgent to tackle ash disposal issues by raising the height of the ash disposal area or other measures. As a countermeasure to suppress ash disposal, the following countermeasures are regarded effective, not only improvement of efficiency of existing power plants but also expansion of effective ash utilization. Such countermeasures on national level review is required. Another issue is cooling water for condenser use. The water is taken from the cooling pond; however, the pond has become shallow with sediment flowing in, causing a drop in efficiency and output due to high water temperature in summer.

Figure 5.2-12 Distant view of ash disposal area

Figure 5.2-13 Location of Zmiivska Power Plant, Ash Disposal Area and Cooling Water Pond

[Condition of Switchyard]

The switching yard has been in operation since 1960, and uses devices that are beyond their design lives or whose spare parts have run out and cannot be procured (thus have to be manufactured at the plant). In this light, the Power Station looks forward to the adoption of GIS.

(Switchyard)

(Transformer)

Figure 5.2-14 Condition of Switchyard

Table 5.2-3 List of Zmiivska Power Station Units (Subcritical Units: No.1to 6)

Item		Unit	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Commercial Operation Date		-	Dec. 1960	Dec. 1961	Dec. 1962	Nov. 1963	Jul. 1964	Jun. 1965
Manufacturer	Boiler	-	TPP-100, fabricated by Taganrog					
	Turbine	-	K-200-130, fabricated by LMZ					
	Generator	-	TGV-200, fabricated by Elektroty Azhmash					
Type	Boiler	-	Subcritical drummed type					
	Turbine	-	Tandem compound, 4-flow, reheat and regenerative, condensing type					
	Generator	-	3-phase, rotating field, horizontal and cylindrical type					
Main fuel		-	Anthracite					
Capacity		MW	175	175	175	175	175	175
Steam Pressure	Main steam	kg/cm^2	130	130	130	130	130	130
	Reheat steam	kg/cm^2	25	25	25	25	25	25
Steam Temperature	Main steam	℃	545	545	545	545	545	545
	Reheat steam	℃	545	545	545	545	545	545
Fuel consumption rate		g/kWh	400–420					
Environmental Equipment	SCR	-	No	No	No	No	No	No
	Dust collector	-	Yes (Scrubber)	Yes (Scrubber)	Yes (Scrubber)	Yes (Scrubber)	Yes (Scrubber)	Yes (Scrubber)
	FGD	-	No	No	No	No	No	No
Height of chimney		m	Collective 120		Collective 120		Collective 180	
Environmental emission values	NOx	mg/Nm^3	925					
	Dust (having passed collector)	mg/Nm^3	3,500					
	SOx	mg/Nm^3	2,950					
Total Operational Time (as of February 2016)		hours	318,215	315,990	287,635	302,729	305,104	297,805

Source: JICA Study Team

Table 5.2-4 List of Zmiivska Power Station Units (Supercritical Units: No. 7 to 10)

Item		Unit	No. 7	No. 8	No. 9	No. 10
Commercial Operation Date		-	Sep. 1967	Dec. 1968	Jun. 1969	Dec. 1969
Manufacturer	Boiler	-	TPP-210, fabricated by Taganrog		TPP-210A	
	Turbine	-	K-300-240, fabricated by Kharkiv	K-325-23.5, fabricated by Siemens-Turboatom	K-300-240, fabricated by Kharkiv	
	Generator	-	TGV-300 fabricated by Elektrotyazhmash	TGV-325	TGV-300	
Type	Boiler	-	Supercritical constant pressure once-through type			
	Turbine	-	Tandem compound, 4-flow, reheat and regenerative, condensing type			
	Generator	-	3-phase, rotating field, horizontal and cylindrical type			
Main fuel		-	Anthracite			
Capacity		MW	285	325	280	290
Steam Pressure	Main steam	kg/cm^2	240	240	240	240
	Reheat steam	kg/cm^2	37	37	37	37
Steam Temperature	Main steam	℃	545	545	545	545
	Reheat steam	℃	545	545	545	545
Fuel consumption rate		g/kWh	390–410	345–360	400–420	390–410
Environmental Equipment	SCR	-	No	No	No	No
	Dust collector	-	Yes (ESP)	Yes (ESP)	Yes (ESP)	Yes (ESP)
	FGD	-	No	No	No	No
Height of chimney		m	Collective 250		Collective 250	
Environmental emission	NOx	mg/Nm^3	1,400	1,700	1,400	1,400
	Dust (having passed collector)	mg/Nm^3	2,500	285	2,500	2,500
	SOx	mg/Nm^3	3,700	4,600	3,600	3,400
Total Operational Time (as of February 2016)		hours	256,689	275,043	244,456	264,260

Source: JICA Study Team

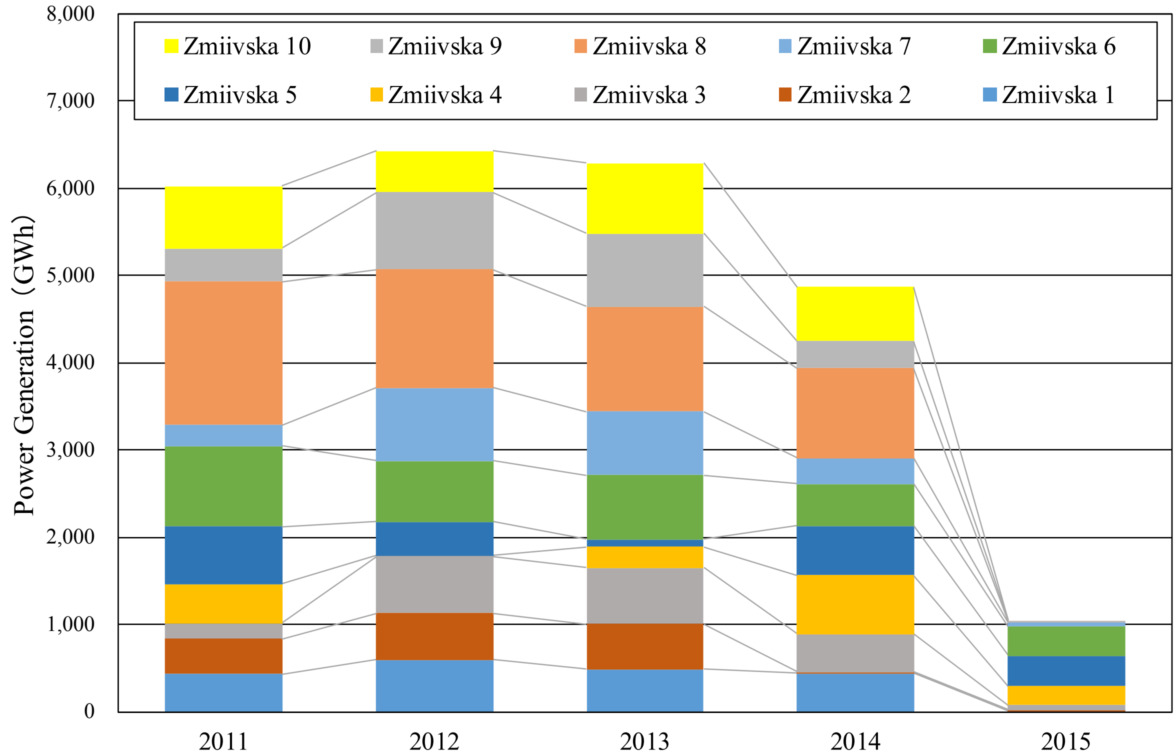
(2) Operational Condition of Zmiivska Power Station

Zmiivska Power Station have had far less indication of PLF since 2014 due to the same anthracite produced in eastern Ukraine as those used in Trypilska Power Station, whereas high PLF had been kept until 2013 (See Figure 5.2-15). Unit No.8, with improvement of thermal efficiency, has played the most important role as main facility of the power stations since its retrofit in 2005. However, lack of anthracite could be avoided even in Unit No.8, resulting in a drop in PLF. Under the circumstances, Zmiivska Power Station is conducting mix-firing test with bituminous coal to aim at independence from anthracite.

Table 5.2-5 Power Load Factors on Zmiivska Power Station Units

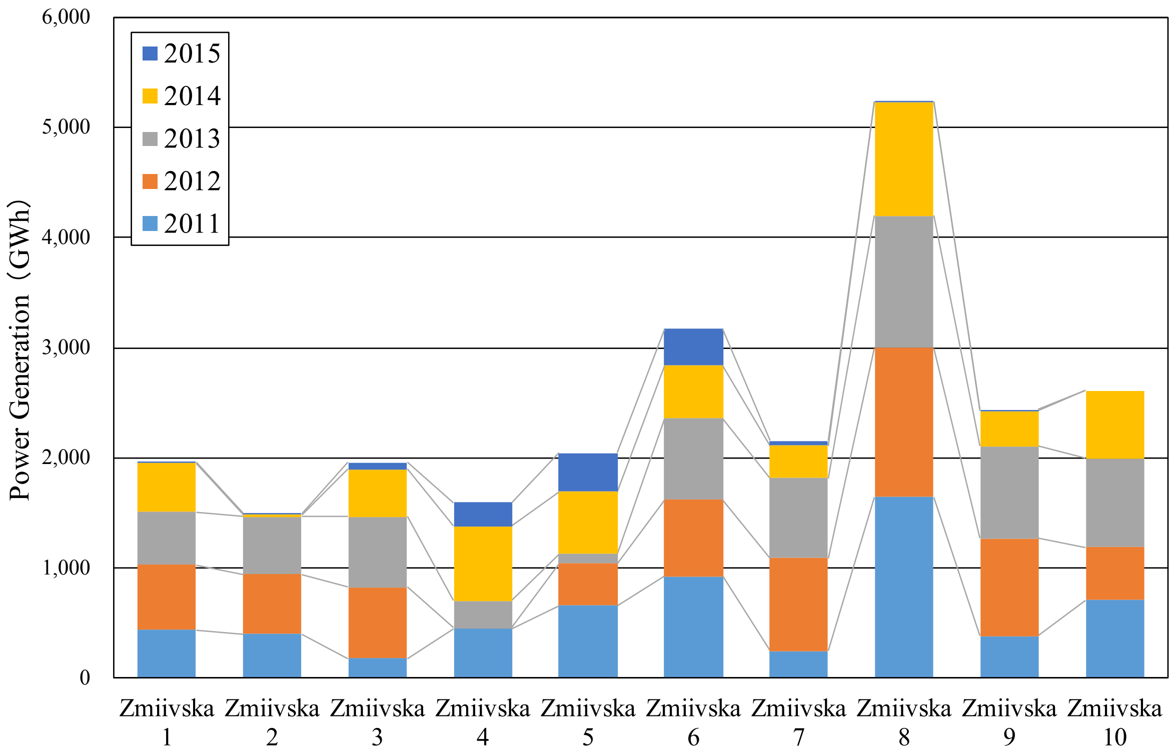
	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10
Fuel	Anthracite									
2011	28.4%	26.0%	11.5%	11.5%	42.9%	60.2%	9.9%	57.7%	15.6%	28.0%
2012	38.6%	35.3%	42.5%	42.5%	25.2%	45.5%	33.8%	47.5%	36.0%	18.8%
2013	31.5%	34.4%	41.6%	41.6%	5.5%	48.1%	29.2%	42.2%	34.3%	31.7%
2014	28.8%	1.0%	28.3%	28.3%	36.9%	31.2%	11.8%	36.2%	12.8%	24.3%
2015	0.4%	0.8%	3.8%	3.8%	22.7%	21.8%	1.8%	0.3%	0.7%	0.0%

Source: JICA Study Team based on the historical data by Centrenergo



Source: JICA Study Team based on the historical data by Centrenergo

Figure 5.2-15 Total power generation of each year in Zmiivska Power Station (2011 to 15)



Source: JICA Study Team based on the historical data by Centrenergo

Figure 5.2-16 Total power generation of each unit in Zmiivska Power Station (2011 to 15)

5.3 Supporting Needs in Coal-Fired Thermal Power Generation field

5.3.1 Trypilska Power Station

The 4 proposals prepared by the Study Team were generally accepted as candidate projects requiring further assistance by the power station staff. Regarding items specific to Trypilska power station, this plant included failure of main valves in boiler system, the power station staff requested Japanese assistance for upgrading of the valves' components located in rear flue gas dust via the flue gas duct to the flue chimney inlet. Further, the Trypilska power station has a problem with poor ESP performance and colored smoke is continuously emitted from its stack, as shown in Figure 5.2-11. It is assumed that coal ash that cannot be collected by ESP has caused blade erosion of the Induced Draft Fan (IDF) located downstream of ESP (the blades must be replaced every year, except in the case of Unit No. 1, for which the ESP performance has been improved by the past retrofit.). As a result of the IDF blade erosion, the prescribed furnace draft has not been maintained in boilers, nor has the feeding air necessary for combustion been provided by the Forced Draft Fan (FDF); this has lowered the output of the entire plant. In cases where ESP has high collection capability, the only smoke emitted from a chimney is generally a white-colored one, i.e. pure steam. In the case of Trypilska Power Station, it is assumed that the source of the observed colored smoke is fugitive unburned coal ash due to the ESP's inability to collect this material or, alternatively, unburned pulverized coal due to insufficient air supply by FDF.

Table 5.3-1 Opinions of Trypilska Power Station

Focus point	Opinion
Countermeasures against deterioration due to aging	➢ Overall, sufficient countermeasures against deterioration due to aging have not been taken. Replacement of some components of old units that have been in operation for approximately 40 years will not yield a fundamental solution; comprehensive rehabilitation will be required for such old units. ➢ The only and best solution is the construction of a new unit, No. 7.
Fuel conversion	➢ Anthracite coal reserves are over-concentrated in the eastern part of Ukraine and continuous procurement of anthracite is now difficult. It is, therefore, desirable to modify the boilers from anthracite-fired to bituminous coal-fired units. ➢ In the case of new construction, a bituminous coal-fired plant is desirable.
Environmental countermeasures	➢ The existing plants comply with Ukrainian domestic regulations of emission, but not with EU regulations. Therefore, urgent upgrades are desirable.
Ash pond countermeasures	➢ The remaining capacity to allow for further disposal is very limited. To ensure continuous operation of this power plant, the highest priority is placed on this issue.
Boiler plant problem	➢ There is frequent leakage from the valves located inside the boilers. These valves should be replaced, along with all parts connected to components from the flue gas duct of the boiler to inlet of the associated stack (the duct, IDF, etc.).
4 proposals from Study Team	➢ In general, the power plant staff agree with our proposals. ➢ The staff would like to make a decision on the turbine retrofit after they obtain the results of the demonstration project planned by NEDO.

Source: JICA Study Team

5.3.2 Zmiivska Power Station

As in the case of Trypilska power station, the 4 proposals prepared by the Study Team were generally accepted as candidate solutions requiring future assistance. Regarding items specific to Zmiivska Power Station, the staff requested assistance with promotion of power plant automation and enhancement of the grid connecting requirement function (expansion of the load sliding range, the addition of a frequency control function, and an increase in the load moving rate). The emission of colored smoke from a chimney was also observed at this power station. As this is a symptom of some fault from a boiler to the flue gas duct, insufficient ESP collection capability was again assumed, as for Trypilska Power Station.

Table 5.3-2 Opinions of Zmiivska Power Station

Focus point	Opinion
Countermeasures against deterioration due to aging	➢ Overall, sufficient countermeasures against deterioration due to aging have not been taken. Replacement of some components of old units that have been in operation for approximately 50 years will not yield a fundamental solution; comprehensive rehabilitation will be required for such old units. ➢ The construction of a new unit, Unit No.11, is also desirable.
Fuel conversion	➢ Anthracite coal reserves are over-concentrated in the eastern part of Ukraine and continuous procurement of anthracite is difficult. It is, therefore, desirable to modify the boilers from anthracite-fired to bituminous coal-fired units. ➢ In the case of new construction, a bituminous coal-fired plant is desirable.
Environmental countermeasures	➢ The plants do not comply with EU regulations. Therefore, urgent updates are desirable.
Ash pond countermeasures	➢ The remaining capacity to allow for further disposal is very limited. To ensure continuous operation of this power plant, the highest priority is placed on this issue.
Enhancement of grid connecting requirement function	➢ In response to requirements from the grid side of operations, expansion of the load sliding range, addition of a frequency control function, and an increase in the load moving rate are desirable.
4 proposals from Study Team	➢ In general, the power plant staff agree with our proposals. ➢ Promotion of DCS introduction is especially desirable. ➢ This plant is faced with a shortage of replacement parts and consumables of GIS. ➢ The power plant staff would like to make a decision on the turbine retrofit after they obtain the results of the demonstration project.

Source: JICA Study Team

5.3.3 Centrenergo

In general, the 4 proposals for improvement prepared by the Study Team were accepted by Centrenergo. In particular, the company realized that upgrading the environmental facility is a pressing and urgent challenge. In addition, as procurement of anthracite has become difficult, Centrenergo has requested construction of a new bituminous coal-fired plant or the reconstruction of an existing plant (i.e., the demolition of an existing plant followed by new construction or “Scrap and Build”) as a candidate project requiring assistance.

Table 5.3-3 Opinions of Centrenergo

Focus point	Opinion
Countermeasures against deterioration due to aging	➢ In the case of new construction, a bituminous coal-fired plant is desirable. ➢ For the gas-fired No.5 and No.6 units of Trypilska power station, “Scrap and Build” or fuel conversion is possible.
Fuel conversion	➢ Anthracite coal reserves are over-concentrated in the eastern part of Ukraine and continuous procurement of anthracite is difficult. It is, therefore, desirable to modify boilers from anthracite-fired to bituminous coal-fired facility.
Environmental countermeasures	➢ The plants do not comply with EU regulations; this is a high-priority issue. ➢ Higher priority is placed on Trypilska Power Station, which is nearer to the Kyiv Region than Zmiivska Power Station.

Source: JICA Study Team

5.3.4 Ministry of Energy and Coal Industry of Ukraine (MECI)

MECI realized that the problems affecting the coal-fired thermal power station in Ukraine have become difficult in procuring anthracite and restricted ash pond capacity, and requested Japanese assistance in this area.

Table 5.3-4 Opinions of MECI

Focus point	Opinion
Fuel conversion	➢ MECI realized that new construction and/or retrofitting of plants to facilitate fuel conversion from anthracite-fired to bituminous coal-fired operations is a political challenge that should be supported by the Government of Ukraine.
Ash pond countermeasures	➢ MECI realized that the ash pond countermeasures are an issue that requires national resolution in order to ensure continuous utilization of coal-fired thermal power plants.

Source: JICA Study Team

5.4 Study of Candidates for Support

Table 5.4-1 Overview of project candidates in coal-fired thermal power generation field

Item	(i)Installation/Modernization of Environmental Facilities	(ii)Modernization of Control System (Upgrading to DCS)	(iii) Modernization with GIS at switchyard	(iv) Replacement of Turbines
Target (Equipment Owner/Business Operator)	Centrenergo(C)/ Trypilska(T)/Zmiivska(Z)	Trypilska(T)/Zmiivska(Z)	Trypilska(T)/Zmiivska(Z)	Trypilska(T)/Zmiivska(Z)
Outline of the Project	➢ Modernize existing ESP and install newly FGD/SCR	➢ Modernize plant control system of the plant by replacing with DCS.	➢ Modernize the circuit breakers at the switchyard by GIS.	➢ Replace the steam turbine with those of the same model introduced under the NEDO project.
Background of Project Selection and Supporting Request from Counterpart	➢ This project is selected from 4 proposals and reached agreement with C/T/Z. ➢ C/T/Z realize the compliance with EU environmental regulations is pressing issue.	➢ This project is selected from 4 proposals after reached agreement with T/Z. ➢ This proposal can solve highest workload on operators due to obsolete design of existing control system.	➢ This project is selected from 4 proposals after reached agreement with T/Z. ➢ The consumables and spares of the existing switchyard have run out due to old design.	➢ This project is selected from 4 proposals after reached agreement with C/T/Z.
Work Period (Short-, Medium- or Long-Term)	Short (approx. 1 to 3 years)	Short (approx. 1 to 3 years)	Short (approx. 1 to 3 years)	Medium (approx. 4 to 5 years)
Estimated Cost	approx. JPY 5 billion / 300 MW (assumed by Study Team)	approx. JPY 600 million per Unit (assumed by Study Team)	T: approx. JPY 12.5 billion Z: approx. JPY 9.5 billion (assumed by Study Team)	approx. JPY 5 billion /300 MW (assumed by Study Team)
Availability of Japanese Technology (Technical Superiority/Interest in Ukraine)	➢ Japanese product is proud of its availability even in narrow space. ➢ Japanese company has great interest in Ukraine.	➢ Technical superiority is on the same level as compared to foreign products. ➢ Japanese company has great interest in Ukraine.	➢ Technical superiority is on the same level as compared to foreign products. ➢ Japanese company has great interest in Ukraine.	➢ Technical superiority will be demonstrated by NEDO project. ➢ Japanese company has great interest on this project following NEDO project.
Expected Project Effectiveness	➢ Synergetic effect is expected by modernizing ESP not only reducing frequency of replacing IDF blades but complying with EU environmental regulations.	➢ There is possibility in saving workforce by easier operations.	➢ Reliability of switchyard is improved by continuous genuine consumables/spares, therefore, the risk of general outage will be reduced. In addition, safe operation will be also secured.	➢ The introduction of latest design of steam turbine contributes to expansion of output and improvement in plant thermal efficiency ➢ Sharing spares between replaced turbines will be more convenient.
Possibility of Governmental Guarantee	➢ Since the plant is considered for privatization, the governmental guarantee is unavailable.	Same as left	Same as left	Same as left
The steps to be taken next and pending issues, etc.	➢ This project is closed because of non-availability of governmental guarantee.	Same as left	Same as left	➢ C/T/Z is to make a decision to apply to the rest of Units after demonstrating the performance of first trial.

Source: JICA Study Team

Item	(v)Fuel conversion for Boiler/ Remodeling of Boiler	(vi) Installation of New Unit at existing power plant	(vii) Installation of New Unit at 3rd point
Target (Equipment Owner/Business Operator)	Centrenergo(C)/Trypilska(T)/ Zmiivska(Z)/MECI(M)	Trypilska(T)/Zmiivska(Z)	Centrenergo(C)
Outline of the Project	➢ Convert anthracite-firing to bituminous-firing in existing boilers. ➢ Or Reconstruct the obsolete boiler with latest technology.	➢ Trypilska No.7 or Zmiivska No.11 is to be constructed neighboring existing power plant premises. ➢ Supercritical or ultra-supercritical technology with 600 MW and bituminous-firing is envisaged.	➢ New installation of power plant is to be constructed at 3rd point with bituminous-firing.
Background of Project Selection and Supporting Request from Counterpart	➢ This project is selected based on the fact that unstable condition to obtain anthracite still remains unsolved. ➢ The project also agrees to governmental policy to move away from anthracite.	➢ The existing infrastructure can be utilized and shared for this project. New installation is imperative in view of medium-/long-term plan. ➢ This request is much expected by Ukraine due to existing obsoleteness.	➢ This project is selected as solve comprehensive solution which can solve pending issues of (vi) (ash pond, double handling facilities between anthracite and bituminous coal) ➢ This request is much expected by Ukraine due to existing obsoleteness.
Work Period (Short-, Medium- or Long-Term)	Long (approx. 6 to 10 years)	Long (approx. 6 to 10 years)	Long (approx. 6 to 10 years)
Estimated Cost	Unknown (Scope yet to be decided)	approx. JPY 100 billion per 600 MW supercritical (assumed by Study Team)	Same as left
Availability of Japanese Technology (Technical Superiority/interest in Ukraine)	➢ There expected to be a lot of difficulties to conduct this project because this project should follow original designing basic concept and development philosophy of OEM in former Soviet Union. ➢ Japanese company has little interest in this project.	➢ Japanese ultra-supercritical technology has a big advantage compared to foreign players. ➢ Japanese company has great interest in the new installation in Ukraine.	Same as left
Expected Project Effectiveness	➢ Fuel conversion to bituminous firing contributes to a variety of coal procurement later on. ➢ Remodeling of boilers contributes to improvement in plant thermal efficiency.	➢ Introduction of bituminous-firing improves a variety of fuel procurement and obsolete plants will be replaced by this plant, therefore, fuel cost and environmental load is fairly reduced.	➢ In addition to the effect of (vi), pressing problem on ash pond can be solved.
Possibility of Governmental Guarantee	➢ Since the plant is considered for privatization, the governmental guarantee is unavailable.	Same as left	Same as left
The steps to be taken next and pending issues, etc.	➢ This project is closed because of non-availability of governmental guarantee.	Same as left	Same as left

Source: JICA Study Team

5.5 Laws and Regulations and Procedure to implement the Support Program

Table 5.5-1 shows the laws and regulations applicable in the case of repair and new construction of thermal power generation facilities for the realization of the EU Directive.
In addition, the adaptation of EU standards of control characteristics and environmental standards is important as shown in Table 5.5-2 to connect to EU network.
See Appendix, List of Laws and Regulations related to Energy Sector in Ukraine.

Table 5.5-1 Major laws and regulations related to thermal power generation

Ukrainian Laws and Regulations	EU Directive
➢ The Protocol of joining the Energy community treaty by Ukraine ➢ Order No.733-p of the Cabinet of the Ministries of Ukraine 'On approval of the action plan for implementation the obligations under the Energy Community Treaty establishment', dated Aug.3, 2011, amended on Oct .7, 2015 ➢ Order No.1080-p of the Cabinet of the Ministries of Ukraine 'On signing an additional agreement No.1 between Ukraine and the European Union, represented by the European Commission, on amending the Agreement on financing the program "Continue to support the realization of the Energy Strategy of Ukraine", dated Dec.20, 2013', dated Oct.13, 2015	➢ Directive 2001/80/EC of Oct.23, 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants ➢ Directive 2006/32/EC of Apr.5, 2006 on energy end-use efficiency and energy services 407 ➢ Directive 2009/28/EC of Apr.23, 2009 on the promotion of the use of energy from renewable sources ➢ Regulation (EC) No 715/2009 of Jul.13, 2009 on conditions for access to the natural gas transmission networks

Source: JICA Study Team

Table 5.5-2 related laws and regulations of the repair and construction of thermal power generation

Item	Laws and Regulations
1.Adaption to EU standards for the control characteristics of the turbine	Feb.25,2010 MECI Order No. 75 Standard Specification on Modernization of 200 MW and 300 MW thermal power plant for Regulation Frequency and Power
	➢SOU N EE YEK 04.156:2009 Basic Requirements for frequency regulation and OES-power in Ukraine. Guidance ➢SOU N EE YEK 04.157:2009 Methods and recommendations of primary and secondary frequency and capacity regulation at thermal power plant (TPP) ➢SOU N EE YEK 04.160:2009 Methods and recommendations on readiness proverke thermal power plants, hydro and nuclear power plants to participate in the regulation frequency-power and OES in Ukraine.
	Modernization of following equipments are required. -Governing System(Replace existing Mechanical Hydrlaulic Control system to Electric Hydlaulic Control System) -Steam Supply System (Main Stop Valves, Control Valves and Reheat Stop Valves)
2. The introduction of environmental equipment in order to adapt to European environmental standards	Sep.25,2008 On Amendments to the Law of Ukraine "On Electrical Power Industry" If the repair of turbine equipment has been carried out in a power plant renovation frame, start of operation is not allowed in the unit. Only within the allowable value of emissions of harmful substances.

Source: JICA Study Team

5.6 EU Request for frequency stability and load tracking capability

Ukrainian power network is planning to connect to the European power network (ENTSO-E) in 2018. (Already in the Burshtynska power station is connected to the European power electricity network.)

Therefore, Ukraine's power generation facilities are required to satisfy the frequency stability and the load tracking capability shown in Table 5.6-1 according to UCTE standards.

[Allied Law is Feb.25,2010 MECI Directive No. 75]

"About the speed and technical requirements that the case is the application of modernization (modernization) of 200 MW and 300 MW unit of the thermal power plant to be carried out in order to ensure the output adjustment".

Table 5.6-1 Frequency stability and the load tracking capability requested by UCTE

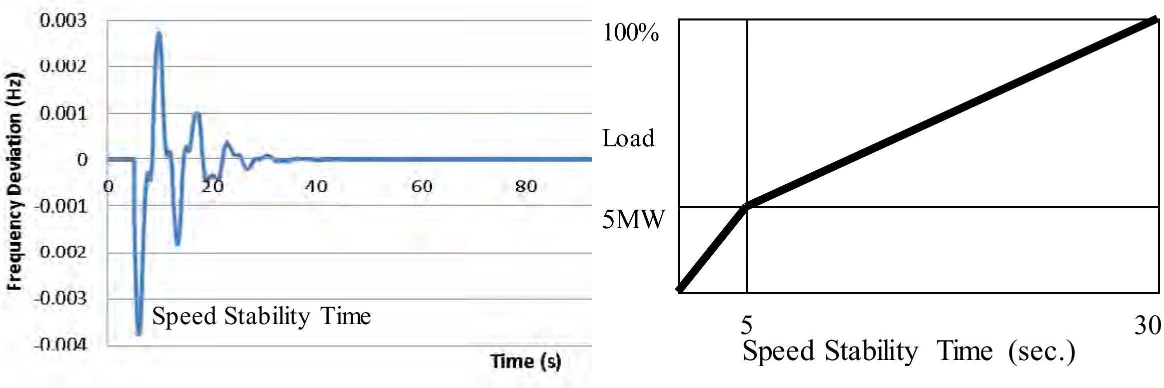
Facilities	Items		Requirements	
Boiler	Load Operating Range		200 MW	300 MW
			60-100%	63-100%
Turbine Generator	Frequency Control Range		within 0.3%	
	Allowable Load Fluctuation from 80 to100% Load		10-15%	
	Rotation Speed Stability Time	5 MW move	5 seconds	
		At 100% load	30 seconds	
	Allowable Operating Frequency		49.5-50.2 Hz	
District Heat	Load range at heat supply	Summer	50-100%	
		Winter	70-100%	

Source: JICA Study Team

In addition, the Speed Stability Time is defined the time to stabilize the frequency fluctuation when the turbine generator is operating with Primary Frequency Mode (called the governor-free operation in Japan) and a step load change is occurred during operation.

Requested time at 5 MW load moving operation is 5 seconds, 100% load operation 25 seconds. Therefore 30 seconds is the time of a total of 100% load operation.

Figure.5.6-1 shows the defined Speed Stability Time and the relation to the load.



Source: JICA Study Team

Figure 5.6-1 Speed Stability Time and the relation to the load

5.7 Environmental Laws and Regulations requested to thermal power generation

Table 5.7-1 shows the environmental standards required by the repair and new construction of thermal power plants in Ukraine.
The current requested values are based on 2001/80/EC, but the values based on 2010/75/EU being requested by EU has not yet been established in Law of Ukraine Law and strongly desired in the approval of future plans.

Table 5.7-1 European Environmental Regulation Value (mg/Nm^3)

<table>
<tr><th rowspan="2"></th><th colspan="4">2001/80/EC</th><th colspan="6">2010/75/EU</th></tr>
<tr><th>Output</th><th>Solid</th><th>Liquid</th><th>Gas</th><th>Output</th><th>Coal</th><th>Biomass</th><th>Peat</th><th>Liquid</th><th>Gas</th></tr>
<tr><td rowspan="3">Dust</td><td>≦500MW</td><td>50</td><td rowspan="3">50</td><td rowspan="3">5</td><td>≦100MW</td><td>30</td><td colspan="2">30</td><td>30</td><td rowspan="3">5
BFG:10</td></tr>
<tr><td rowspan="2">>500MW</td><td rowspan="2">100</td><td>≦300MW</td><td>25</td><td colspan="2">20</td><td>25</td></tr>
<tr><td>>300MW</td><td>20</td><td colspan="2">20</td><td>20</td></tr>
<tr><td rowspan="3">SO2</td><td>≦100MW</td><td>850</td><td>850</td><td rowspan="3">35
Liquid:5</td><td>≦100MW</td><td>400</td><td>200</td><td>300</td><td>350</td><td rowspan="3">35
Liquid:5</td></tr>
<tr><td>≦300MW</td><td>200</td><td>200-400
Linier</td><td>≦300MW</td><td>250</td><td>200</td><td>300</td><td>250</td></tr>
<tr><td>>300MW</td><td>200</td><td>200</td><td>>300MW</td><td>200</td><td>200</td><td>200</td><td>200</td></tr>
<tr><td rowspan="3">NOx</td><td>≦500MW</td><td>600</td><td>450</td><td>300</td><td>≦100MW</td><td>300</td><td colspan="2">300</td><td>450</td><td rowspan="3">200
GT/
GE:100</td></tr>
<tr><td rowspan="2">>500MW</td><td rowspan="2">200</td><td rowspan="2">400</td><td rowspan="2">200</td><td>≦300MW</td><td>200</td><td colspan="2">250</td><td>200</td></tr>
<tr><td>>300MW</td><td>200</td><td colspan="2">200</td><td>150</td></tr>
<tr><td>Goal</td><td colspan="4">Dec.31,2015</td><td colspan="6">Dec.31,2027</td></tr>
</table>

Source: JICA Study Team

5.8 Possibility of entry of Japanese companies

The 4 proposals and new installation of generation unit (Trypilska No.7, Zmiivska No.11) or the one at 3rd point) expects to employ Japanese companies because their needs to participate is also the same in these project candidates. In particular, a lot of cases often finds new plant counstruction diffcult to arrange on the existing premises because it is very narrow, however, Japanese manufacuturers have experienced a lot to construct urban-side coal-fired thermal power plant, with the well-trained know-how like not only effectively arrangement of facilities, but also steady progress on schedule as well as keeping high quality of construction. In brief, Japanse companies have great advantages of not only hard aspect but also soft one. Replacement of turbines taken up in this Section, the input design is limited only to steam condition, and its auxilirary facility don't need additional space to install. Hence, the work is not relatively diffcult to conduct even by not OEM of the facility, but 3rd engineering. If the performance of preceding project is evaluated excellent, the possibility of winning the following projects by preceding the Japanese company will be much higher, the advantage of the project can be also shared with Ukraine side.

Regarding Fuel conversion for Boiler/ Remodeling of Boiler, the design input must cover 3 conditions lke fuel, air and water. The 3rd manufacturer different from OEM must take care of original design philosophy, therefore, it is rather difficut for them to conduct the work. In addition, in case where Trypilska Units No.5 and NO.6 is replaced with coal-firing, it will be far more difficult to conduct because a lot of additonal facilities are requested in the limited existing space, which don't exist at gas-fired plant. In the case where fuel conversion from anthracite-firing to bituminos-firing, the capacity of coal handling plant and coal yard storage for 2 type of coal should be confirmed.

Based on above fuel conversion/ remodeling of boiler should be taken care of throughout a lot of consideration. Furthermore, since higher hardle to participate in these works will be given to the contracted manufacturer, Japanese company is deemed not to participate in these works.

5.9 Conclusion

5.9.1 Overall

Trypilska and Zmiivska power station of Centrenergo have experienced long time flow; the oldest plant was about 50 years old from its commercial operation date(COD). In general, since the power plant can suvive and extend their life by replacing partially with new system, it is difficult to limit their life expectancy to a certain fixed period. The philosophy of life extension often varies by internal or extenal circumstances like the present surrounding situation; running out of the comsumables and spares, regulations newly introduced after its COD, external request to reduce generation cost by pursuing effectiveness of operation, relatively lowered generation efficiency by new unit installation and so on. The discussion on how to maintain the obsolete facilities should be conducted with a target of certain years aging. In this point, 40 years aging is considered to be a good opptunity to discuss it. In Ukraine, a lot of power plants were constructed in 1960s to 1970s. Now, it is time to examine how to handle this matter.

Considering the current situation of power plant facilities, it is the best solution to construct the new unit. However, adding new unit to the exisiting power plant is relativey short than new construction at 3rd point. Even in this case, it takes 6 to7 years (selection of EPC takes 2 years and construction takes 4 to 5 years) at the shortest from Loan Agreement (L/A) execution. During this period, the aging at the existing power plants goes further. The close balance of new construction and partially rehabilitation should be taken of from both short- and medium/long-term perspective.

For obsolete facilities, bold measures shold be taken like giving up repair and restart when critical shutdown happens, after new installation is established.

From above view points, the 4 proposal which can be made in relatively short time and the new installation which needs long period, are recommended.
Furthermore, other apprehension toward continuos operation from the staff of the power station was observed like little residual life of ash pond. Althoufh these requests are understandable on the same point of power plant operator, there is few advantages for Japanese companies to tackle this problems. Those viewpoint excluded these requests as project candidates.

5.9.2 Possibility of granting governmental guarantee

As shown in Section 2.4.2 (3), the stock to have been owend by the Government of Ukraine was move to the State Property Fund. Under the condition the organization plans new investors to have the stock. The process is at final stage, hence, possibility to grant governmental guarantee is closed.

5.9.3 Interest in Ukraine by Japanese companies

Project candidates taken in this Section are interesting to Japanse companies. In particular, ultra-supercritical technology is one of the most competitive field for Japanese companies. They will be deemed to have interest in the project released officially.

5.9.4 Environmental and Social Consideration (Thermal Power Generation)

(1) Environmental Resulation

Coal power project is considered to have relatively high environmental impact because of emission of air pollutants (e.g. SOx, NOx, PM) and greenhouse gases and ash generation. However, in Ukraine, coal power generation is an important base load power source. In fact, modernization of its aging plants built in 1960s is considered as a one of main issue at present in Ukraine.
Within thermal power generation field, projects that can be supported are those related to improvement or modernization of facility. Since these are considered as slight development, it is assumed that there is no need to submit an EIA report according to Ukraine's regulations. Yet, there is a need to confirm the matter with MENR, which is the agency responsible for the EIA system.
In addition, when upgrading environmental equipment, there is a need to pay attention to air emission standards. As shown in " 4.5 Comparison with EU Standards", Order No. 541 of the Ministry of Environmental Protection of Ukraine sets the air emission standards for coal-fired power station in Ukraine. Order No. 541 complies with the EU Directive 2001/80/EC, which was issued earlier. However, it does not meet requirements set by a newer Directive 2010/75/EU, which sets

stricter emission standards. The Government of Ukraine is in the process of amending the law in order to adhere to the requirement of Directive 2010/75/EU. Thus, when implementing new environmental equipment, it is important to pay attention to the design that complies with Directive 2010/75/EU.

(2) Other Considerations

Potential impacts related to candidate projects include noise and dust generated during construction. Thus, it is important to adopt best practice when constructing buildings/facilities during construction. Through upgrading and modernization of facilities, one positive impact during operational stage is the improvement of the surrounding environment condition. Upgrading of existing Tryplislka and Zmiivska power stations, which are both projects that can be supported, can significantly contribute in improving environmental conditions.

Also, for coal-fired power generation, there is a need to pay attention to fly ash generation. At present, a percentage of fly ash generated from the coal-fired power station can be recycled, while all the remaining are dumped into the ash disposal area. Thus, there is a need to secure enough land for disposing fly ash. Particularly for Tryplislka power station, the existing ash disposal area is already full and yet the surrounding area for expansion has not been secured. Therefore, there is a need to confirm the intended ash management policy.

6. Transmission Lines and Substations Sector

The Transmission network of Ukraine consists of 8 voltage classes which are 800 kV (D.C.), 750 /500/400/330/220/110 kV and 35 kV (A.C). Total length of the overhead transmission lines reaches approximately 23,005 km and approximately 12,890 km of them have been operated for 40 years or more[17]. There are 137 substations in the network and total capacity of the network transformers is 78,600 MVA[19]. The transmission network, transmission lines and their associated substations, is operated by only the state enterprise National Power Company of Ukraine (Ukrenergo), however, no distribution lines are under Ukrenergo. The network of Ukraine is interconnected with neighboring countries of Russia, Belarus, Moldova, Romania, Hungary, Slovakia and Poland, and it creates favorable conditions for the import and export of electric power.

Source: Ukrenergo 2013 Annual Report

Figure 6-1 Electric Power Line Network of Ukraine

Since MOU on cooperation in the energy sector between Ukraine and the EU was exchanged in which the parties agreed taking the maximum effort to combine the European and Ukrainian energy system, Ukraine carried out activities on preparation for adaptation of his legal framework to that of the EU and also implements measures of approximation of national technical standards, regulatory

[17] Ukrenergo Annual Report 2013
[19] The United Energy System Development Plan of Ukraine for 2016 - 2025

and technical documents to common European standards.

In this Study, the Study Team organizes the needs of future operation of transmission line and substation field by understanding the current situation of facilities and their planning for future operation as well as financial health, extracting subjects to be studied on facilities and operational aspects. The Study includes the necessity of modernization of facilities, strengthen of network elements such as new installation and/or expansion of equipment.

The electric power produced by generating companies, flows to distribution network through the national transmission network operated by Ukrenergo and is sold to end users from retail companies.

The needs of the distribution field for future operation in Kyiv which were identified during the survey are referred to as well.

6.1 Overview of National Power Company Ukrenergo

The history of the transmission line network in Ukraine began in the 1930s. In 1940, the commercial operation of the 22 kV power transmission line between the Dnipropetrovsk Region and the Donbass Region in the former Soviet Union began. At that time a load dispatch center was also established to control and manage demand/supply regulation and operation. In 1995 the Ukrelectroperedatcha was established as the state-run power generation company and became responsible for the operation of the transmission network of all voltage classes in Ukraine as well as 750/500/330/400/220 kV substations.

In 1998 the load dispatch center and the Ukrelectroperedatcha were merged into the National Power Company Ukrenergo. This new company was responsible for operating the head load dispatch center that integrates the transmission network in Ukraine, and load dispatching instructions in 8 districts. That resulted Ukrenergo became in charge of handling all aspects of power transmission network operations in Ukraine.

However, in the Crimea, which was one of the 8 regional dispatch centers, which had been outside jurisdiction of Ukrenergo regarding the power supply to Crimea area following the political upheavals of 2014.

However, since information has not been updated by Ukrenergo as of April 2016, caution is needed because this report partially includes information on Crimea.

Ukrenergo is the state-run power company and it is under jurisdiction of MECI.

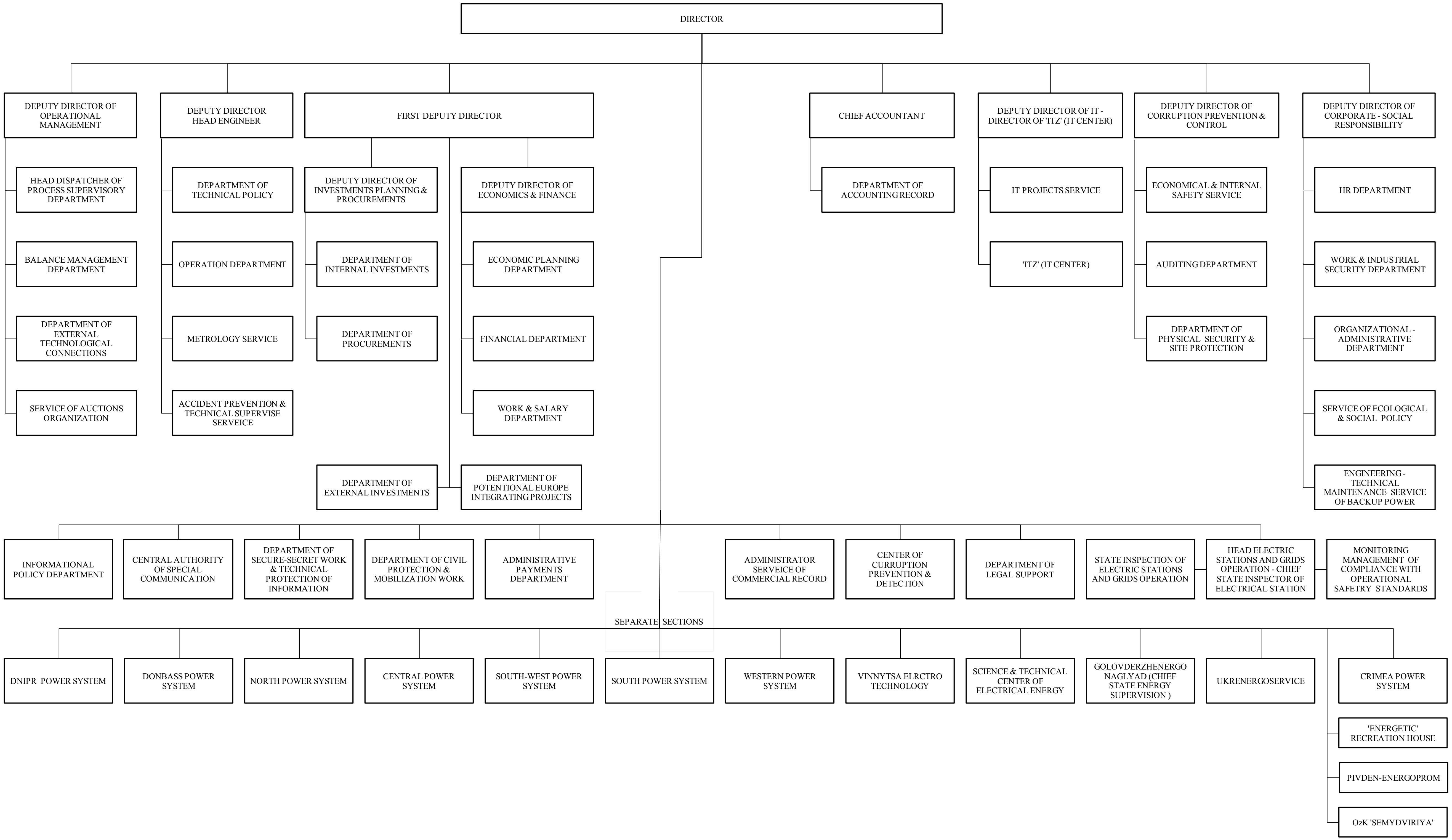
6.1.1 Organization

The organization of Ukrenergo is shown in Figure. 6.1-1. The organization was amended on December 22, 2015. The chart indicates that there are Director, 6 Deputy Directors and 8 chief accountants, and departments under each executive have been organized. The total number of employee of Ukrenergo is approximately 15 thousand peoples. The network is divided in 7 (Central, North, West, South, South-West, Dnipropetrovsk and Donbas) by the area and the special individual organization so called Power System which is placed for each 8 areas under direction of the Director General.

The Power Systems are operating their jurisdictional transmission network independently including maintenance activities.

However, the organization chart in Figure 6.1-1 still shows the Crimean power system.

The head dispatch center is located in the head quarter of Ukrenergo and 7 area dispatch centers are installed at the corresponding Power Systems. Those dispatch centers are coordinated each other and instruct power supply operation to power stations and substations.



Source: Ukrenergo Web Site translated by JICA Study Team

Figure 6.1-1 Organization Chart of Ukrenergo

6.1.2 Overview of power transmission facilities

(1) General description of power transmission facilities

The installed capacity of power supply facilities in Ukraine including Crimea as of the end of 2014 was 55.1 GW in total, and the breakdown is as follows: thermal power (62.2%), nuclear power (25.1%), hydraulic power (10.6%), and others (wind power, solar power, and biomass, 2.1%). The breakdown in the latest Ukrenergo 10-year plan: 2016–2025 (draft) is as follows: thermal power (61.4%, reduced by 0.8), nuclear power (24.8%, reduced by 0.3), hydraulic power (11.1%, increased by 0.5) and other (wind power, solar power, and biomass, 2.7%, increased by 0.6). This suggests that the power supply facilities are planning to change to renewable energy, including hydraulic power, in the future.

Construction of a transmission line system has been carried out gradually since 1930. At the end of 2014, the system was extended to approximately 22,300 km, including the transmission line, into neighboring countries (2,260 km). The breakdown is described in Table 6.1-1.

Table 6.1-1 Installation of power transmission line in Ukraine

Voltage level (kV)	Distance (km)
400 - 800	4,900
300	13,400
220	4,000

Source: Ukrenergo 10-year plan (2015–2024)

(2) Transmission/transformation facility status

Although Ukrainian old electrical transmission/substation facilities have been abolished or updated continuously, 90% of transmission lines of 220 kV class facilities and 55% of major substations have been operating longer than 25 years of their life span, and some are operating over 40 years without rehabilitation.

Therefore, Ukrenergo receives support from European donors to update or newly construct facilities, but this is not sufficient for long-term operation in future since so many facilities are aging while demand is increasing.

The following has been confirmed from the work (substations in western Ukraine and Dnipropetrovsk).

- Routine operation monitoring is conducted by teams of 2 working in a 2-shift system, however, concerning maintenance of transmission and transformation equipment, engineers are sometimes called in from manufacturers in cases where expert know-how is required or the local staff cannot ensure the required quality control. Having said that, basically the personnel of Ukrenergo implement maintenance. In cases where replacement parts cannot be obtained for equipment that has become obsolete or is no longer in production, the employees remove parts from broken down units and utilize them. Accordingly, the number of personnel differs according to each substation. The key substations are well staffed, while personnel are dispatched as needed when staff shortages arise at other substations.

- Concerning key, high-voltage facilities that play a central role in power transportation, upgrading work is being successively implemented with a view to extending the service life of equipment. Although functions have been improved thanks to the installation of digital indicators and data collection units, there are numerous cases where the system configuration has not been changed and the old equipment continues to be used, meaning that the equipment inside substations comprises a mixture of new and old products.
- Based on modernization of control equipment, there is still room to improve operations through improving operability and adopting remote operations by operators, however, employees wish to see the installation of new equipment rather than better convenience. From this, the Study Team sensed a high level of awareness among employees regarding stable power supply based on improved reliability of equipment.
- Facilities that have been operated without rehabilitation are noticeably aged exhibiting rusting and discoloration. Although they say operation is proper thanks to the maintenance, it is difficult to confirm tolerance deviation due to fixation and change of characteristics of analog equipment and mechanical protective relays and therefore there is concern about whether the equipment will operate properly in case of accident.
- Concerning expansion of facilities, this is partly required in order to improve reliability rather than address increased demand in the supply area. Accordingly, it is necessary to assess the urgency and necessity of equipment expansion, however, this is difficult because the method for demand forecast was not established at the time of the study.

Against the background of these current conditions, in order to continue to stably operate equipment, there is an urgent need to upgrade badly deteriorated equipment, however, this is not proceeding as planned due to financial constraints and a lack of procurement management capability.

For example, construction of 330 kV class transmission lines in Ivano-Frankivsk, western Ukraine, has been suspended after completing 60 km out of the total distance of 104 km and now waiting for funding. Construction of the remaining lines and update of air insulated switchgear and line protection equipment are set forth in the 10-years plan. The addition of 400/220 kV transformers in Zakarpattya, western Ukraine, has been suspended with only the transformers procured and stored in the substation, and now waiting for funding and other material procurement.

Concerning the demand-supply balance in western Ukraine, power consumption is 650 to 700 MW during the summer and 1,000 MW during the winter. Since the installed capacity of power generation facilities in this region is approximately 4,600MW, there is ample surplus capacity even when the peak exported power of 650 MW for the EU interconnection is deducted.
Accordingly, it is thought that the development of transmission lines originating out of western Ukraine will make a major contribution to power supply in Ukraine including interconnection with EU.

Concerning equipment inside the western load dispatch center, a Polish control system has been used since 2004, however, since this was not made in Ukraine, the company plans to install a backup server made by Hewlett Packard of the United States at its own cost from now on.
Telecommunications equipment comprise 2 systems – one that is owned by the company and another that is loaned from the domestic telecom operator (Ukrtelecom). It uses the Ukrtelecom system, which is capable of high-speed communications, for control purposes, and its own system for management and information collection purposes. Equipment in these systems was made by Siemens and A.B.B.
Zakhidnoukrainska Substation in western Ukraine is the largest substation in that region: it has installed capacity of 750 kV/330 kV - 3,000 MVA (1,000 MVA x 3), 4 transmission lines of 750 kV, and 5 transmission lines of 330 kV, each of which is outdoor air insulated conventional types of 1+1/2 bus scheme. This is also the largest substation in Ukraine with an area of 70 hectares.
In addition to the systems supplying power to Ukraine, the substation also has the Burshtynska Island system that is interconnected with the EU as described in 3 Power Interchange with Neighboring Countries, however, since this is physically separated at the conductor level, it cannot be used for interchanging power in emergencies.

On the other hand, concerning Zaporizka Substation in the Dnipropetrovsk region in eastern Ukraine, there is a 750/330 kV substation serving 3 and 6 transmission lines respectively. Zaporizka Substation is also connected to the nearby Dniprovska hydropower station and thus plays a key role.
The 750 kV bus scheme differs from that is the abovementioned Zakhidnoukrainska Substation in that it is a double-bus scheme, however, the 330 kV bus scheme is the same 1+1/2 scheme.
The circuit breakers and AT (Automatic Transformer) at the substation have been upgraded. Whereas air insulated switchgear were used before, they have been upgraded to gas insulated switchgear made by A.B.B. and Siemens. Transformers can be produced in Ukraine and this substation is equipped with transformers made by ZIR (Zaporozhtransformator).
The protection relay panels for 750 kV trunk transmission lines have been upgraded to A.B.B system; moreover, because the operating panel for the 330 kV system has been upgraded, the main facilities for substation operation has been replaced already. The upgrading works were

implemented under assistance from EBRD. The upgrading work was determined according to the ability to conduct repairs and procure parts, but examination of service life based on equipment diagnosis was not carried out.
Now that upgrading of the main equipment has been completed, employees at the substation said that there were no particular problems concerning operation and maintenance.

At all the substations, although digital indicators have been added to the monitoring and operation panels, the original equipment from the time of construction continues to be used. Meanwhile, an operator's PC-based monitor is installed on the monitoring consoles, and the software for this is made by a company in Kharkov.

Insufficient capacity of transmission lines is one of the reasons of power supply shortage in Ukraine. As shown in Figure 6.1-2, which illustrates the comparison of regional maximum load and power facility capacity in 2014 winter season in Ukraine, the western region has enough capacity thanks to the nuclear power plants but the capacity of the transmission systems is not sufficient to use its excess capacity for the central and eastern regions, resulting in insufficient and unstable power supply to the capital, Kyiv, and other cities.

Source: Ukrenergo Plan for 10-Years (2015-2024)

Figure 6.1-2 Comparison of Regional Maximum Load and Power Plant Capacity

In December 2015, the transmission lines between the Rivneuvska Nuclear Power Station (western Ukraine) and Kyivska Substation (central region) started to operate, so the situation of network in the western region where the excess supply capacity has and the Rivneuvska Nuclear Power Station operation will be changed should be monitored.

(3) Power interchange with neighboring countries

ENTSO-E, the power transmission company for European countries, involves in operating power transmission between Ukraine and neighboring countries except Belarus, Moldova, and Russia.

As shown in Figures 6.1-3 and Figure 6.1-4, Burshtynska Island in western Ukraine is supplied power to Hungary, Slovakia, and Romania, synchronized with EU, via Zakhidnoukrainska (Western Ukraine) Substation and Mukachevo Substation. The power system facility assets in Burshtynska Island are owned by Ukraine, but ENTSO-E cooperates with the western region power supply control center of Ukrenergo to be involved with power supply operation in western Ukraine and to meet the EU connection standards.

Concerning interconnection with the EU, there are no members of ENTSO-E stationed in the western load dispatch center, however, this dispatch center has close relations with ENTSO-E and it conducts operation inside Ukraine based on commands from the head load dispatch center in Kyiv as well as managing interconnection with EU.

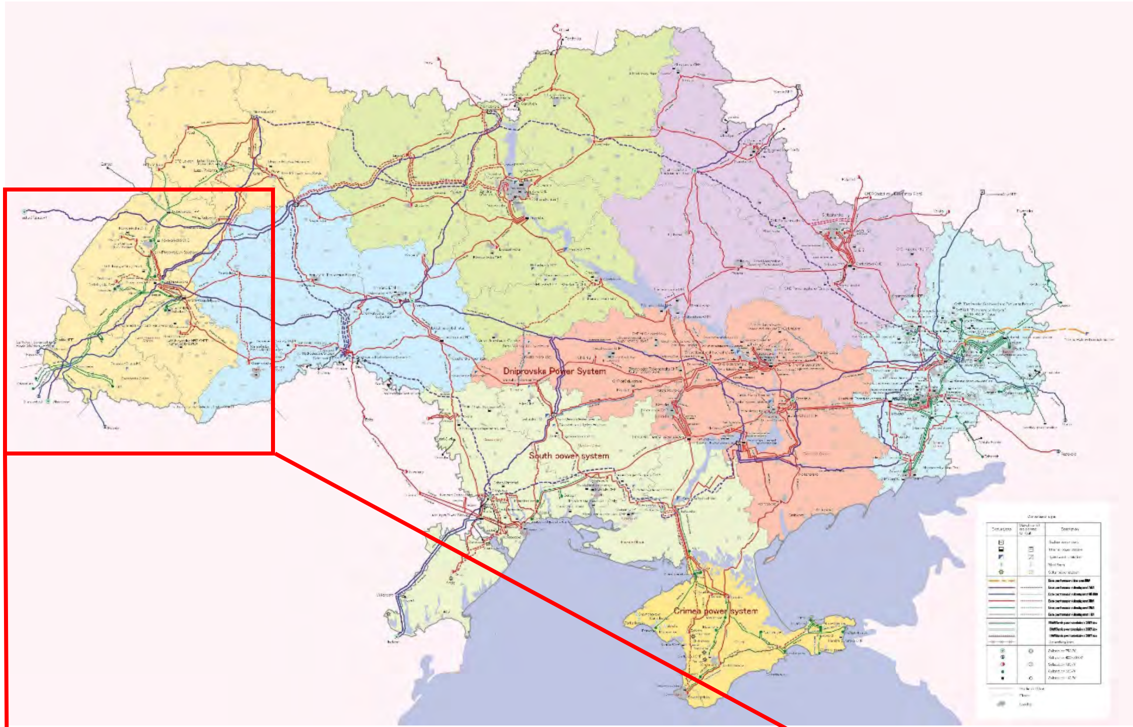
Concerning the amount of export based on interconnection with the EU, no specific equipment was indicated, however, the upper limit on transmission line capacity is currently 650 MW, although at the time of the survey this was limited to 147 MW due to works being conducted on part of the transmission line. Ukraine has not signed any Power Purchase Agreement with neighboring countries concerning the amount of power exports, however, any surplus inside Burshtynska Island is exported to cater to the demand from neighboring countries. Accordingly, Energoynok inside Ukraine exercises de facto control over operation.

Concerning the amount of export, the control system inside the western load dispatch center automatically calculates the generation requirement every 10 minutes based on actual demand over the past 5 minutes, and then sends output commands to Burshtynska Power Station. On receiving the commands, Burshtynska Power Station creates output commands for each unit and controls output from the overall station.

However, even with export from the same Western Ukraine region, for example, export from Dobrotvirska Power Station to Zamost Substation in Poland does not apply the 650 MW limit, since power is exported from inside Ukraine rather than Burshtynska Island that is interconnected with the EU, the 650 MW limit does not apply.

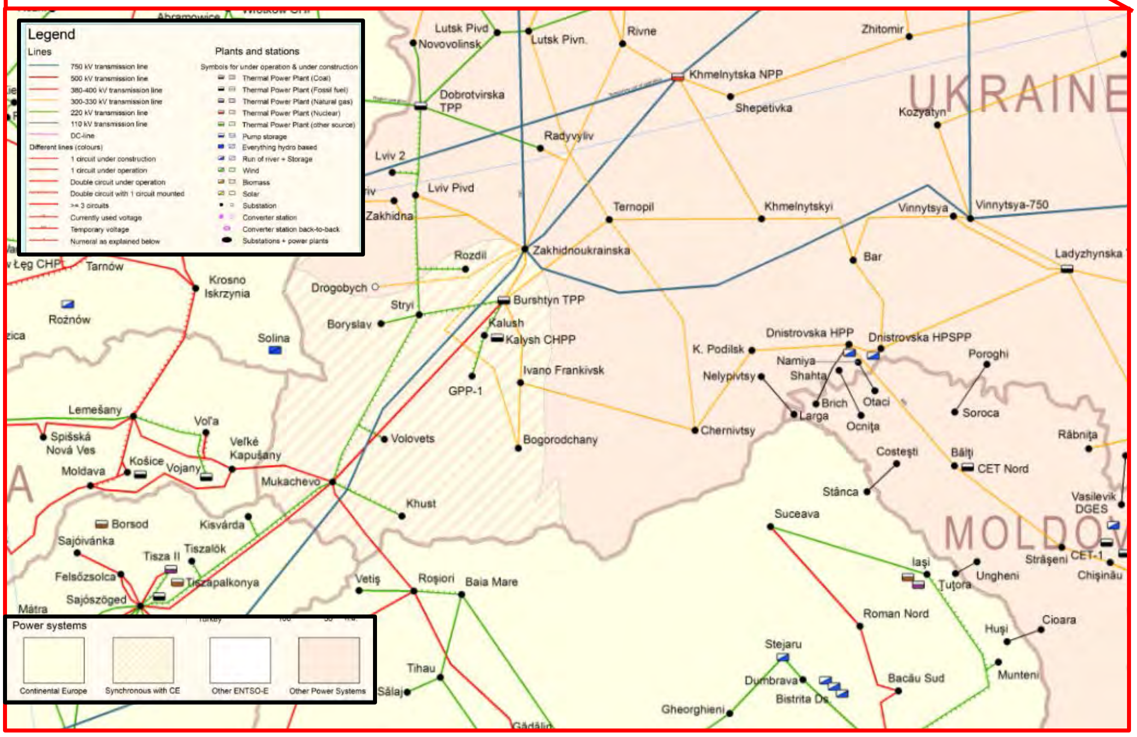
Slovakia is connected via the 750 kV transmission line but 750 kV is not the European standard voltage, and therefore Ukrenergo performs maintenance of the 750 kV transmission lines in Slovakia. Slovakia requests change from 750 to 400 kV and Ukraine considers construction of a new 750/400 kV substation in Uzhhorod or addition of 750 kV area in Mukachevo Substation to enable 400 kV transmission to Slovakia.

Ukraine considers to coordinate with the EU system in all regions and have plans for related investment. Currently, a European consortium for power system operation which is led by Romania is examining feasibility study of synchronous connection between Ukrainian and Moldovan power systems and the European network. Issues regarding technology, organization and legality as well as the procedures/processes to analyze/solve them were set to be described here. They were set to be completed by the end of 2015 but nothing has been disclosed at the time of creating this document.



Source: JICA Study Team

Figure 6.1-3 Regions Synchronous with EU



Source: JICA Study Team

Figure 6.1-4 Regions Synchronous with EU (enlarged view)

Figure 6.1-5 Transmission network map in Ukraine (overview)

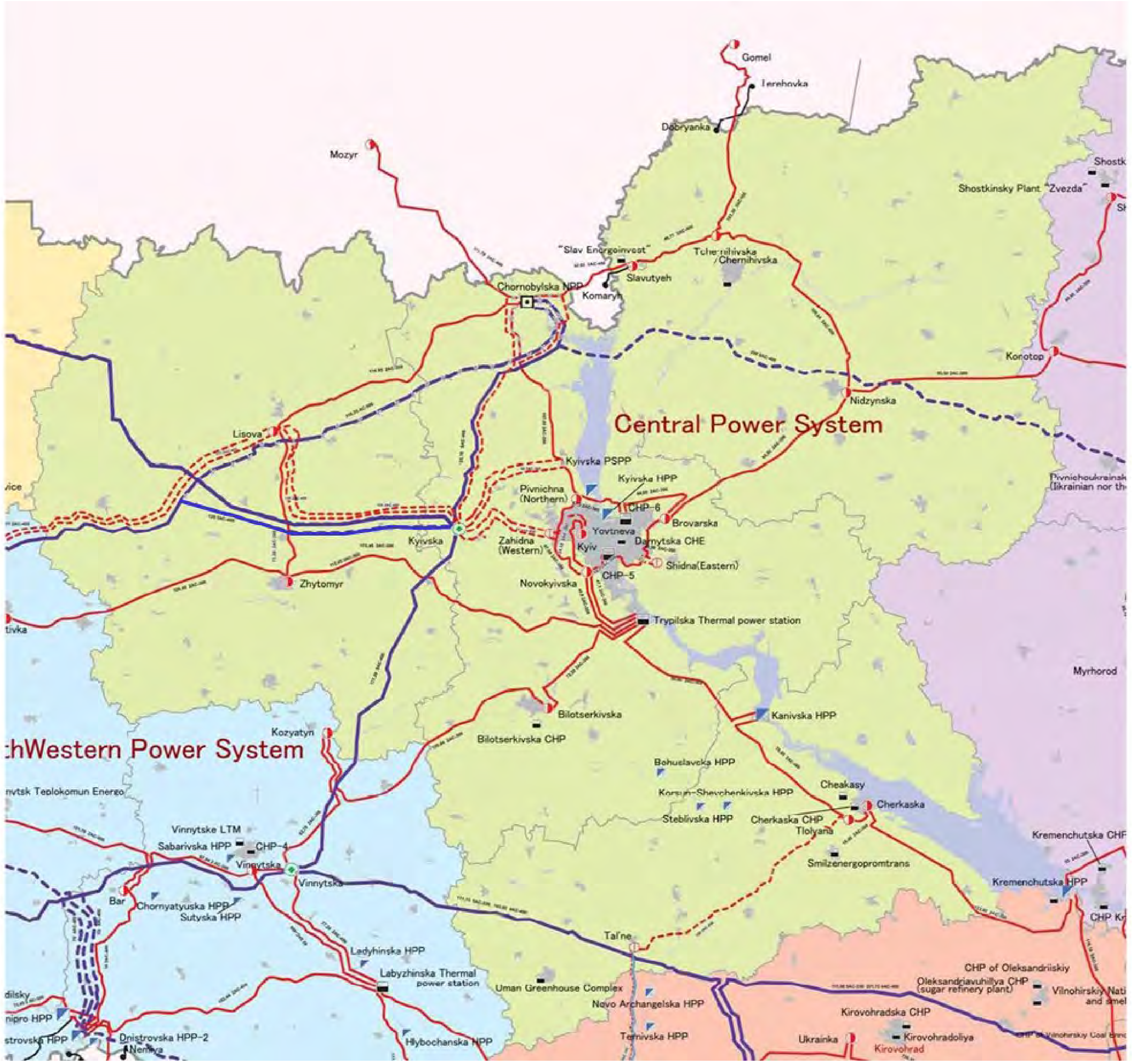


Figure 6.1-6 Transmission network map in Ukraine (Central Power System)

Figure 6.1-7 Transmission network map in Ukraine (Northern Power System)

Figure 6.1-8 Transmission network map in Ukraine (Southern Power System)

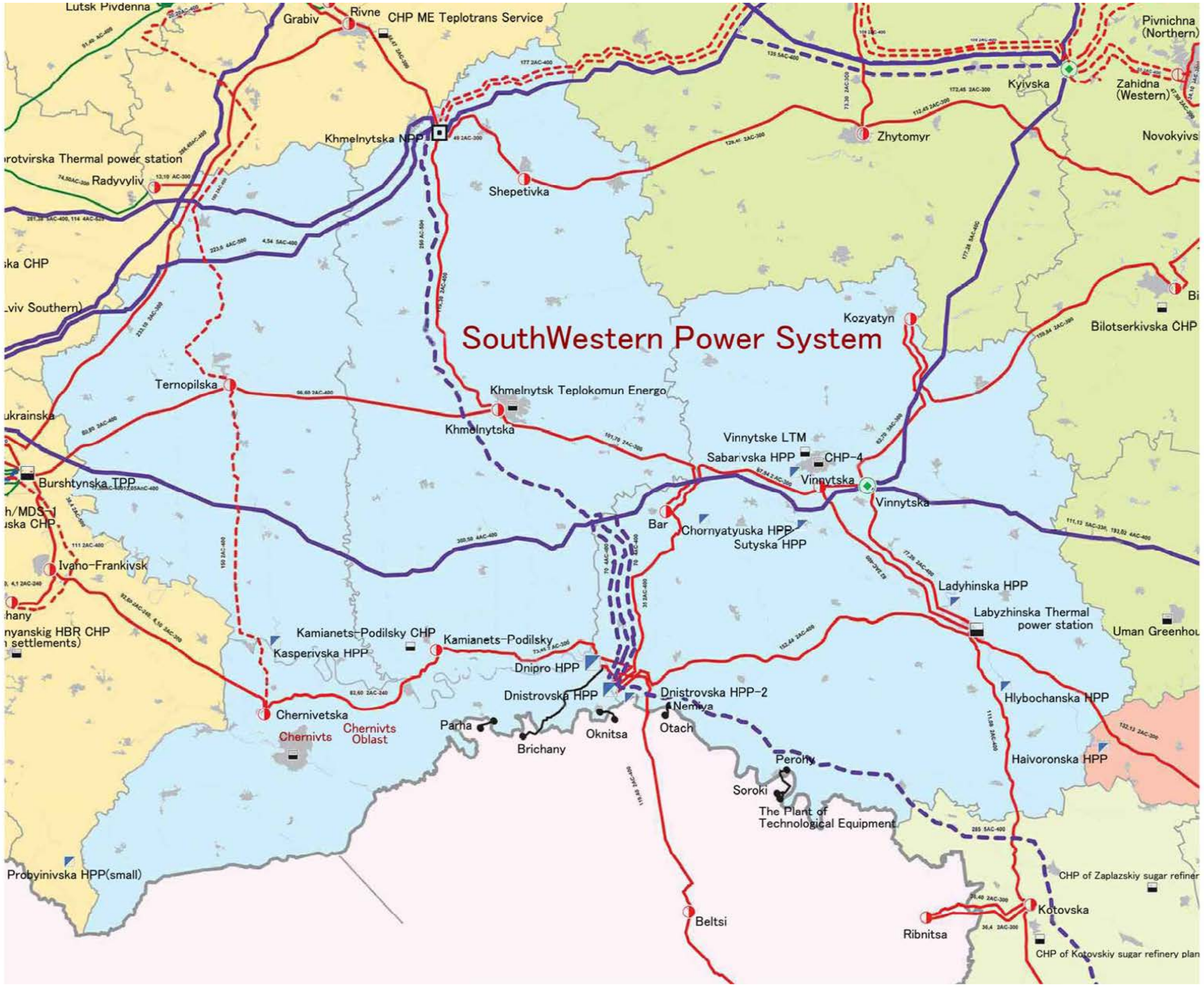


Figure 6.1-9 Transmission network map in Ukraine (South Western Power System)

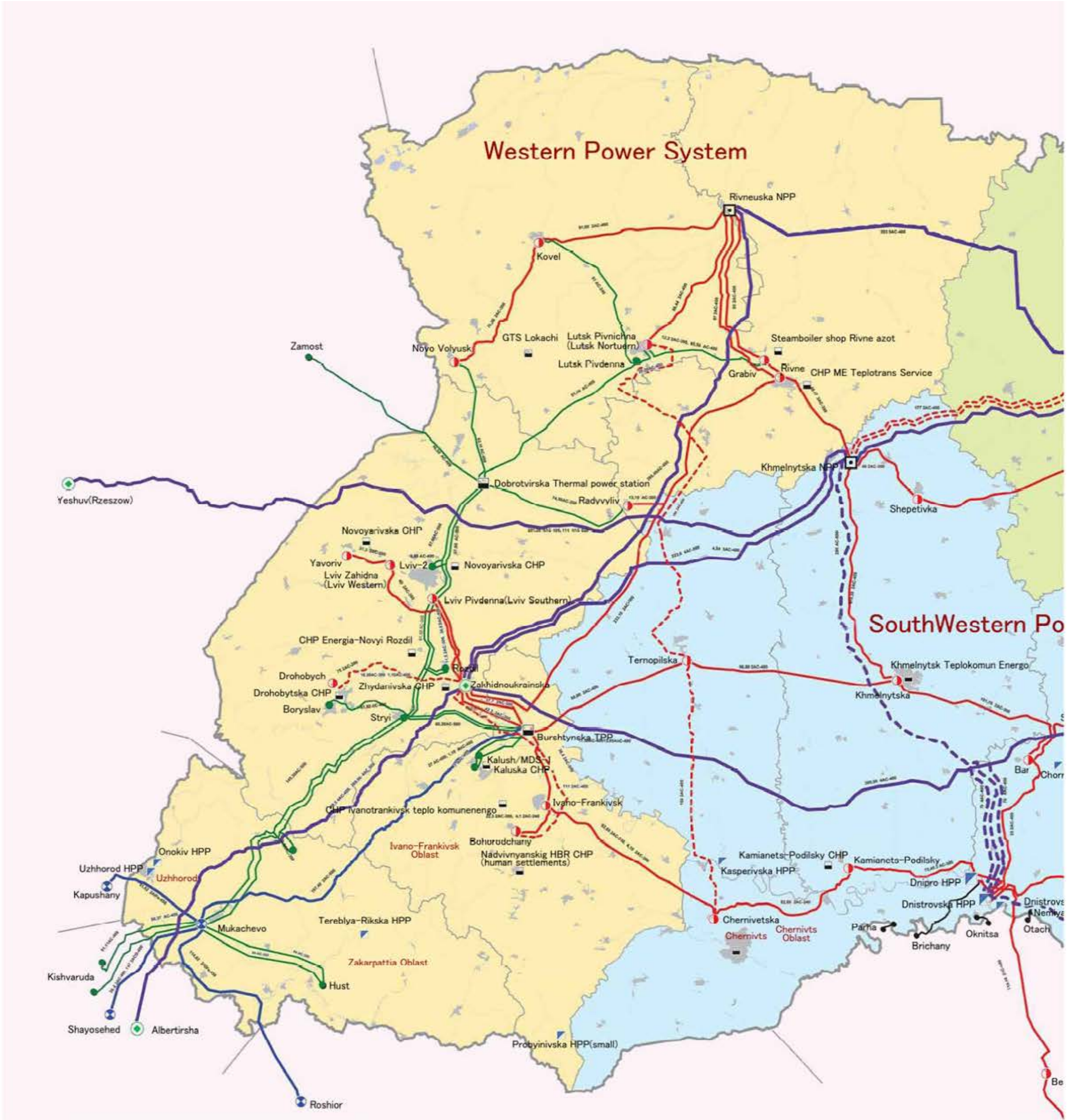


Figure 6.1-10 Transmission network map in Ukraine (Western Power System)

Figure 6.1-11 Transmission network map in Ukraine (Dnipro Power System)

Figure 6.1-12 Transmission network map in Ukraine (Donbass Power System)

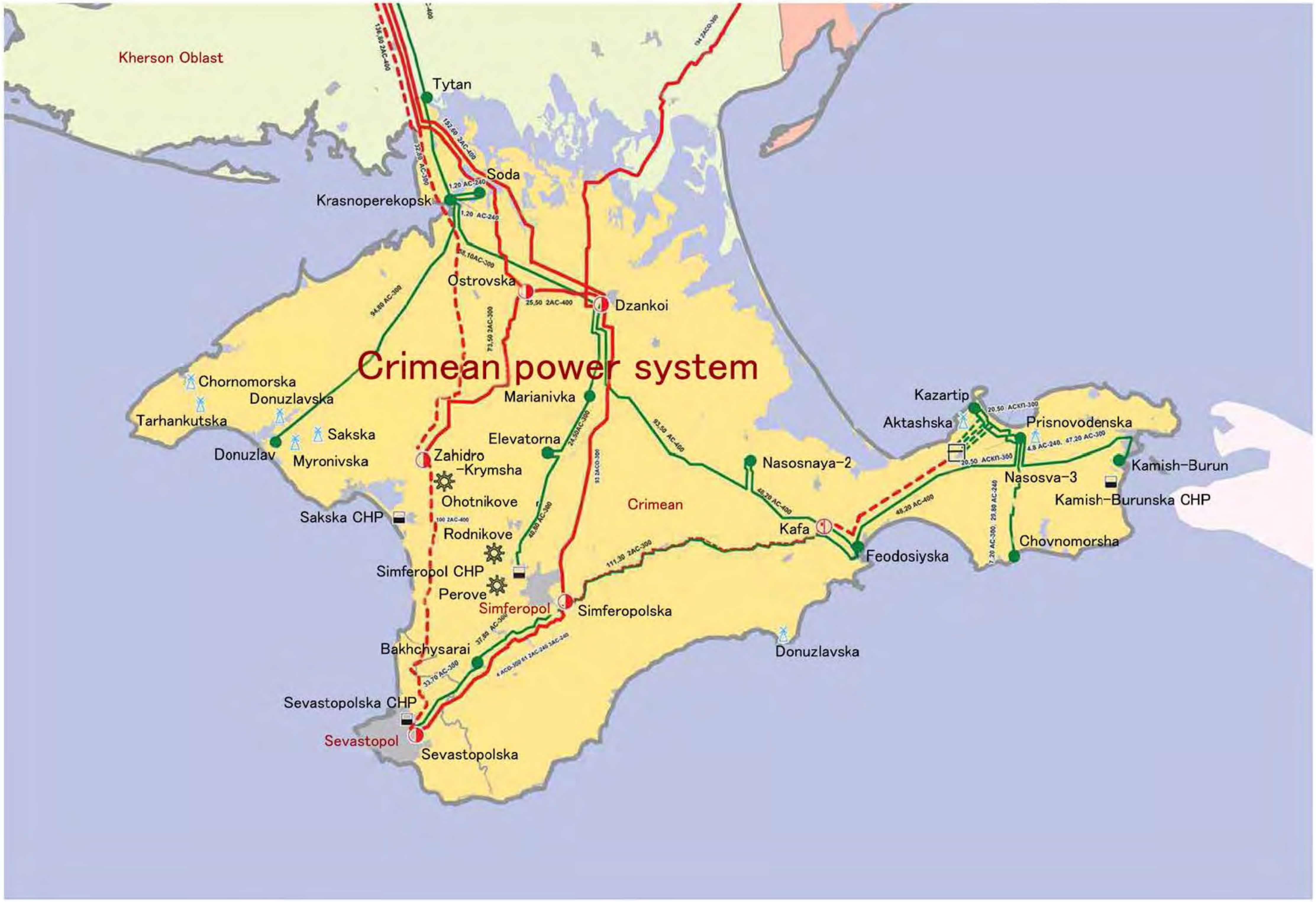


Figure 6.1-13 Transmission network map in Ukraine (Crimean Power System)

6.1.3 Ukrainian System Operation

(1) System Operation Status

Ukraine encounters difficulty of fuel procurement due to implementation difficulties of facility expansion for increased demand and rehabilitation of aged facilities as well as conflicts in the eastern region, resulting in decrease in thermal power plant utilization but increase in nuclear power station utilization. Conflicts in the eastern region also affect Ukrenergo's business plans as well as the Transmission Network Development Plan 2016 - 2025, and therefore power source configuration and locations remain to be carefully considered.

For the transmission line networks in Ukraine, development for the lines owned by Ukrenergo is delayed. The United Energy System Development Plan for 10 Years created by Ukrenergo describes regional operational status of Ukrainian power systems. The overview is as follows.

1) Central Power System

The supply capacity is not sufficient for the power demand in the central region. The shortage reaches 2,500 MW. Trypilska coal-fired power plant operates 2 or 3 units and CHP-5 and CHP-6 according to the heat supply schedule.

The Mozyr Substation and Gomel Substation in Belarus are supplied imported power via Ukrainian Chornobylska Nuclear Power Station and Chernihivska Substation.

The demand is increasing in the central region, especially in Kyiv city where the 330 to 750 kV transmission line network and 330/110 kV substations are imperative. The Kyiv area exhibits a year-on-year consumption increase of 5 to 7% but decreased CHP-5 and CHP-6 power generation, entering in serious power supply situation. To solve this problem, the 330 kV transmission line between the 750 kV Kyivska Substation and Pivnichn Substation and Novokyivska needs to be constructed. Also, a 750/330 kV automatic transformer needs to be added to Kyivska Substation, the 330 kV transmission line to Chornobylska Nuclear Power Station needs to be constructed, and a new 330 kV substation (Western substation) needs to be constructed between the Kyivska Substation and Pivnichna Substation.

2) North Power System

The north region is supplied from Dnipropetrovsk and Donbass regions and the power generation amount in the region is not sufficient for the demand. The north region relies on the Zmiivska coal-fired Power Station and Kharkivska CHP-5, and the Zmiivska Coal-fired Power Station has recorded 1,126 MW output under high load and 1,880 MW output at the short term peak load times. When the power consumption increases in future, 110 kV distribution lines from the 330 kV Zaliutyne Substation and Artema Substation are expected to be overloaded. To solve this problem, the 330 kV Slobozhanska Substation needs to be constructed in Kharkiv.

3) South Power System

The south region has Yuzno-Ukraynska Nuclear Power Station which produces more power than the regional demand.

Yuzno-Ukrainska Nuclear Power Station has 750 kV and 330 kV switchyards that contribute power supply to the south region. However, constraints on the plant's reactive power generation capacity make voltage control difficult. This greatly affects the maintenance plans Operation of Yuzno-Ukrainska Nuclear Power Station is deeply related to the operation of Tashlitska Pumped-Storage Power Station, and supply-demand balance is achieved by pumping under low load.

There is only one transmission line between Artsyz Substation and Moldavska Power Station, and therefore the supply reliability decreases in case of maintenance of the line which forcing power supply via the 110 kV distribution lines. In view of voltage retention and system stability, construction of 330 kV transmission lines between Novoodeska and Artsyz Substations is planned.

Although power is supplied from neighboring Moldova to Ukraine, greatly increasing power consumption in Odesa is problematic. Furthermore, operation of Moldavska is unstable. Therefore, a new Primorska Substation will be constructed in northwestern Odessa to supply power to existing systems and solve the problem.

4) Western Power System

The western region has more supply than demand like the south region.

As a feature of the western region, Burshtynska Island with which ENTSO-E is involved can export 650 MW power.

The supply base in the western region is Rivneuska Nuclear Power Station and Dobrotvirska Power Station. Rivneuska Nuclear Power Station can output maximum of 2,835 MW and the Khmelnytska Nuclear Power Station can output maximum of 2,000 MW, but the power supply to the southwest region is limited to 1,300 MW due to the line capacity between the Zakhidnoukrainska Substation and the Vinnytska Substation.

The following power system development is deemed to be required for improving the supply reliability in the western region and making the most use of Rivneuska Nuclear Power Station and Khmelnytska Nuclear Power Station.

- Transmission line between 750 kV Rivneuska Nuclear Power Station and Kyivska Substation.

  This transmission line may be flexible for regional power interchange because it started operation in December 2015.

- Transmission line between 330 kV Zakhidnoukrainska Substation and Bohorodchany Substation
- Transmission line between 330 kV Zakhidnoukrainska Substation and Drohobych Substation

- Additional 400/220 kV automatic transformer installation in Mukachevo Substation
- Transmission line between 330 kV Novo Volyusk Substation and Lviv Zahidna Substation and replacement of both substations
- Transmission line between 330 kV Lutsk Pivnichna Substation and Ternopilska Substation and connection to Chernivetska Substation

Furthermore, shunt reactors need to be installed in the Lutsk-South, Novo Volyusk Substation and Kovel Substations to keep the voltage within an acceptable range for 35 kV substations which supply electric power directly to end users.

5) Southwestern Power System

The southwestern region has more supply than demand like the south and western regions.

Khmelnytska Nuclear Power Station and Ladyzhinska Coal-fired Power Station work as the base power source, and the Dnistrovska Hydroelectric Power Station and Dniprovsk Pumped-Storage Power Station supports the supply at peak times.

Khmelnytska Nuclear Power Station and Rivneuska Nuclear Power Station in the western region supply power to the southwestern region via the transmission line between Zakhidnoukrainska and Vinnytska and a new 750 kV transmission line between Rivneuska Nuclear Power Station and Kyivska Substation. In future, the system will be connected to the European Network via the 750 kV transmission line between Khmelnytska Nuclear Power Station and the Yeshuv Substation (Poland), Khmelnytska Nuclear Power Station, and the transmission line between Zakhidnoukrainska Substation and Albertirsha Substation (Hungary), and therefore it is said that reliability will improve.

The voltage level of Chernivetska Substation could be maintained at winter peak load times in 2013 and 2014 but the capacity will be insufficient due to extension of 110 kV distribution lines, requiring installation of additional transformers. To improve supply reliability in Vinnytska region, a 330/110 kV-125 MVA transformer needs to be installed in the 750 kV Vinnytska Substation.

6) Dnipropetrovsk Power System

Dnipropetrovsk region has more power supply than demand and the excess supply is diverted to Donbass, Crimean, and north regions. However, Zaporizhia Nuclear Power Station cannot supply the full output due to the transmission line capacity constraint. The capacity of approximately 700 MW is restricted. To solve this problem, a new 750 kV transmission line between Zaporizhia Nuclear Power Station and Kahovska Substation and the construction of Kahovska Substation are planned. If this plan is realized, power interchange for southern consumers will be possible and power supply situation in Kherson oblast and Mykolayiv oblast will improve.

2 transmission lines between the 330 kV Zaporizhska Power Station and the Dnipro - Donbass Substations were constructed with the single conductor, and they do not have enough capacity to supply power to the load. Therefore, Krivorozhska Coal-fired Power Station output is restricted. It is important that additional transformers and transmission lines for the 330 kV substation should be planned.

7) Donbass Power System

Donbass region has the worst supply shortage which is complemented from Dnipropetrovsk region.

The following should be considered to solve problems in Donbass region.

- Construction of bifurcated transmission lines and connection to 500 kV Central Novodonbasska Substation from the 500 kV transmission lines between Donbasska Substation and Peremoha Substation.
- Additional 500/220 kV transformer installation in the 500 kV Central Novodonbasska substation, and connection of bifurcated lines to the substation from the 220 kV Mironivska Substation - Myhailivka Substation transmission line and Chaykine Substation - Myhailivka Substation transmission line.
- Construction of double circuit transmission lines between Central Novodonbasska Substation and Almazna Substation

8) Crimean Power System

Crimea has been removed from Ukrenergo's jurisdiction, however, the following is stated in the 10-year plan.

Crimean region has more power demand than the supply, and is supplied power from Dnipropetrovsk region. Aged old-fashioned facilities need to be operated in order to meet the demand in the region.

Voltage level retention within the normal range should be considered, and the reactive power adjustment equipment needs to be installed or the capacity needs to be increased for the transmission and distribution systems. Installation of Static Reactive Power Compensation equipment (SRPC) in the 330 kV Simferopolska Substation has the high priority.

To improve the power supply capacity and reliability, construction of the 330 kV transmission line between Zakhidro - Krymsha Substation and Sevastopol Substation and the 220 kV transmission line between Simferopolska and Kafa as well as voltage rising from 220 kV to 330 kV at Kafa Substation are required immediately.

(2) Power supply control system

Concerning the power supply setup of Ukrenergo, the head load dispatch center in headquarters acts as the order center, under which 8 regional load dispatch centers serving each power system are arranged, however, since the Crimean region has been controlled by Russia, it currently is outside of the jurisdiction of Ukrenergo.

Also each regional transmission control center (per oblast) as subjacent organization of local dispatch centers directs each substation for operation. Ukrenergo's power supply control system structure is shown in Figure 6.1-15.

Basically, the load dispatch centers in each state where the substations are located issue orders, however, in cases where transmission lines are connected to other power system, orders are also received from the load dispatch centers in those states.

However, in cases where connected states are within the jurisdiction of another power system load dispatch center, orders are issued from the head load dispatch center in Ukrenergo headquarters.

Concerning operation of power plants, orders are directly issued from the head load dispatch center, however, concerning Burshtynska Power Station, since this is affiliated to Burshtynska Island, it receives orders from the Western load dispatch center.

Ukrenergo does not own distribution lines and does not operate power supply to the distribution network.

Local dispatch centers and their jurisdictional states are shown in Table 6.1-2 and Figure 6.1-14.

Table 6.1-2 Local Dispatch Centers and Jurisdictional States

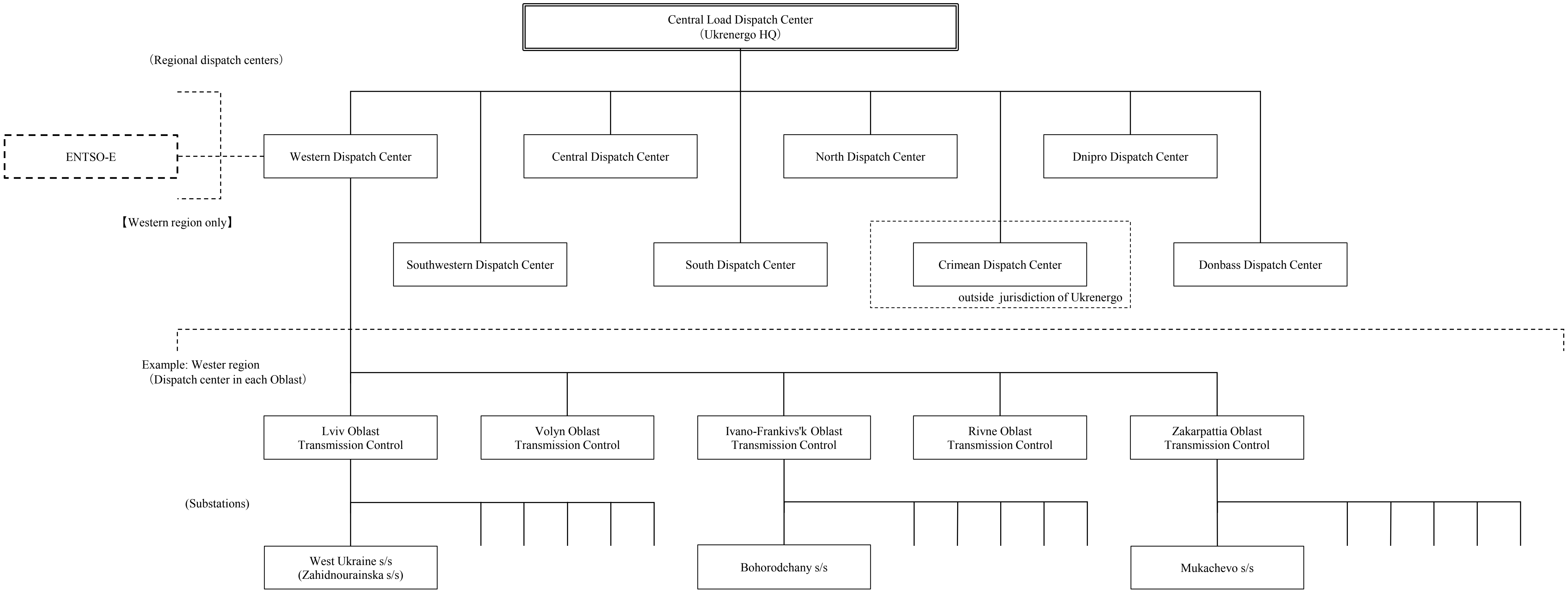
Central Load Dispatch Center a. Zhytomyr Oblast b. Kyiv Oblast c. Cherkasy Oblast d. Chernihiv Oblast	South Dispatch Center h. Mykolayiv Oblast i. Odesa Oblast j. Kherson Oblast	Southwestern Dispatch Center p. Vinnytsya Oblast q. Ternopil' Oblast r. Khmelnytsky Oblast s. Chernivtsi Oblast	Donbass Dispatch Center w. Donetsk Oblast x. Luhansk Oblast
North Dispatch Center e. Poltava Oblast f. Sumy Oblast g. Kharkiv Oblast	Western Dispatch Center k. Volyn Oblast l. Zakarpattya Oblast m. Ivano-Frankivsk Oblast n. Lviv Oblast o. Rivne Oblast	Dnipro Dispatch Center t. Dnipropetrovsk Oblast u. Zaporizhia Oblast v. Kirovohrad Oblast	Crimean Dispatch Center y. Autonomous Republic of Crimea (outside jurisdiction of Ukrenergo)

Source: JICA Study Team

Source: JICA Study Team

Figure 6.1-14 Power Supply Dispatch Regions

Alphabets shown in Figure 6.1-14 correspond to those left to the state names in Table 6.1-2.



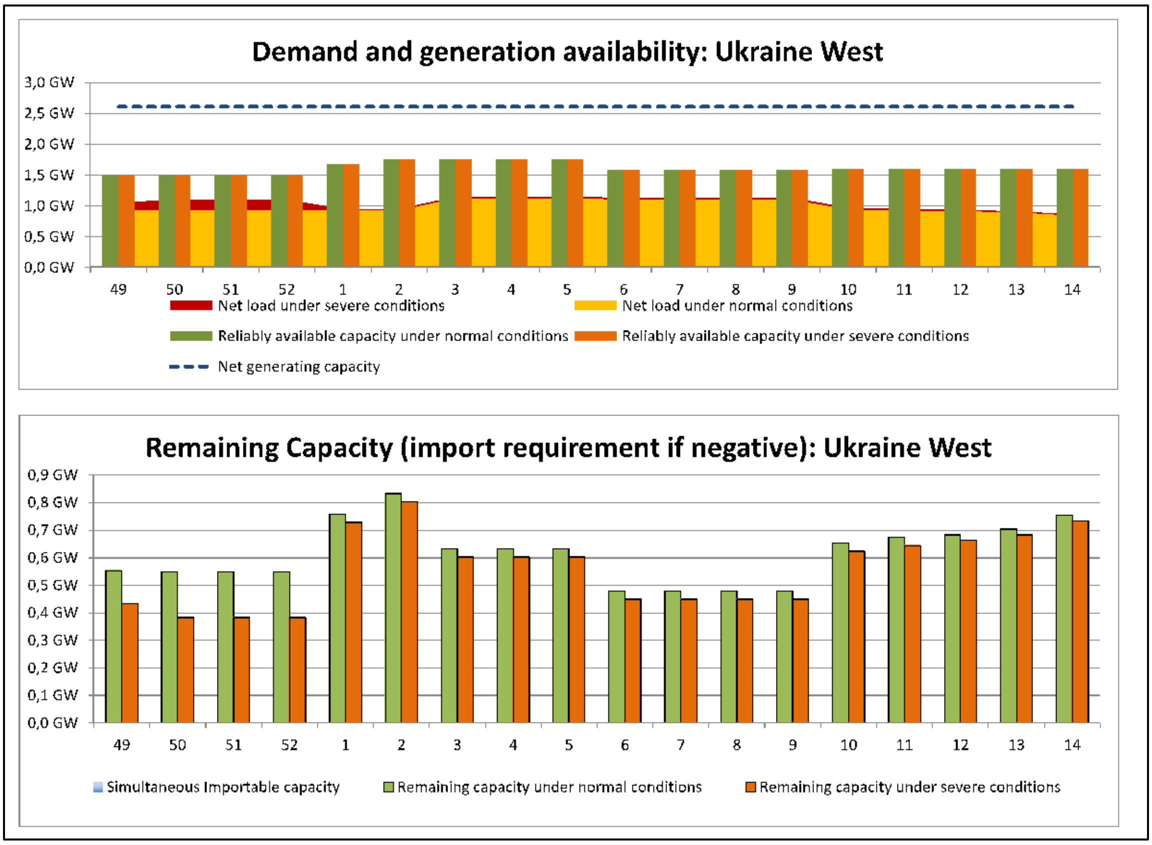
Source: JICA Study Team

Figure 6.1-15 Ukrenergo Power Supply Dispatch System Diagram

(3) Roles of ENTSO-E

ENTSO-E was established from 6 organizations of transmission operators in each European region. 34 European countries and 41 transmission system operators join. The roles of ENTSO-E include (i) establishment of EU-scale system rules, (ii) promotion of system operation based on the common system operation method, (iii) planning of long-term power transmission system development across Europe, and (iv) outlook of summer/winter power supply capacity.

Although Ukraine has not joined ENTSO-E, part of the western region already coordinates with EU. Estimation of summer/winter power supply for that coordinated part is covered in Winter Outlook 2015/2016 & Summer Review issued by ENTSO-E (See Figure 6.1-16). Note that Ukraine is not covered in the analysis results for member countries.



Source: ENTSO-E Winter Outlook 2015/2016 & Summer Review

Figure 6.1-16 Winter Results and Summer Estimation in western Ukraine in 2015/2016

In Figure 6.1-16, the x axis represents weeks (49th to 52th (December) weeks of 2015 and 1st to 14th weeks (January to April) of 2016).

(4) System analysis status

Continuous system analysis based on the actual power flow of the system trends and future configuration of system is mandatory since the necessity of additional transmission systems needs to be confirmed in view of changes in power source configuration and expansion and relevant power flow trend variation. The Study Team heard that Ukrenergo conducts system analysis every 5 years in addition to consideration of each project, but the economic situation in Ukraine does not seem to be considered to forecast the demand which is required to be input for analysis. This is because old Soviet style is still used. However, Ukrenergo recognizes the necessity of demand estimation and system analysis with appropriate method.

The Soviet Union made software was used for analysis but currently German made PSS/E (Siemens) and Power Factory (DIgSILEN) are used, and no special direction is given to designing companies. Domestic and foreign consultant agency to be responsible for designing can join the project provided they have acquired design qualification authentication from Ukraine.

Moreover, only Ukrenergomerezhproekt in Kharkov holds whole data on the transmission and transformation systems in Ukraine.

Transmission network that coordinated with EU is operated separately from Ukraine domestic power system isolated in the substation. Rapid expansion of EU coordination may decrease the stability of Ukrainian transmission network. Therefore, system analysis for both Ukrainian domestic systems and EU-coordinated systems must be conducted before expanding Ukrainian coordination with EU. When the European consortium for power system operation discloses the feasibility study of system coordination with ENTSO-E, the future development vision will be more concrete.

(5) Transmission and Substation Facilities Design Agencies

When conducting design for construction of transmission and substation facilities in Ukraine, since it is necessary to hold Ukrainian design qualifications at the time of tender, Japanese corporations that hold no such qualifications are unable to make independent bids. In order for a Japanese company to win the tender, it is necessary to form a consortium with an enterprise that holds Ukrainian design qualifications and to make a joint tender.

The main design agencies in Ukraine that have been introduced by Ukrenergo is shown in Table 6.1-3.

Table 6.1-3 Main Design Agencies Involved with Transmission and Substation Equipment Design in Ukraine

Name	Address	Website
Ukrenergomerezhproekt (Branches)	61050 Kharkiv, Krasnoshkolna Quay 2	-
	(03680, Kyiv, Solomenskaya str, 5)	-
	(79034, Lviv, Heroes Krut str.,1a)	-
	(49000, Dnipropetrovsk, Central str., 6)	-
Engineering Agency "TEPLOELECTROPROEKT"	79026, Lviv, Energetychna str., 10	if-tep.com
Kharkiv Designing – Development Institute “TEPLOELEKTROPROEKT – SOYUZ” LLC	61052 Kharkiv, prov. Simferopolskiy, 6	Tep-soyuz.com.ua
PIVDENNA ENERGETYCHNA KOMPANIYA, LLC	65009 Odessa, Pedagogichna str., 2, office 1	www.southpower.com.ua
STEPC NPC Ukrenergo	04112, Kyiv, str. Dorogozhytska,11/8	ukrenergo.energy.gov.ua
LLC "DniproVNIPIenergoprom"	49044, Dnipropetrovsk, st. Barnaul, 2A	dneprom.dp.ua
LLC“Podilskiy Energoconsulting”	21017, Vinnitsa, Gonty str., 39-A	tovpek.com.ua

Source: JICA Study Team

During the survey, the Study Team visited “DniproVNIPIenergoprom,” which has its headquarters in Dnipropetrovsk, and collected information on facilities design work.

There are multiple agencies that are qualified to conduct design of transmission and transformation facilities in Ukraine. The former Soviet system of receiving orders for specific regions only is disappearing, and Ukrenergo basically accepts tenders from firms that possess design qualifications in Ukraine regarding the design of transmission and substation facilities.

Regarding design work in Ukraine, it is necessary to obtain the central government approval at multiple stages in the process from the start of design through to commencement of construction. Generally speaking, in the case of constructing a 220/110 kV substation, roughly one year is required including the time for obtaining national approval. However, this period can be shortened depending on the contents of the works and the capability of the design agency.

In design work in actual projects, shorting capacity is calculated for selecting the specifications of switchgear and circuit breaker, however, load flow calculations and stability analysis are not performed.

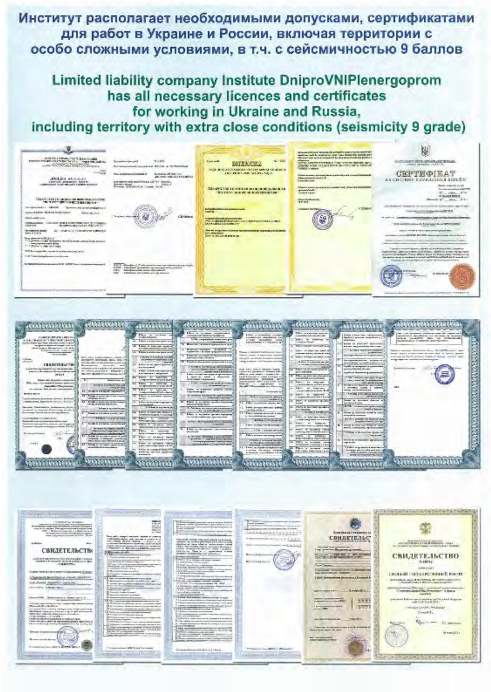


Figure 6.1-17 Certificate and Design License (Example)

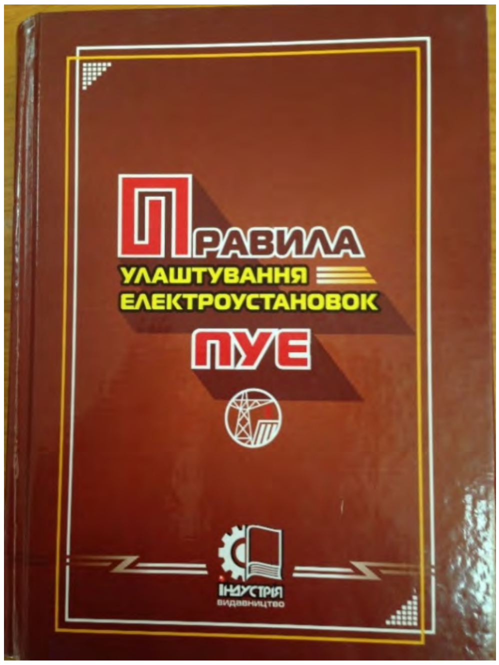


Figure 6.1-18 Technical Standards for Electrical Equipment Works in Ukraine (Example)

6.1.4 Transmission Network Development Plan for 10 Years (2016 to 2025)

(1) The United Energy System Development Plan for the next 10 years

The United Energy System Development Plan for the next 10 years has been formulated every year by Ukrenergo based upon the "Order preparation system operator development plan of the United Energy System of Ukraine for the next 10 years" approved by MECI in 2014 which is one of the measures in order to implement the Ukrainian electricity market reform, which began with the adoption of the Law of Ukraine No.663 in 2013 "On the Principles of the Electricity Market of Ukraine". The development plan for the next 10 years which has been approved by the Government is that for 2014 to 2023 prepared in 2013 only at present and the later versions have not been approved yet.

The development plan approval procedure is to prepare the draft plan by Ukrenergo, to confirm by and coordinate with NERC, MECI and other related ministries, and to deliberate in the Cabinet. The latest draft of development plan for the next 10 years 2016 to 2025 has been already disclosed in the web site of Ukrenergo.

The objectives of the development plan for the next 10 years include:

- Ensuring energy security in normal condition and in emergency situations
- Creating conditions for full integration of Ukraine network into EU network
- Increasing the reliability and efficiency of the electricity sector, overcoming the problem of energy deficit regions of the country

And to be designed to achieve the nationwide network to ensure reliable and efficient production and distribution of electricity for supply to domestic consumers as well as for export and import.

The development plan states about the subjects of Ukrainian electricity network as follows.

1) Analysis of Ukrainian electricity network
- Composition and characteristics of the network system
- Evaluation of the actual condition and restrictions of objects in the network at present and future
- Assessment of the actual condition of the sources of power generation and long term plans for their development
- Assessment of the adequacy of reserve power capacity in the network

2) Electricity power balance: demand and supply
- Electricity generation by the type of power plant
- Electricity consumption by industries and cost
- Balance of supply and demand
- Assessment of the necessity of electricity import and export opportunities
- Forecast and balance of load flow

3) Development Plan
- Assessment of required generating capacity and its optimization taking account type of generation, source of energy and cost
- Generation development plan
- Transmission network development plan
- Planning on removing and preventing systemic constrains in the network with system wide importance

4) Necessary investment for the development
- Cost estimation and investment plan for the development plan of generation and transmission network

The development plan for 2016 to 2025 revealed the following weaknesses of the Ukrainian network upon analysis of current condition.

- Physical wear and obsolescence have been found in 80 % or more of thermal power plants and CHP.
- Nuclear power stations are approaching their design lifetime.
- Type of power stations is neither well balanced nor optimized in the network for energy security.
- Lack of maneuverability and regulatory capacity of the power stations are observed to meet demand
- Power network connection capacity is insufficient between high demand regions and generators.

- Static and dynamic stability of components in the network is weak.

Based on the current condition and assessment of the electricity sector, the development plan is briefly summarized as follows.

- Construction of new thermal power stations and CHPs based on modern technologies and proper fuels which can comply with environmental standards for their operation.

- Reconstruction and modernization of existing thermal power stations and CHPs with higher capacity.

- Extension of existing nuclear power stations lifetime in condition of positive outcome of periodic safety reassessment.

- Completion of Units No.3 and No.4 Khmelnytska nuclear power plants.

- Implementation of construction projects with renewable energy source power generating plants to meet the needs optimizing the structure of generating capacity in the network.

- Construction of new substations and transmission lines as well as reconstruction and modernization of existing major facilities of the transmission network to increase their capacity.

- Apply higher plant efficiency equipment for generating plants and network components to meet modern requirements of technical standards, environmental standards and technological safety.

The development plan for the next 10 years have been prepared in detail in consideration of the above mentioned concepts.

The development plan provides for an increase in the period of 10 years from 2016 to 2025 the generating capacity 10,078 MW which includes the adaption of additional huge number of renewable energy generating facilities that reflects the reviewing results of the generating type ratio structure in the network and total generating installed capacity will be resulted 65,546 MW. In order to achieve the plan above, total UAH 414,490 million, equivalent to JPY 2,072,450 million, is estimated during above said 10 years.

For one of the priority projects of the integration of Ukraine to the United Power Interconnection European ENTOS-E, the development plan includes technical survey and measures such as establishment of specifications for parallel operation of whole Ukraine power system with energy union of Europe, and it was estimated to spend UAH 2,803 million, equivalent to JPY 14,015 million during 3 years from 2016 to 2018.

(2) Transmission Network Development Plan for 10 years

The development plans for the transmission network are included in the United Energy System Development Plan as well and in which new construction of substation and transmission lines as well as replacement and modernization of the existing facilities are itemized. The transmission lines are planned to develop total length of 3,899 km at the voltage from 220 kV to 750 kV, and the transformers are planned to develop total capacity of 18,413 MVA. Furthermore, the fiber optic cables are also planned to extend 600 km for strengthening supervision, control and protection of the network system.

The transmission network development plan summary and the details are described in the Tables 6.1-4 and 6.1-5 respectively. Total amount of UAH 70,386 million, equivalent to JPY 351,930 million is estimated for those of development of the transmission lines and substations.

Table 6.1-4 Transmission Network Development Plan Summary (2016–2025)

Year	**Transformer (MVA)**	**Transmission Line (km)**						**Fiber Optic Cable (km)**
		700 kV	500 kV	400 kV	330 kV	220 kV	Total	
2016	4,763	186	0	0	75	0	261	0
2017	600	0	0	0	176	16	192	60
2018	1,025	140	0	0	230	0	370	0
2019	4,175	0	0	0	491	0	491	0
2020	1,050	275	0	0	734	30	1,039	0
2021	2,500	150	0	4	334	0	488	0
2022	1,600	0	0	0	119	0	119	0
2023	500	0	2	0	353	0	355	0
2024	0	320	0	0	0	0	320	0
2025	2,200	114	0	0	0	0	264	0
Total	**18,413**	**1,185**	**2**	**4**	**2,662**	**46**	**3,899**	**600**

Source: The United Energy System Development Plan of Ukraine for 2016-2025, Attachment

Table 6.1-5 Transmission Network Development Plan (2016–2025)

Legend of Progress: **P**: Planning, **F**: Feasibility Study, **M**: MECI Approval, **C**: Cabinet Minister, **E**: Execution stage

No	Name		Progress					Supporting Donner
	Items	Specification	P	F	M	C	U	
1.1	Construction of 750 kV Zaporizhzhya NPP-Kakhovska, PS 750 kV "Kakhovka" construction activities on the SS 750 kV "Kakhovka" 330 kV Kakhovka-Kherson and 330 kV Kakhovska-Ostrowska	AT 750 kV - 2 x (3 x 333) MVA; AT 330 kV - 250 MVA 750 kV - 186,1 km 330 kV - 43,8 km					●	EBRD & EIB
1.2	Reconstruction of 750 kV Substation "Kyivskaya" with the installation of a second 750 kV autotransformer and construction activities 330 kV overhead lines in the Kyiv region	AT 750/330 kV - 1000 MVA 330 kV -69,6 km					●	EBRD & EIB
1.3	Reconstruction of the SS 400 kV "Mukachevo" Installation of single-phase AT 133000/400/220/35 kV (3 * 133 MVA)	400 MVA				●		
1.4	Reconstruction of the 330 kV "levels" with the establishment of JSC 125000/330/110 kV	125 MVA	●					
1.5	Construction of 330 kV Western - Bogorodchani with the reconstruction of the 330 kV "Bogorodchani" and 750 kV "Western"	330 kV – 103,989 km				●		
1.6	Installing a second AT 330/110/35 kV substation 750/330/110 kV "Vinnitsa"	AT 330/110 kV - 125 MVA			●			
1.7	Becoming the third BP 330/110/35 kV substation 330 kV "Chernivtsi":	AT 330/110 kV - 200 MVA				●		
1.8	Installing the AT-3 capacity 200 MVA at 330 kV "Brovary" with the reconstruction of 110-330 kV Parliament	AT 330/110 kV - 200 MVA		●				
1.9	Reconstruction ASE 330 kV with installation of AT-3 and VR 110 kV substation 330/110/10 kV "Novokyyivska"	AT 330/110kV - 200 MVA				●		
1.10	330 kV North Lutsk - Ternopil' with the reconstruction of 330 kV Lutsk North and 330 kV Ternopil'	330 kV - 223 km		●				EBRD & EIB
1.11	Reconstruction of the 330 kV "Adjalyk" with the replacement of AT capacity of 125 MVA to 200 MVA capacity AT	AT 330/110 kV – 2 x 200 MVA	●					
1.12	Construction of 330 kV line Ternopil' - Chernivtsi	330 kV - 230 km	●					
1.13	750 kV "Zaporizhzhya". Setting AT№3 capacity of 1000 MVA, installation of PDT in each of BP neutral and switch AT№1, AT№2 in "sesquioxides" field on the side of 330 kV	AT 750/330 kV - 1000 MVA	●					
1.14	Reconstruction of 750 kV "Dnepr" with the installation of AT-3	AT 750/330 kV - 1000 MVA	●					

No	Name		Progress					Supporting Donner
	Items	Specification	P	F	M	C	U	
1.15	Construction of 330 kV Pobuzhzhya - Talne - Glade of 330 kV "Talne"	3 x AT – 250 MVA 330 kV - 89 km		●				
1.16	Construction of 750 kV "Maritime" with measures 750-330 kV transmission line	AT 750 kV – 2 x (3 x 333) MVA; 750 kV - 150 km 330 kV – 2 x 5, 2 x 20, 2 x 40 km		●				
1.17	Construction of 330 kV Novovolinsk - Lviv West with the reconstruction of the 330 kV "Novovolinsk" and 330 kV "Lviv western"	330 kV - 115 km	●					
1.18	Construction of 330 kV Khmelnytsky NPP - Kyiv event of one circuit on the 330 kV "Forest" and the other - on the 330 kV "N - Volyn."	330 kV - 236 km 330 kV - 260 km	●					
1.19	Construction of 330 kV OL Krivoy Rog TES-Tryhaty at SS 330 kV "Nicholas" with the reconstruction of 150 kV and RU RU 330 kV to 330 kV "Nicholas"	330 kV - 2 x 7 km	●					
1.20	Construction activities 750 kV Vinnitsa-Western to the Dniester PSP	750 kV - 2 x 70 km	●					
1.21	Construction of 330 kV Kakhovka HPS - Polyana, 330 kV Kaniv PSP - PSP Bilotserkivska and Kanev - Talne (Figure issuing power Kaniv PSP)	3 x 330 kV – 230 km	●					
1.22	Reconstruction of the 330 kV "Pobuzke" with the establishment of AT-3	AT 330/150 kV - 250 MVA	●					
1.23	Reconstruction of the 330 kV "Kozyatyn" with reconstruction of RU 330 kV and establish AT-2	AT 330/110 kV - 200 MVA	●					
1.24	Reconstruction of the 750 kV "Kyiv" with the establishment of AT-3	AT 750/330 kV - 3 x 333 MVA	●					
1.25	750 kV Dniester HAES - Seashore	750 kV - 320 km	●					
1.26	Reconstruction of the 330 kV "Western" with the establishment of AT-3	AT 330/110 kV - 200 MVA	●					
1.27	Construction of 750 kV line from 750 kV "Kyiv" to the 750 kV "Pivnichnoukrains'ka" under construction by adding 750 kV "Chornobyl-KNPP" (area of intersection with the 330 kV Konotop- Nizhin to 750 kV "Pivnichnoukrains'ka")	750 kV - 114 km	●					
2.1	Construction 330/110/35 kV Substation "Western" of the 330 kV	AT 330 kV – 2 x 200 MVA 330 kV – 2.34 km				●		

No	Name		Progress					Supporting Donner
	Items	Specification	P	F	M	C	U	
2.2	Completion of the SS 330/110 kV "Drogobych" with 330 kV Western - Drohobych	AT 330/110 kV – 2 x 200 MVA	●					
2.3	Construction of FOCL on 330 kV to 750 kV section "Dnepr" - 330 kV "May Day" - 330 kV "Kirov" - 330 kV "South" - Krivoy Rog TPP - Substation 330 kV "Nikopol" - 330 kV "Ferroalloy" - Zaporizhia TPP - Zaporizhzhya NPP	250 km	●					
2.4	330 kV "Pavlogradskaya." Sectioning tires 150 kW	150 kV	●					
2.5	Modernization of radio relay lines (RRL) between 750 kV "Kakhovskaya" EU and South (built under the scheme 1 + 0: RRL one barrel without reservation) with 100% redundancy	350 km	●					
2.6	330 kV Dnieper TPP - left bank of the 330 kV "left bank"	2 AT 330/150 kV - 250 MVA 330 kV - 30 km	●					
2.7	The second 330 kV Dnipro 750 - VHMK with the reconstruction of the 330 kV "VDHMK"	330 kV - 6 km	●					
2.8	Reconstruction of GRP - GRP and 330 kV - 150 kV 330 kV "May Day"						●	
2.9	Reconstruction of the RTP 35, 150 and 330 kV to 330 kV "Dnipro-Donbas"					●		KfW
2.10	330 kV Novoodesskaya - Artsyz Replacement for 330 Artsyz AT 330 / 110kV capacity of 125 MVA to 200 MVA	330 kV - 104 km AT 330 kV - 200 MVA	●					
2.11	Construction of 330 kV "Junction" with measures 330 kV Dnieper TPP - May Day	2 x AT 330/150 kV - 250 MVA 330 kV – 2 x 12 km	●					
2.12	Construction of 330 kV "Slobozhanskaya" with measures 330 kV	AT 400 MVA 330 kV – 94.6 km		●				
2.13	Reconstruction VRP- 150, 330 kV 330 kV "Kirov"					●		KfW
2.14	Completion of the complex reconstruction of GRP-750 kV 750 kV "Vinnitsa".		●					
2.15	Construction of KL 330 kV West - October with reconstruction of the SS "October"	330 kV - 20 km	●					
2.16	Construction of 330 kV "Western" of the 330 kV Kyiv HPP-5 - Brovary	2 x AT 330/110 kV – 200 MVA 330 kV - 2 x 10 km	●					
2.17	Reconstruction of ZRU 6 kV, GRP 35-110 kV 330 kV "Zalyutino."		●					

No	Name		Progress					Supporting Donner
	Items	Specification	P	F	M	C	U	
2.18	Reconstruction of GRP 110-330 kV 330 kV "Artem" the transition to KRUE-110kV and 330kV-KRUE.		●					
2.19	Construction of 400 kV Substation "Uzhgorod" with measures 400 kV transmission line Mukachevo - Kapushany		●					
2.20	19. Reconstruction 330 kV "October" 330 kV "Novokyyivska", SS 330 kV "Zhytomyr", SS 330 kV "Cherkasy" 330 kV "Kremenchug" and 330 kV "Sumy"			●				IBRD
2.21	Construction of 330 kV "Novograd Volyn" of the 330 kV Khmelnytskyi NPP-Forest	2 x AT 330/110 kV - 125 MVA 330 kV 2 x 10 km	●					
2.22	Switching on voltage 330 kV 220 kV "Tsentrolit" with the implementation of measures to PS "Tsentrolit" 330 kV Adzhalyk- Usatove 1	AT 330/110 kV – 2 x 200 MVA 330 kV - 2 km	●					
2.23	Construction of 330 kV "Vorskla" of the 330 kV Pivnichnoukrains'ka-Poltava	AT - 400 MVA 330 kV – 50 km	●					
2.24	Construction activities 330 kV Central - Lozovaja to 330 kV "Chervonoarmijska"	330 kV – 2 x 5 km	●					
2.25	Reconstruction of ORU 330 kV 330 kV "Jawor" 330 kV "Radivilov", SS 330 kV "ferroalloy", SS 330 kV "Nikopol"		●					
2.26	Replacement ID-CP on Substation 220 kV «Volovets»		●					
2.27	Replacement of equipment at SS 220 kV above is not appropriate settlement levels or speed recovery circuit voltage (including that exhausted their resource)		●					
2.28	Construction of 330 kV "Fastovsky" with connection to the 330 kV network by construction of the 330 kV Zhytomyr - TpTES	AT 330/110 kV – 2 x 200 MVA 330 kV – 2 x 10 km	●					
3.1	Reconstruction Land 330 kV "Zaporizhzhia 750 - Dnipro-Donbas №1, 2" with increased capacity	330 kV – 2 x 15.4 km	●					
3.2	Construction of 750 kV Maritime - Kakhovska	750 kV - 275 km	●					
3.3	Reconstruction of 330 kV RU - South Street number 2 with the formation of a new 330 kV Western Lviv - Lviv South	330 kV - 8 km	●					
3.4	Transfer submarine NPP - Quartzite voltage class 330 kV	330 kV - 123 km	●					

No	Name		Progress					Supporting Donner
	Items	Specification	P	F	M	C	U	
3.5	Joining 750 kV "Kyiv" to Network 330 kW (with 330 kV perezavedennya Chornobyl - Mozyr on the SS "Kyiv" 330 kV Substation CHAES- Slavutych "Kyiv" and construction of 330 kV Kyivska-Forest)		●					
3.6	Reconstruction of the 330 kV transmission line "South - Pervomayskaya №1, 2" with increasing bandwidth	330 kV – 2 x 41 km	●					
4.1	Design and construction of 330 kV "Aquilon"	2 x AT 330/150 kV - 250 MVA	●					
4.2	Construction of 330 kV OL Adjalyk-Tryhaty at GCHQ "Tiligul" Reconstruction of 330 kV "Novoodesska" Reconstruction of RU 110 kV 330 kV "Kamyanets Podolsky"	330 kV – 94.4 km	●					
4.3	Reconstruction of SS 220/35/10 kV "Berezan"	AT 220/35/10 kV - 63 MW		●				
4.4	Reconstruction of 330 kV "Melitopol" to connect 330 kV transmission line from Zaporizhzhya WEIGHT	330 kV	●					
4.5	Reconstruction of GRP 220 kV and 220 kV "Borislav" with replacement of ID-CP	2 EB 220 kV	●					
5.1	Installing the AT-2 330/150 kV connection HAES	AT 330/150 kV	●					
5.2	Installing AT 330/110 kV Tripoli TPP (replacing damaged)	AT 330/110 kV - 125 MVA	●					
5.3	Reconstruction of GRP 330 kV Zaporizhzhya TPP (division of AT-1 and AT-2 connectivity in their individual fields 330 kV)	3 switch 330 kV, 330 kV equipment	●					
5.4	Reconstruction of GRP 330 kV and 150 CE kV Kryvyi Rih TPP (division of AT 1 and AT-2 connecting them into a separate E-field 330 kV and 150 kV)	2 switch 330 kV 2 switch 150 kV	●					
6.1	Setting static compensators for SES-station node (110 kV "Solar - Kiliia")		●					
6.2	Setting static compensators for SES-station node (110 kV "Solar - Reni")	2 x 6.0 Mvar	●					
6.3	Setting static compensators on the SES-station node (110 kV "Solar - Kiliia")	2 x 8.00 Mvar	●					
6.4	Replacing the GRP-35 kV compensating devices for reactive power 330 kV "Kamenetz-Podolsk" 330 kV "Shepetovka" 330 kV "Kovel" 330 kV "Novovolinsk" and PS 220 kV "Lutsk-South"			●				

Source: The United Energy System Development Plan of Ukraine for 2016-2025, Attachment and Ukrenergo information at 1st work

(3) Supports of Donners related to the Development Plan for 10 years

The outlines of projects which are supported by donners in the Transmission Network Development Plan (2016 to 2025) are described as follow.

1) EBRD/EIB (1)

- Project Name: South Ukraine Transmission Project (750 kV Zaporizhzhia – Kakhovska Line)

- Corresponding No. in Table 6.1-4: 1.1 and 1.2 (Package 1 to 4)

- Project outline [20]

  - Package 1
    Construction of overhead transmission line 750 kV Zaporizhzhia NPP - Kakhovska substation (190 km) including installation of OPGW

  - Package 2
    Construction of a new Kakhovska substation (including 750/330 kV 1,000 MVA transformer)

  - Package 3
    Construction of double circuit overhead transmission line 330 kV new Kakhovska substation - Ostrovska substation (2 x 27.9 km) and changeover from existing Kakhovska substation
    Rehabilitation of Ostrovska substation

  - Package 4
    Construction of double circuit overhead transmission line 330 kV new Kakhovska substation - Khersonska substation (2 x 15.9 km) and changeover from existing Kakhovska substation.
    Rehabilitation of Kakhovska substation

  - Package 5
    Construction of new 330 kV Zahidna substation and two 330 kV lines connecting the new substation to the existing 2 substations in the vicinity of Kyiv

- Tendering for the Packages 1 - 4 has been completed and tendering for the Package 5 is planned to start in March 2016 from the pre-qualification stage.

- Loan amount: EBRD and EIB fund EUR 175 million each (Total EUR 350 million)

[20] EBRD Web Site

2) EBRD/EIB (2) (planned)

- Project Name: Construction of overhead transmission line 330 kV Lustk pivnichna – Ternopilska with rehabilitation of substations

- Corresponding No. in Table 6.1-4: 1.10

- Project outline [21]

  The object of the project is that the improvement of the reliability and enhancement of electricity supply by construction of one of main transmission lines to western area from Rivneuska NPP and increase of power output of Rivneuska NPP as well.

  - Construction of overhead transmission line 330 kV between Lustk pivnichna substation – Ternopilska substation (223 km)

  - Replacement of facilities in the substations of Lustk pivnichna and Ternopilska

- The scoping stakeholder meeting were held in March 2016 in the region of the project implementation according to the EBRD's Environmental and Social Policy and the EIB's Environmental and Social Principles and Regulations.

3) IBRD

- Project Name: Second Power Transmission Project

- Corresponding No. in Table 6.1-4: 2.20 (Component 1)

- Project outline [22]
  - Component 1

    Loan amount: USD 268 million

    Rehabilitation of Transmission Substations

    - Novokyivska Substation

      Installation of indoor 330 kV and 110kV GIS, additional Automatic Transformer

    - October Substation

      Installation of indoor 330 kV GIS and outdoor 110 kV GIS

[21] Ukrenergo Web Site
[22] IBRD Project Apprisal Document Report No: PAD1093

- Kremenchug Substation
  Installation of indoor 330 kV and 150kV GIS

- Zhytomyrska Substation
  Installation of indoor 330 kV and 150kV GIS

- Cherkassy Substation
  Replacement of 330 kV outdoor switchyard facilities and one 110 kV outdoor Gas insulated switchgear

- Sumy Substation
  Replacement and expansion of 110 kV switchyard facilities

✧ Component 2

Loan amount: USD 107.925 million (IBRD funds USD 59.5 million and CIF funds USD 48.425 million)

- Subcomponent 2.1
  - Shunt Reactors (20 Mvar) installation at five 35 kV substations
  - For 5 substations of Novovolinskaya、Lutsk Pivdenna、Kovel、Shepetivka and Kamenets-Podilska

- Subcomponent 2.2
  - Introduction of Smart Grid
  - Modernization of the telecommunication network between renewable energy sources, key substations of transmission networks and system operator control centers
  - Modernization of the regional and national system of load control centers to improve system control and dispatch including more efficient integration renewable energy into the power grid

- Subcomponent 2.3
  - Provision of support to the Balancing Market
  - Procurement and installation of hardware, software, metering, and other elements needed by Ukrenergo as the Balancing Market Operator (Cross-border trading)

- Subcomponent 2.4
  - Establishment of a corporate-wide Management Information System (MIS) in Ukrenergo
  - Consulting services for Ukrenergo to improve financial management, build capacity in procurement and project management, and train its staff

✧ Component 3

Loan amount: USD 2.5 million

Capacity Building of MECI for Reform Implementation

Institutional support for the implementation of energy sector reforms in line with commitments of Ukraine within the framework of membership in the Energy Community and the EU Association Agreement.

4) KfW

- Project Name: Increasing Efficiency of Electricity Transmission (Modernization of Substations)
- Corresponding No. in Table 6.1-4: 2.9 (Lot 2) and 2.13 (Lot 1)
- Project outline [23]

Rehabilitation of 5 substations of the Dnipro and Donbass Power Systems

✧ Lot 1

Rehabilitation of Kirovskaya Substation

- Replacement and expansion of 330/ 150/ 35 kV Switchgear
- Replacement of protection and supervisory equipment

✧ Lot 2

Rehabilitation of Dnipro - Donbas Substation

- Replacement of 330/150/35 kV Switchyard facilities
- Replacement of protection and supervisory equipment

✧ Lot 3

Rehabilitation of Tsentralnaya Substation

- Replacement and expansion of 330/110/35 kV Switchgear facilities
- Replacement of protection and supervisory equipment

[23] Ukrenergo Web Site

- ✧ Lot 4

  Rehabilitation of Mikhaylovskaya Substation

  - Replacement of 220 kV Switchyard facilities of 330/220/110/35 kV Substation
  - Replacement of protection and supervisory equipment of 220 kV system

- ✧ Lot 5

  Rehabilitation of Lysychanskaya Substation

  - Replacement of 110 kV Switchgear facilities of 330/110/35 kV Substation
  - Replacement of protection and supervisory equipment

- ➢ Loan amount: EUR 65.5 million

- ➢ Lot 1 and 2 was contracted with the Contractor as one package in December 2015 at the amount of EUR 18.1 million.

6.2 Support Needs for Transmission Lines and Substations

Ukrenergo creates the 10-year United Energy System Development Plan every year and makes the application for approval of the Government, however, the current business plan, whose prerequisite of transmission network development plan including formulation of master plan adopts the methods of the former Soviet Union, has been recognized as unsuitable for situation at present. Therefore, Ukrenergo would like to request JICA to support formulating power system development master plan with an appropriate modern method.

In other hand, as the results of site visits, the Study Team noticed that the people working at the fields recognize that the priority issue should be the replacement of the aged existing facilities with new ones in order to remain their operating power system safe and stable, even though the new and expansion projects are planned.

The Study Team also confirmed that existing aged facilities needs some countermeasures such as replacement with new ones, because the diagnosis of long operated transmission lines was made and the deterioration of foundations like crack and/or deformation, corrosion of tower materials, etc. were reported.

As for new technology adaption, High Temperature Low Sag (HTLS) wire for transmission line was introduced by the Study Team, however, the new transmission line construction is highly desirable than the replacement of modern wire only with utilizing old towers taking into consideration safety, which is to avoid power supply failure even in case the transmission tower collapse, based on the diagnosis results. HTLS wire for transmission lines was not considered as one of the needs from Ukraine side in this site survey.

As for the support candidates in terms of the transmission network facilities, Ukrenergo offered the following 5 projects picking up from the United Energy System Development Plan 2016 to 2025 upon the Study Team's request.

(i) Reconstruction of 330kV Adjalyk Substation (Table 6.1-4 Item No. 1.11)
Includes upgrade of the transformer capacity from 125 MVA to 200 MVA
Expected execution period: from 2016 to 2018
Planned cost: UAH 1,250 million (approx. JPY 6,250 million)

(ii) Replacement of 330 kV and 150 kV switchgear of Mykolaivska Substation and construction/changeover of 330 kV transmission line (length: approx. 7 km) (Table 6.1-4 Item No. 1.19)
Expected execution period: from 2018 to 2019

Planned cost: UAH 65 million (approx. JPY 325 million)

(iii) Reconstruction of 330 kV Kozyatyn Substation (Table 6.1-4 Item No. 1.23)
Includes installation of 330 kV switchgear and 330/110 kV 200 MVA transformer
Expected execution period: from 2020 to 2021
Planned cost: UAH 180 million (approx. JPY 900 million)

(iv) New installation of 330 kV Slobozhans'ka Substation and construction/changeover 330 kV transmission line (length: approx. 94.6 km) (Table 6.1-4 Item No. 2.12)
Expected execution period: from 2016 to 2020
Planned cost: UAH 1,807 million (approx. JPY 9,035 million)

(v) Upgrading of Tsentrolit Substation from 220 kV to 330 kV with 2 x 330/110 kV 200 MVA transformers and construction/changeover of 330 KV transmission line from Adzhalyk to Usatove-1 (length: approx. 2 km) (Table 6.1-4 Item No. 2.22)
Expected execution period: from 2019 to 2020
Planned cost: UAH 1,100 million (approx. JPY 5,500 million)

Furthermore, upon the discussion with Ukrenergo headquarters at the 2nd site survey, it was confirmed that it was important to support substations in western area of Ukraine where the transmission network is interconnected with EU network, so that the following 2 items which are also itemized in the United Energy System Development Plan have been added, and the site visit of 4 substations was made for grasping actual situation of facilities.

(vi) Additional installation of 400/220 kV 400 MVA Transformer in Mukachevo Substaion
Installation of 400 kV switchgear, transformer (400/220 kV single phase 3 x 133 MVA) and 220 kV switchgear (Table 6.1-4 Item No. 1.3)
Expected execution period: from 2015 to 2016
Planned cost: UAH 201.567 million (approx. JPY 1,008 million)

400/220 kV Transformer was already procured in 2012 (Manufactured in Ukraine), not fabricated completely, oil filled in main tank and stored in Mache Substation[24]

(vii) Replacement of major facilities in 330 kV Bogorodchani Substation and construction of 330 kV Bogorodchani–Zahidnourainska transmission line (Table 6.1-4 Item No. 1.5)

[24] Found in the second site survey by JICA Study Team

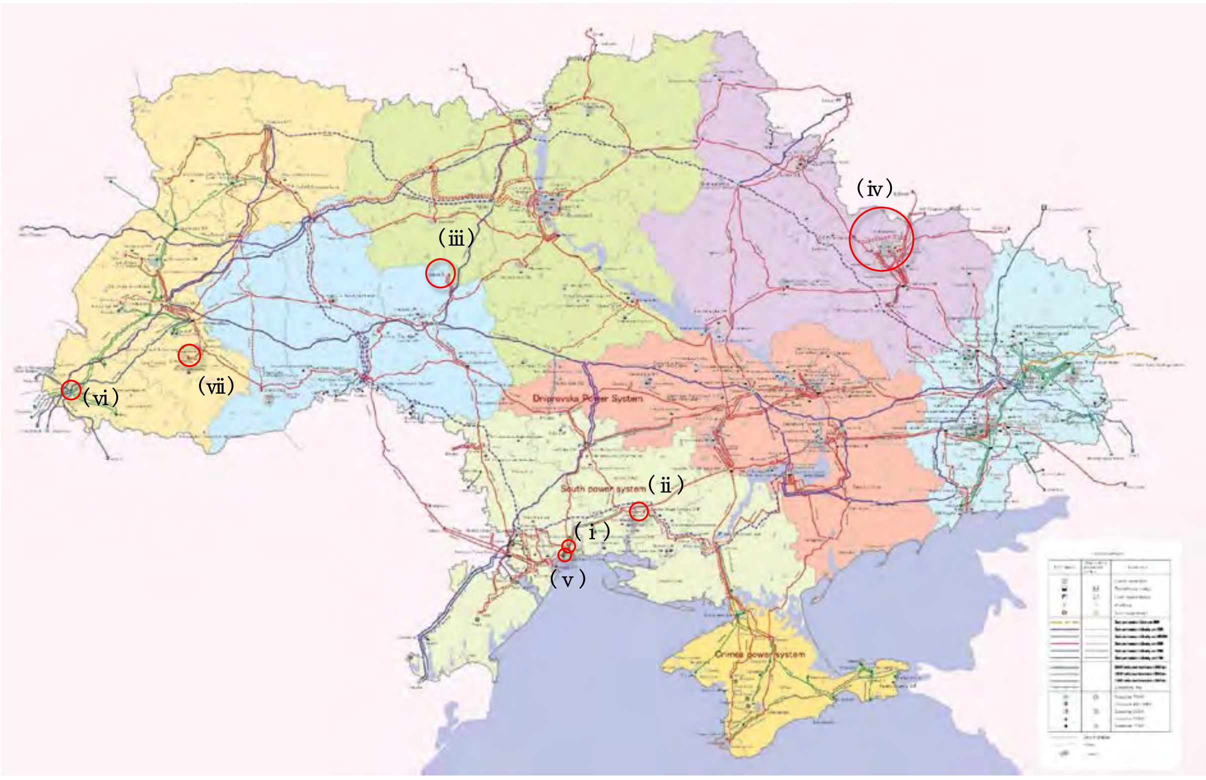
Replacement of 330 kV primary facilities (4 x air insulated switchgear and 2 x Voltage Transformer) and Protection relay panels for 2 transmission lines

Construction of 330 kV transmission line (remaining 40 km of total 104 km)

Expected execution period: from 2015 to 2017

Planned cost: UAH 305.693 million (approx. JPY 1,528 million)

The candidate areas mentioned above are described in the network diagram as shown in Figure 6.2-1. The numbers (i) to (vii) shown in the Figure 6.2-1 are corresponding to the item number mention above.



Source: Indicated by JICA Study Team on Ukrenergo Network Diagram

Figure 6.2-1 Location of Candidates for Transmission and Substation

Although received the offer of the support candidates mentioned above, it is strictly limited to reveal the documents and drawings related to the projects, also taking photography were prohibited in the visited substations. Therefore, there are still lots of unknown part such as construction scale, specifications of equipment in the said substations, etc.

6.3 Study of Candidates for Support

The facilities of transmission lines and substations of Ukrenergo have been used for decades and are aged so that it is considered that the rehabilitation of overall facilities is essential for future healthy operation of the network. Therefore, the appropriately planned rehabilitation or replacement of facilities should be conducted continuously other than the candidates mentioned in "6.2. Support Needs for Transmission Lines and Substations."

The Study of the above mentioned candidates which were selected upon the consultation with Ukrenergo are summarized in Table 6.3-1.

Table 6.3-1 Overview of project candidates in transmission and substation field

Item	(i) Renewal of 330kV Adjalyk Substation	(ii) Renewal of 330 kV Mykolaviska Substation	(iii) Renewal of 330 kV Kozyatyn Substation	(iv) Construction of New 330 kV Slobozhanska Substation
Target (Equipment Owner/Business Operator)	Ukrenergo (Ownership and Operation)	Same as left	Same as left	Same as left
Outline of the Project	➢ Renew the 330 kV Adjalyk Substation, including replacement of transformers (125 to 200 MVA) to increase the capacity of the substation.	➢ Renew the 150 kV and 330 kV switchgears at the 330 kV Mykolaivska Substation and the construction/switching of 330 kV transmission line (approx. 7 km).	➢ Renew of the 330 kV Kozyatyn Substation, including the installation of new 330 kV switchgear and transformer (330/110 kV, 200 MVA).	➢ Construct the new 330 kV Slobozhanska Substation and the construction/switching of 330 kV overhead transmission line (94.6 km).
Background of Project Selection Supporting Request from Counterpart	➢ Following interviews with Ukrenergo, this project was selected by Ukrenergo based on the 10 year development plan (2016 to 2025) prepared by Ukrenergo as this project commands high priority despite no clear funding prospect, including the possible assistance of a donor.	Same as left	Same as left	Same as left
Work Period (Short-, Medium- or Long-Term)	2016 to 2018 (designated by Ukrenergo)	2018 to 2019 (designated by Ukrenergo)	2020 to 2021 (designated by Ukrenergo)	2016 to 2020 (designated by Ukrenergo)
Estimated Cost	UAH 1,250 million (approx. JPY 6,250 million) (estimated by Ukrenergo)	UAH 65 million (approx. JPY 325 million) (estimated by Ukrenergo)	UAH 180 million (approx. JPY 900 million) (estimated by Ukrenergo)	UAH 1,807 million (approx. JPY 9,035 million) (estimated by Ukrenergo)
Availability of Japanese Technology (Technical Superiority/Interest in Ukraine)	➢ Since 330 kV is not part of the voltage classes used in Japan, the higher voltage class facilities will be selected. That will be low possibility of utilizing Japanese Technologies in terms of competitiveness.	Same as left	Same as left	Same as left
Expected Project Effectiveness	➢ Since Odessa is an international port city and tourist destinations in the 4th largest city in Ukraine, effectiveness corresponding to the growth of the electric power consumption is considered to be large.	➢ Although the need of facilities update is considered by the reason of deterioration, concrete effectiveness is unclear because the investigation has not been performed yet.	Same as left	➢ As the response to the growth of the electric power consumption and improvement of the network stability can be predicted, the certain amount of effectiveness can be expected.
Possibility of Governmental Guarantee	➢ Possible, Ukrenergo has implemented many projects assisted by other donors/aid organizations, including the EBRD and EIB.	Same as left	Same as left	Same as left
The steps to be taken next and pending issues, etc.	➢ Verification of the validity of the project should be made.	Same as left	Same as left	➢ Feasibility study has been completed. It will be possible to examine the direction of the support once the feasibility study report, etc. has been obtained.

Source: JICA Study Team

Item	(v) Stepping-up at Tsentrolit Substation from 220 kV to 330 kV	(vi) Additional Installation of Transformer in 400 kV Mukachevo Substation	(vii) Replacement of Major Equipment in 330 kV Bogorodchani Substation
Target (Equipment Owner/Business Operator)	Ukrenergo (Ownership and Operation)	Same as left	Ukrenergo (Ownership and Operation)
Outline of the Project	➢ Step up to 330 kV (2 x 330/110 kV, 200 MVA) and the construction/switching of 330 kV Adzhalyk - Usatove-1 transmission line (2 km).	➢ Install additionally transformer (400/220 kV, 400 MVA) in Mukachevo Substation.	➢ Replace major equipment (CBs, VTs & Protection Relays) in Bogorodchani Substation and the construction of 330 kV Bogorodchani – Zahidnourainska transmission line (40 km).
Background of Project Selection and	➢ Following interviews with Ukrenergo, this project was selected by Ukrenergo based on the 10-year development plan (2016 to 2025) prepared by Ukrenergo as this project commands high priority despite no clear funding prospect, including the possible assistance of a donor.	➢ Following consultation with Ukrenergo, this project was selected by Ukrenergo based on the 10-year development plan (2016 to 2025) prepared by Ukrenergo as considered higher priority than items of (i) to (v) mentioned left in the western area.	Same as left
Work Period (Short-, Medium- or Long-Term)	2019 to 2020 (designated by Ukrenergo)	2015 to 2016 (designated by Ukrenergo)	2015 to 2017 (designated by Ukrenergo)
Estimated Cost	UAH 1,100 million (approx. JPY 5,500 million) (estimated by Ukrenergo)	UAH 201.567 million (approx. JPY 1,008 million) (estimated by Ukrenergo)	UAH 305.693 million (approx. JPY 1,528 million) (estimated by Ukrenergo)
Availability of Japanese Technology (Technical Superiority/Interest in Ukraine)	➢ Since 330 kV is not part of the voltage classes used in Japan, the higher voltage class facilities will be selected. That will be low possibility of utilizing Japanese Technologies in terms of competitiveness.	Same as left	Same as left
Expected Project Effectiveness	➢ Since Odessa is an international port city and tourist destinations in the 4th largest city in Ukraine, effectiveness corresponding to the growth of the electric power consumption is considered to be large.	➢ Since the facilities that are interconnected to EU network, the project will contribute to secure the stable export capacity and also to strengthen the power supply to surrounding area so that the effectiveness is considered to be large.	➢ Although the need of facilities update is considered by the reason of deterioration, no large benefit effect is expected because the area power to be supplied is a not major city.
Possibility of Governmental Guarantee	➢ Possible, Ukrenergo has implemented many projects assisted by other donors/ aid organizations, including EBRD and EIB.	Same as left	Same as left
The steps to be taken next and pending issues, etc.	➢ Verification of the validity of the project should be made.	Same as left	Same as left

Source: JICA Study Team

6.3.1 Possibility of entry of Japanese companies

Japanese companies can enter into this market since some already provide products used for transmission/substation facilities. However, it should be considered that the standards are different since the market mainly used the Soviet made products. For example, Ukraine uses the voltage classes of 750, 400 kV and 330 kV but these are not the standards in Japan. Also, their voltage classes do not match International Electrotechnical Commission (IEC) international standards. In general market operation, products are selected from the product lineup for each voltage class according to the system configuration. Therefore, to use Japanese products as main circuit products, products are selected from the lineup of products whose voltage class is higher than the standards in Ukraine. That means expensive products need to be selected. Japanese products for transmission/transformation generally more expensive than European products, so it may be difficult to win competitive bidding against European products which already have supply experiences.
Also, IEC Standards define the network standards for substation equipment such as protection and control equipment, but worldwide popular IEC standard products are rarely produced in Japan. This is mainly because Japanese power companies do not used IEC standard products.
In such environment, Japanese products are expected to be introduced for the following areas: compact size, high-quality GIS, Static Reactive Power Compensator (SRPC or SVC) using the semiconductor control technology, and HTLS wire for replacement with high-load high-capacity transmission lines.

GIS can be introduced for rehabilitation of facilities because it is mainly used in high-voltage substation in Ukraine and included in the current plans. Introduction of full GIS facilities where the bus is also gas-insulated is covered in the construction plans supported by other donors.
In view of voltage standards retention, power phase modification equipment is considered necessary for Ukrainian extensive systems, and therefore introduction of Japanese static reactive power compensator is possible which enables flexible control of phase modification capacity along with reactors and capacitors
Long-term economic efficiency of HTLS wire is not recognized well, and therefore description of specifications including economic efficiency may be required. In Ukraine, soundness of steel towers that have been used for a long time is problematic, and therefore introduction only for wire type change seems to be difficult.
Transmission/substation related electrical products used by Ukrenergo require Ukrainian equipment authentication. Therefore, when Japanese companies enter into the Ukraine market, they need to understand the authentication system, get the authentication for the relevant products, and then participate in the bidding. Otherwise, they may be disqualified under the qualification requirements.

Ukrenergo requires manufacturers to provide at least 3-year but generally 6-year product warranty. Also, drawings, materials and equipment tags need to be written in Ukrainian which takes a lot at the initial phase considering on-site installation and technical transfer.
At this survey, the Study Team got information regarding European counterparts but not Chinese and Korean counterparts entering into Ukrenergo. These European companies already got authentication of their products in Ukraine.

6.3.2 Laws and Regulations and Procedure to implement the Support Program

Table 6.3-2 shows the laws and regulations applicable in the case of repair and new construction of transmission and substation facilities for the realization of the EU requirements. See Appendix in detail, List of Laws and Regulations related to Energy Sector in Ukraine.

Table 6.3-2 Major laws and regulations related to transmission and distribution equipment

Ukrainian Laws and Regulations	EU Directive
➢ The Protocol of joining the Energy community treaty by Ukraine ➢ Order No.733-p of the Cabinet of the Ministries of Ukraine 'On approval of the action plan for implementation the obligations under the Energy Community Treaty establishment', dated Aug.3, 2011, amended on Oct.7, 2015 ➢ Order No.1080-p of the Cabinet of the Ministries of Ukraine 'On signing an additional agreement No.1 between Ukraine and the European Union, represented by the European Commission, on amending the Agreement on financing the program "Continue to support the realization of the Energy Strategy of Ukraine", dated Dec.12,2013', dated Oct.13, 2015 ➢ Order No.671-p of the Cabinet of the Ministries of Ukraine 'On the launch of the pilot project "Energy Bridge "Ukraine - European Union", dated Jun.15, 2015 ➢ Law of Ukraine "On operating principles of the electricity market of Ukraine"	➢ Directive 2006/32/EC of Apr.5, 2006 on energy end-use efficiency and energy services 407 ➢ Directive 2009/28/EC of Apr.23, 2009 on the promotion of the use of energy from renewable sources ➢ Regulation (EC) No 715/2009 of Jul.13, 2009 on conditions for access to the natural gas transmission networks

Source: JICA Study Team

These certification, licensing construction should be presented to the construction contractors together with the purpose of construction, design, manufacturing and installation documents showing other business activities that are carried out under contract, before the relevant start of construction.

After completion of construction, the permission by the relevant Energy Market Company is required before the connection to the power system together with the construction complete Reports.

6.3.3 Environmental and Social Consideration

(1) Environmental Regulation

Projects that can be supported under power transmission network include renewing existing substations (e.g. changing transmission lines), and constructing new substations and/or transmission lines. In the EIA system of Ukraine, power transmission networks above 330kV need to submit a detailed EIA. Thus, if the project to be supported fall under that category, the need to abide by the laws of the country (e.g. develop an EIA report, conduct public consultation and get approval from the relevant authority), should be considered.

(2) Other Considerations

In case the project is related with renewal of existing facilities such as substation and transmission line, environmental impact is limited mainly in construction stage, such as dust and noise generated from construction activity.

One of the specific issues related with replacement of substation is the management and treatment of transformer oil. Poly Chlorinated Biphenyl (PCB), which is commonly used in transformer oil, is a persistent chemical compound and is regarded as harmful to both human health and living environment. In Ukraine, PCB were never produced, but were reportedly used in power generation and distribution system. Under the current legislation in Ukraine, PCB is included in the list of pollutants[25] that must be controlled.

However, there is no specific policy or regulation concerning PCB management. PCBs shall be treated and managed in proper manner according to good industrial practice.

When changing transformers as part of updating a facility, there is a need to check the use of PCB and examine policy regarding storage of PCB waste.

When installing new substations and transmission lines, it is important to secure land for - the substation, building new access roads, and installing a tower. In addition, land use may temporarily be affected by the construction/exchange of transmission lines. Securing ROW (Right of Way) for

[25] Regulation No.1120 of the CMU 'On approval of the provision for controlling transboundary transportation of hazardous waste and its utilization/disposal, and Yellow and Green lists of waste', dated 13.07.2000

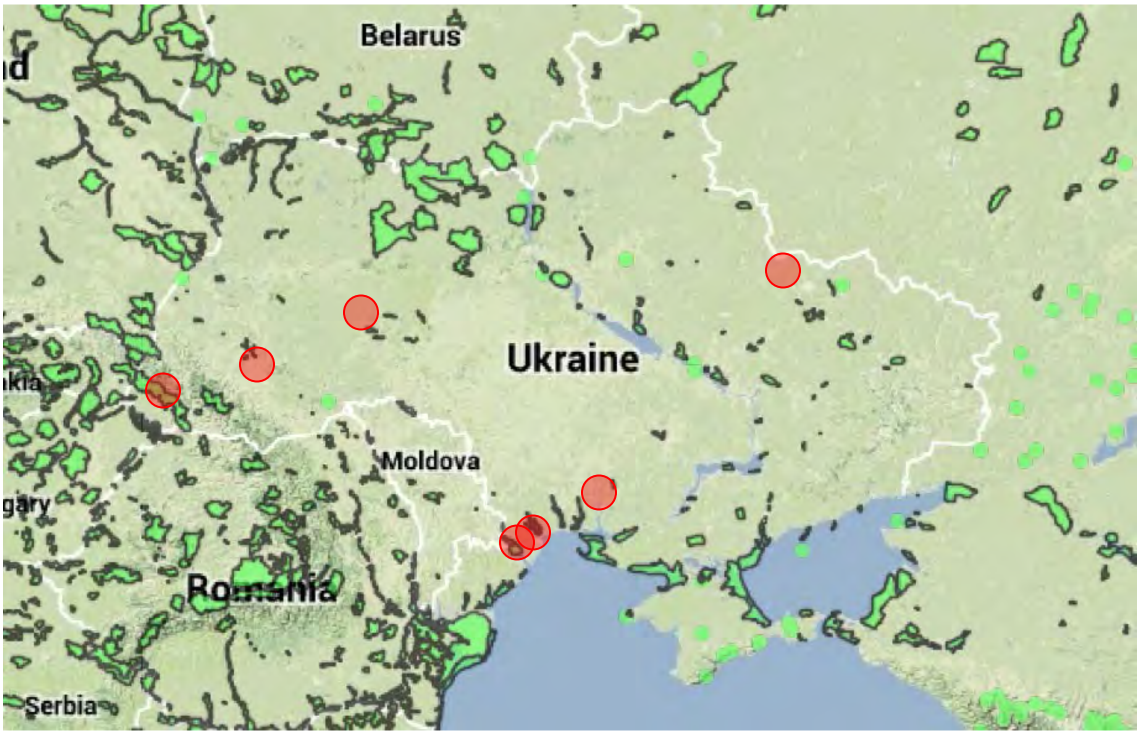
transmission line construction is stipulated in the Regulation of the Cabinet of the Ministries of Ukraine No.209 'On approval of the rules for electrical networks protection' (dated 4.03.1997). Under the regulation, the project proponent could obtain a land use right from the landowner for the construction/operation of transmission line without acquiring the subject land. The length of ROW for transmission lines should be based on the voltage as followings;

- 2 meters - up to 1 kV
- 10 meters - up to 20 kV
- 15 meters - 35 kV
- 20 meters - 110 kV
- 25 meters - 150, 220 kV
- 30 meters - 330, 400, 500, + (-) 400 kV
- 40 meters - 750 kV:

According to Ukraine's law, it is possible to use the land within ROW for agricultural purpose. However, in case that land use is restricted and land owners may lose their livelihood with the installation of power transmission network, there is a need to examine appropriate compensation, in compliance with guidelines set by Ukraine and JICA. Also, when investigating transmission line routes and land for substations, it is important to investigate routes that can minimize impacts on land use.

In addition, bird strike related with transmission line is another environmental risk which shall be considered for transmission line project, when the transmission line route is located near bird sensitive area or migratory route. The Important Bird Areas (IBAs) in Ukraine designated by BirdLife International is shown in Figure 6.3-1. IBA is represented by dark green areas, while areas of projects that can be supported are represented by red areas.

Although no new long transmission line is expected to be built (excluding 40 km of new transmission lines that will be built between Substations of Bohordchany and West Ukraine), it is recommended to collect information regarding to evidence of bird collision on existing transmission line, once the project is confirmed. If any risk has been identified, mitigation measures such as installation of markers shall be considered.



Source: BirdLife International

Figure 6.3-1 Location of IBAs (dark green areas) and candidate projects for support (red areas)

6.4 Distribution sector

6.4.1 General description of distribution sector

The companies in Ukraine which hold the electricity network for distribution are 45 and 42 among them sell electricity at regulated tariff to the end users as retail companies. The list of distribution companies is shown in Table 6.4-1.

Table 6.4-1 List of distribution companies

Company name	Retail	Company name	Retail
Dnieper Railway	●	Sevastopolenergo	●
Odessa Railway	●	DTEK Energougol	●
Southern Railway	●	Rivneoblenergo	●
South-Western Railway	●	DTEK Dniprooblenergo	●
Zaporizhzhyaoblenergo	●	DTEK Krymenergo	●
East-Crimean Power Company	●	ATOMSERVIS	●
Ternopiloblenergo	●	Prykarpattyaoblenergo	●
Power Supply Company Odesaoblenergo	●	Lvivoblenergo	●
ZEM		Chernigivoblenergo	●
Lviv Railway	●	DTEK Donetskoblenergo	●
Lugansk Energy Association	●	Energy-New Section	●
Kharkivoblenergo	●	Kyivoblenergo	●
Donetsk Railway	●	Sumyoblenergo	●
Energy-Novoyavorivsk	●	Poltavaoblenergo	●
DTEK The Grid	●	Central Energy Company	●
Luganskoblenergo	●	Cherkasyoblenergo	●
Vinnytsyaoblenergo	●	City Electric Networks	
Chernivtsioblenergo	●	Zakarpattyaoblenergo	●
Khmelnytskoblenergo	●	Mykolaivoblenergo	●
Kirovogradoblenergo	●	Kyivenergo	●
Volynoblenergo	●	102 Company Electric Networks	
Zhytomyroblenergo	●	Regional Power Grids	●
Khersonoblenergo	●		

Source: NERC Web Site

The company “Regional Power Grids” is the only 100 % state-run enterprise except railway companies listed in Table 6.4-1 and supplies electricity for Donetsk, Luhansk, Lviv and Volyn areas as a distribution retailer. Almost all companies other than mentioned above are Joint Stock Company whose stocks are partially owned by state or municipality with the progress of the privatization, and there are few Limited Liability Company among them.

6.4.2 General description of Kyiv City distribution

Kyivenergo is the joint stock company which supply electricity 100 % for Kyiv city. The company operates CHPs with electricity output 1,200 MW which are the property of Kyiv city, local government, and CHPs contribute approximately 30 % of electricity consumed in Kyiv city. Remaining is supplied to the covered area by purchasing through the wholesale power market. The private company "DTEK" holds 72 % shares of Kyivenergo and the municipal government of Kyiv does 25 %. As mentioned above, CHPs are the assets of the government, however, power distribution facilities including substations are assets of Kyivenergo.

The total length of distribution lines 110 kV or less of Kyivenergo, which is summed of overhead lines and buried cables, is approximately 13,000 km, and the total capacity of transformers which includes ones installed in substations is 7,629 MVA[26].

According to the information received during the site survey, it is prohibited from constructing new overhead transmission or distribution line in Kyiv city including replacement. Therefore, it is predicted that the overhead lines will be eliminated in the future, even they currently account for about half of the total length of distribution lines.

All substations of Kyivenergo are operated remotely from the central control room which is located in the headquarters and there is no operator in each substation. There are several 10 kV distribution instruction rooms scattered in the city and from them the remote control of the load switches, which are installed in the distribution network, is performed for the stable operation of the distribution network such as change of power supply route, isolation of fault point, etc. However, the auto reclosing function after the tripping of circuit breaker is not activated because there is the company rule that if an accident occurs in the network, actual situation has to be firstly confirmed at site in advance to the breaker or switch operation.

The distribution power development plans are formulated periodically for short term (5 years), medium term (10 years) and long term (15 years). These plans are basically formulated based on the urban planning of Kyiv city and the study is outsourced to the design company. It has been adopted competitive bidding system in order to select the company for the study, however, there are many cases that a special company who has a lot of design experience proven and has many existing data takes orders.
The Study Team visited Moskovska Substation (110/10 kV) during the 2nd site survey. The substation commenced operation in 1935 as a conventional air isolated substation and after long

[26] Kyivenergo December, 2014

years' operation it has been modified to modern indoor GIS type substation with utilizing the European products in 2003. It equips 110 kV GIS, 2 x 110/10 kV 63 MVA transformers and 10 kV switchgear on the ground floor inside substation building. The protection relay facilities and SCADA system, those of which are the modern digital type adopted, are installed on the 2nd floor of the building. The power transformers and power cables among primary equipment used in the substation are manufactured in Ukraine.

According to the explanation of Kyivenergo the configuration of this Moskovska Substation, indoor GIS type, is considered as the standard design for the company so that the substation to be constructed future will be basically the same design as Moskovska Substation. The pictures of GIS on the ground floor and the protection relay panels on the second floor in the substation building are shown in Figure 6.4-1 and 6.4-2 respectively.

Figure 6.4-1 Indoor 110 kV GIS

Figure 6.4-2 Digital Protection Relay Panel

6.4.3 Support needs for Kyiv city distribution

Power distribution demand of Kyiv city in recent years shows approximately 2 % of growth per year that is necessary to enhance the distribution facilities to meet the steady demand increase. Furthermore, most of the facilities were constructed in the era of the former Soviet Union, and updating construction of substations have only been implemented partially. In these considerations Kyivenergo believes that it is necessary to conduct capital investment of approximately EUR 400 million until 2030.

However, the revenue of electricity tariff is a limit to devote all necessary resource to maintenance of the existing facilities and it is difficult to cover the investment in new facilities in its revenue. As currently there are many standby demand customers who are waiting for electricity connection, the delay of power supply capital investment is an obstacle to the infrastructure development of the nation plan and it could be a cause to hinder the economic growth. Therefore, Kyivenergo is very wish to receive the support for construction of substations, renewal & enforcement of facilities in substations and extension and enforcement of distribution lines (110 kV and 35 kV etc.).

The 4 projects for distribution network enforcement planned by Kyivenergo is as follows.

(i) 110 kV Novokyivska - Moskovska Transmission Line Construction, 2 lines

- This project is to increase power supply capacity to Kyiv downtown from 200MW to 400 MW and to improve the reliability by the addition of power supply source.
- Installation of 1,400 mm^2 cable, approximately 20 km length
  Switchgear for both substations to be connected have been already installed.
- Project cost: USD 27 million (estimated by Kyivenergo)

(ii) 110 kV Slavutych Substation Construction and CHP 5 - Slavutych - Poznyaky 110 kV Transmission Line Construction

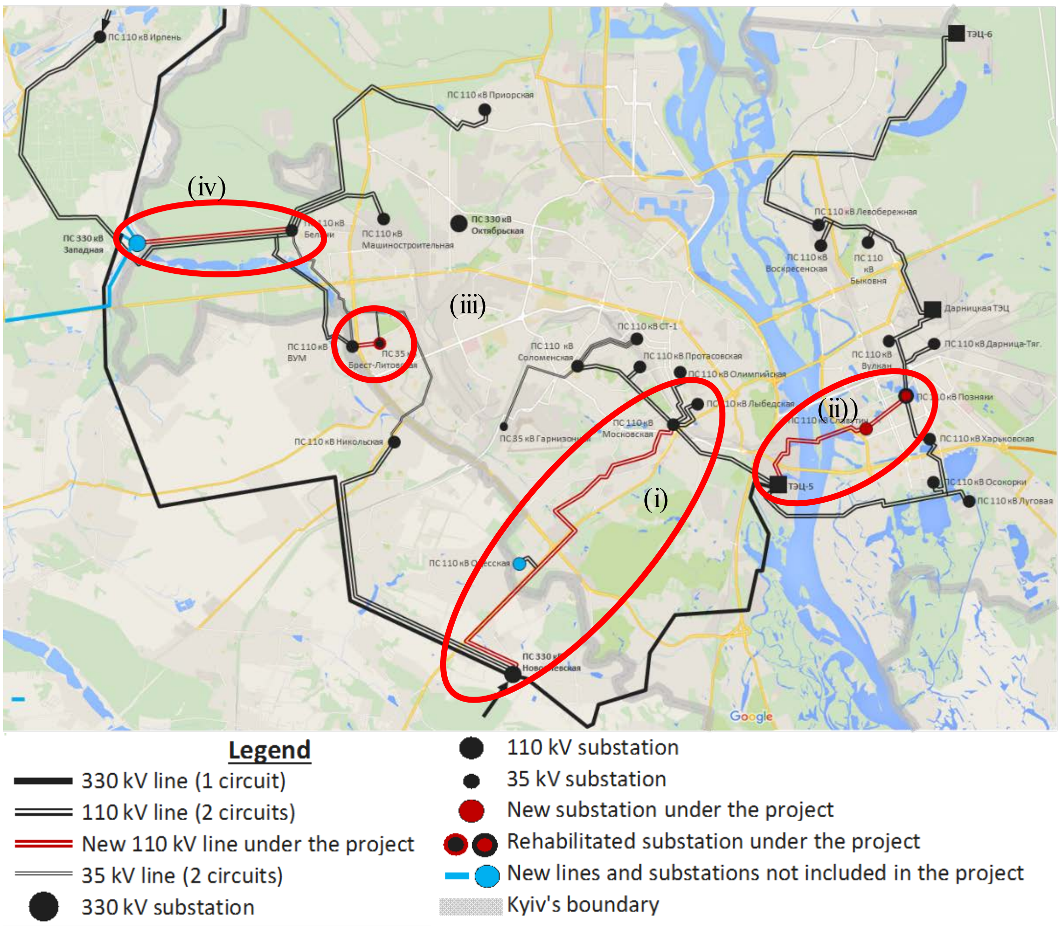
- This project is to increase power supply capacity to eastern Kyiv city (peak load: 500 MW vs supply line capacity: 420 MW) and to improve the reliability by the addition of power supply source.
- Project cost: USD 59 million (estimated by Kyivenergo)

(iii) Brest-Lytovska 110/10 kV Substation Construction and 110 kV Transmission Line Construction

- This project is to increase power supply capacity to Borshchahivka area and the boiler for heat supply (Countermeasure against 108 % overload at peak load). The existing 35/10 kV substation (commencement of operation: 1973) will be newly enhanced to 110/10 kV substation. It includes the construction of transmission line to 110 kV VUM substation as well.
- Project cost: USD 7 million (estimated by Kyivenergo)

(iv) Zakhidna - Bilitchi 110 kV Transmission Line Construction

- This project is to improve the reliability by the addition of power supply source to western Kyiv city other than the existing 110 kV power supply transmission line which is long (50 km) and high fault probability because that passes through the forest area, and to increase supply capacity for the future load.
- Project cost: USD 51 million (estimated by Kyivenergo)



Source: Kyivenergo project brief modified by JICA Study Team

Figure 6.4-3 Kyivenergo Distribution Network Project Location Map (red marked)

6.4.4 Study of Candidates for Support

As for enhancement of the power transmission and distribution network including substations in the distribution company of Kyiv city, it was confirmed the needs of Ukraine side as mentioned previously. It is judged to obtain high benefit effect when the support to the distribution field is made in the sense of contributions to the Kyiv citizens and industrial development. And further, it is a possible use of Japanese technology with a proven in the field of substation facilities all over the world.

However, in terms of facilities, Ukraine's domestic products of power transformers and power cables have been utilized widely so that it seems difficult to apply Japanese products of them. Furthermore, many distribution companies in Ukraine have decided to become privatized and Kyivenergo is the joint stock company which are owned by private company and municipality of Kyiv so that the acquisition of the governmental guarantee which is a condition of JICA support is considered impossible.

Therefore, it is not taken up the support candidates of the power distribution field in Kyiv city aggressively in this Study.

6.5 Hydraulic sector

Ukrhydroenergo is a state-run corporation in the hydraulic sector in Ukraine. Ukrhydroenergo owns hydraulic and pumped-storage power plants and provides generated power to the state-run transmission corporation Ukrenergo. The capacity of Ukrhydroenergo's facilities account for 7% of the Ukrainian power stations capacity.

6.5.1 Overview of Ukrhydroenergo

Ukrhydroenergo has 3,000 employees and more than 1,500 subcontractors and suppliers as of 2014. It owns 102 hydraulic power plants including pumped-storage power plants (PSPP) and the total capacity is 5,400 MW. It produces 1 billion kWh per year on average, and handles mainly variable load and peak load operation.

(1) Overview of hydraulic power station

Many of Ukrhydroenergo's facilities are highly aged and under rehabilitation. Between 1995 and 2002, Ukrhydroenergo's 16 hydraulic power plants were rehabilitated as the 1st stage, resulting in 88 MW increase of output. Also 54 control devices are replaced.

Between 2003 and 2005 is the intermediate stage during which 10 plants were rehabilitated to expand the output by 43.7 MW.

The current 2nd stage started 2006 and 70 plants are under rehabilitation which will be completed in 2024. Rehabilitation include the waterwheel governor, excitation system, controller, generator circuit breaker, and protection device. The output has been increased by 155 MW, and the total increase will be 400 MW.

Note that Ukrhydroenergo owns hydraulic power plants including pumped storage power plants but does not own transmission facilities and other facilities.

(2) Plans of hydraulic power stations

It is planned that by 2020, the capacity will be increased by 1,333 MW and the generation ratio will be increased from the current 7% to 12.3%, and by 2025, the capacity will be increased by 3,357 MW and the generation ratio will be increased to 15.5%.

Ukrhydroenergo's main business plans are shown in Table 6.5-1.

The Dnister PSPP construction project in Novodnistrovsk region shown in Figure 6.5-1 and Figure 6.5-2 was planned as a bundled project (Units No.1 to 7; total of 2,268 MW) but divided into Phase 1 (Units No.1 to 3: Total of 972 MW) and Phase 2 (Units No.4 to 7: Total of 1,296 MW) due to funding issues.

Units No. 1 and No. 2 in Phase 1 already started operation and Unit No. 3 unit will start operation in 2016. The 2nd survey confirmed that Unit No. 3 unit was during test run which was doing well.
For the upper and lower side facilities of Phase 2, construction and environmental effect evaluation for 7 units were completed in Phase 1.
Units No. 4 (324 MW) was planned to start operation in 2020 in Phase 2 but currently whether to construct it is under consideration in Phase 1. It is planned to be constructed with own fund like Phase 2 but the 2nd survey confirmed that it was not settled and funding by donors was not expected at the time.
Ukrhydroenergo estimated that the construction cost would be UAH 9.35 billion, but this will be decreased if Unit No. 4 is included in Phase 1.

Table 6.5-1 Ukrhydroenergo's Main Business Plans

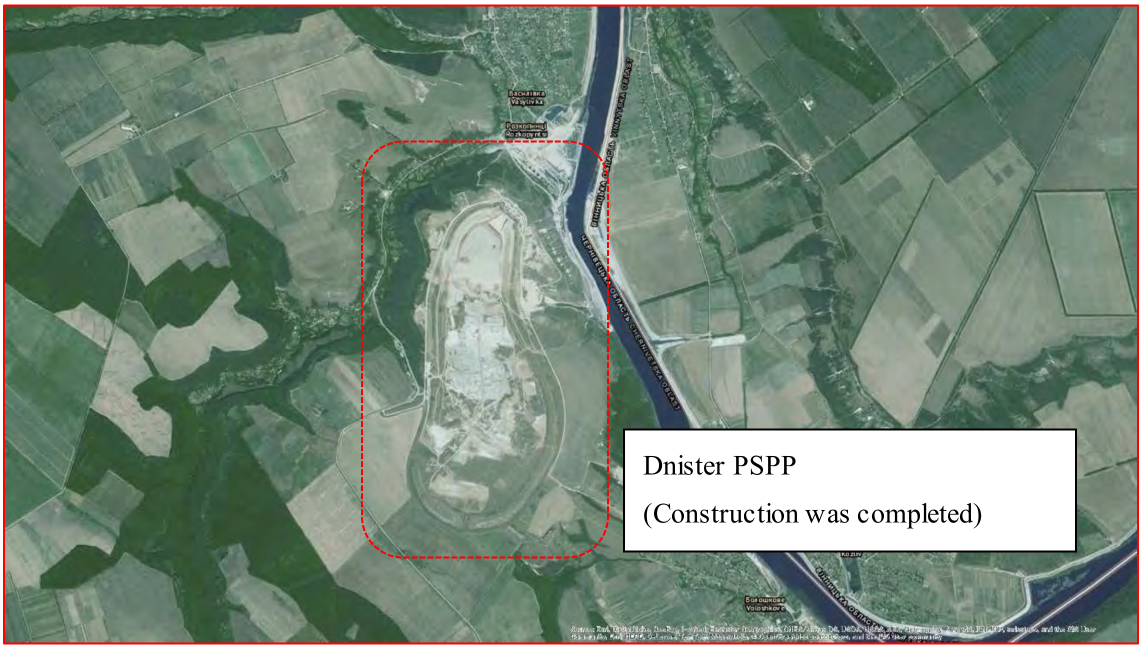
Items	Capacity (MW) Design	Capacity (MW) Installed	Year 2006-2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Project															
Dnister PSPP (Phase1)															
Capacity (MW)	972	648	**324.0**	**324.0**		324.0									
Cost (kUHA)			**7516.4**	**1601.6**	851.4	1419.7									
Design							Considering to move to Phase 1								
Construction			**75816.4**	**1601.6**	851.4	1416.7									
Own Funds (incl. VAT)															
IFO Loans															
Kaniv PSPP															
Capacity (MW)	1,000	0							250 x 1	250 x 1	250 x 1	250 x 1			
Cost (kUHA)			**66.0**	**0.4**	0.4	955.2	1610.8	2781.4	2740.6	1679.2	1633.5	516.8			
Design			**66.0**	**0.4**											
Construction															
Own Funds (incl. VAT)					0.4	356.5	483.2	833.1	822.2	503.7	490.0	175.3			
IFO Loans					–	598.7	1127.6	1948.3	1918.4	1175.5	1143.5	341.5			
Kakhovka-2 HPP															
Capacity (MW)	270	0								45 x 1	45 x 2	45 x 2	45 x 1		
Cost (kUHA)			**0.2**	**0.0**	25.4	70.0	909.0	3061.0	2048.9	1419.2	1419.6	1421.1	1298.1		
Design			**0.2**	**0.0**	25.4	70.0									
Construction															
Own Funds (incl. VAT)							909.0	430.0	277.2	276.9	278.7	272.8	0.0		
IFO Loans							–	2631.0	1771.7	1142.3	1140.9	1148.4	1298.1		
Dnister upstream HPP cascade															
Capacity (MW)	324	0									54 x 1	54 x 2	54 x 2	54 x 1	
Cost (kUHA)						30.0	71.0	95.3	403.0	1133.3	1743.3	3053.3	2353.3	1683.5	
Design						30.0	71.0	65.0							
Construction								30.3	403.0	1133.3	1743.3	3053.3	2353.3	1683.5	
Own Funds (incl. VAT)								30.3	403.0	537.3	537.3	921.2	921.2	921.2	
IFO Loans								–	–	596.0	1206.0	2132.1	1432.1	762.3	
Dnister PSPP (Phase2)															
Capacity (MW)	1,296	0										324 x 1	324 x 1	324 x 1	324 x 1
Cost (kUHA)						80.0	20.0	5.0		1100.0	1900.0	2000.0	2200.0	1600.0	550.0
Design						80.0	20.0	5.0							
Construction										1100.0	1900.0	2000.0	2200.0	1600.0	550.0
Own Funds (incl. VAT)										1100.0	1900.0	2000.0	2200.0	1600.0	550.0
IFO Loans										–	–	–	–	–	–

NOTE: Bold figures indicate the out come

Source: Provided by Ukrhydroenergo

Source: Materials provided by Ukrenergo

Figure 6.5-1 Dnister PSPP Location



Source: JICA Study Team

Figure 6.5-2 Dnister PSPP Location (enlarged)

6.5.2 Support needs in the hydraulic sector

Business in the hydraulic power generation sector in Ukraine is mainly operated by Ukrhydroenergo. Power plants owned by Ukrhydroenergo are aging and update of waterwheels and generator circuit breakers is planned in rehabilitation of these facilities.

Rehabilitation is already supported by donors and no new donor are proposing support, and therefore Ukrhydroenergo seems to want support from donors for new power plants to increase the facility capacity. Dnister PSPP Phase 2 is especially of high capacity and has high priority because the upper and lower side facilities are well organized.

6.5.3 Study of Candidates for Support

The Dnister PSPP (Phase 2) project started 4 years ago which is considerably related to Japanese companies since they made presentation for Ukrhydrenergo at that time. Ukrhydroenergo staff also remember that time.

The design capacity for F/S was 324 MW but it was 10 years ago and the capacity may be increased if reviewed with the current Japanese technology.

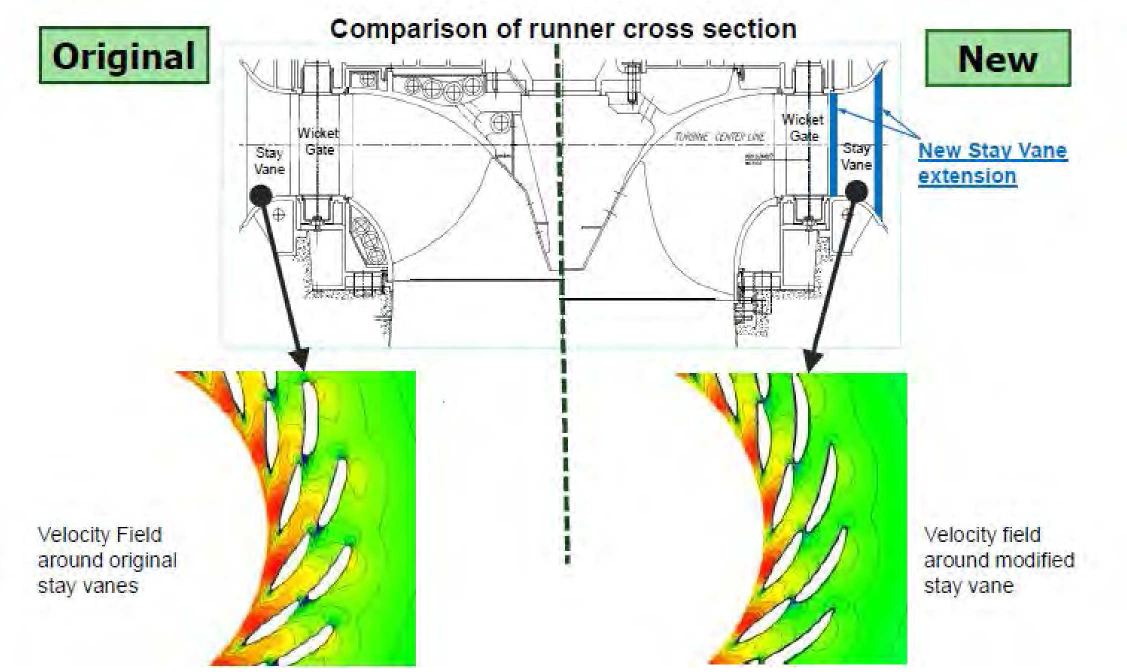
6.5.4 Possibility of entry of Japanese companies

The Ludington pumped-storage power plant in the United States (commencement in 1973) was rehabilitated in 2013. The waterwheel runner delivered was world's largest at that time and the capacity is expected to increase by approximately 50 MW in the design phase.

Although the Dnister PSPP (Phase 2) project requires re-F/S using the current knowledge, the capacity for each equipment planned by Ukrhydroenergo may be increased by 324 MW which satisfies the Ukrhydroenergo policy.

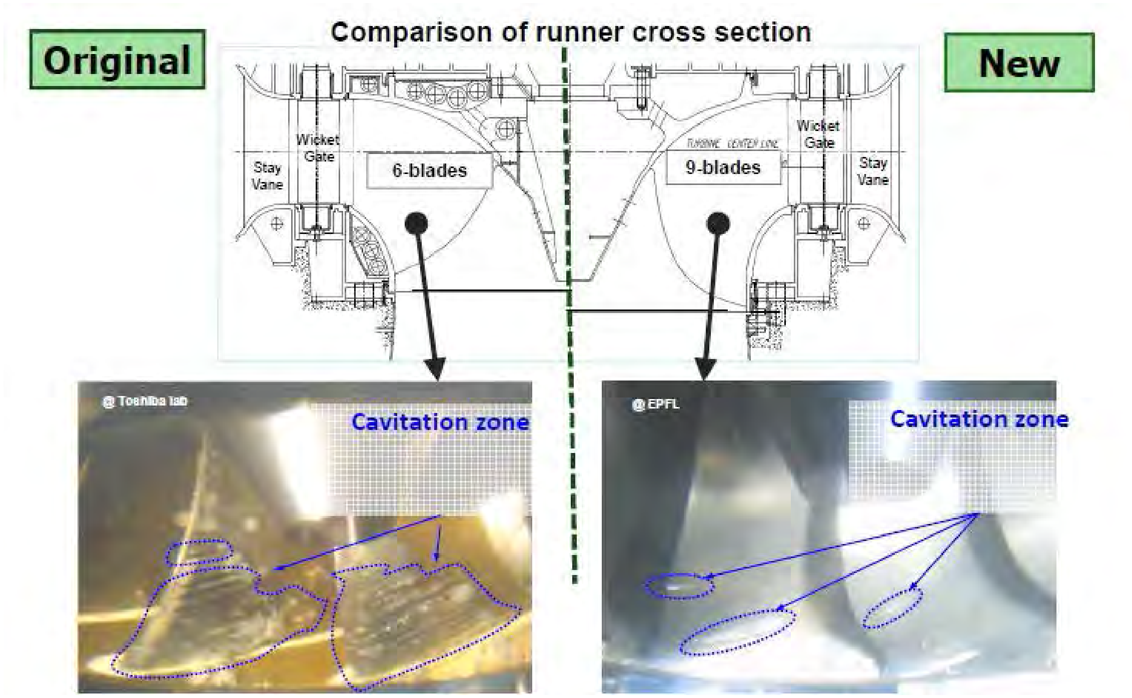
(Reference)

Latest waterwheel model facility and analysis technology are used to optimize the waterwheel (runner) shape and convert fluid energy guided through the conduit into mechanical energy more efficiently, resulting in more output. Also, as shown in Figure 6.5-4, narrower cavitation may contribute to the decreased maintenance costs and longer machine life. Moreover, through adopting a split runner, not only can the turbine efficiency be improved, but also it will be possible to improve the cavitation performance and resistance to sediment abrasion, thereby extending the service life.



Source: JICA Study Team

Figure 6.5-3 Review of Runner Blade Design



Source: JICA Study Team

Figure 6.5-4 Review of Moving Blade Design

6.5.5 Estimated project costs

(1) Calculation condition

As a result of interview with Ukrhydroenergo, they recognize that Japanese products are expensive. Therefore, the current calculation condition should only cover very minimum of Japanese pump waterwheels and generator motors, and EPC manufacturers should conduct Pre-F/S surveys in view of domestic products and inexpensive foreign products to suppress BOP related costs.

For this reason, we conducted interview with manufacturers regarding main equipment costs.

(2) Estimated project costs

Currently, the status of the upper and lower side facilities is unknown. The Study Team requested F/S documents to be disclosed but they could not provide such information unless the proposed support is concrete.

Accordingly, even though there is a possibility that the amount will differ greatly as a result of confirming the F/S materials or implementing the F/S again, Table 6.5-2 shows the cost of equipment (based on Free on board) in a main unit supplied by a Japanese company based on the rough calculation criteria and output.

Table 6.5-2 Main Equipment Costs

Item	Equipment cost (Million USD)
Pump waterwheel	(300million per Unit)
Generator motor	(300million per Unit)

Source: JICA Study Team

6.6 Conclusion

In transmission lines and substations sectors, making of the power system development master plan and facility update (including new construction) are expected to be supported by JICA.

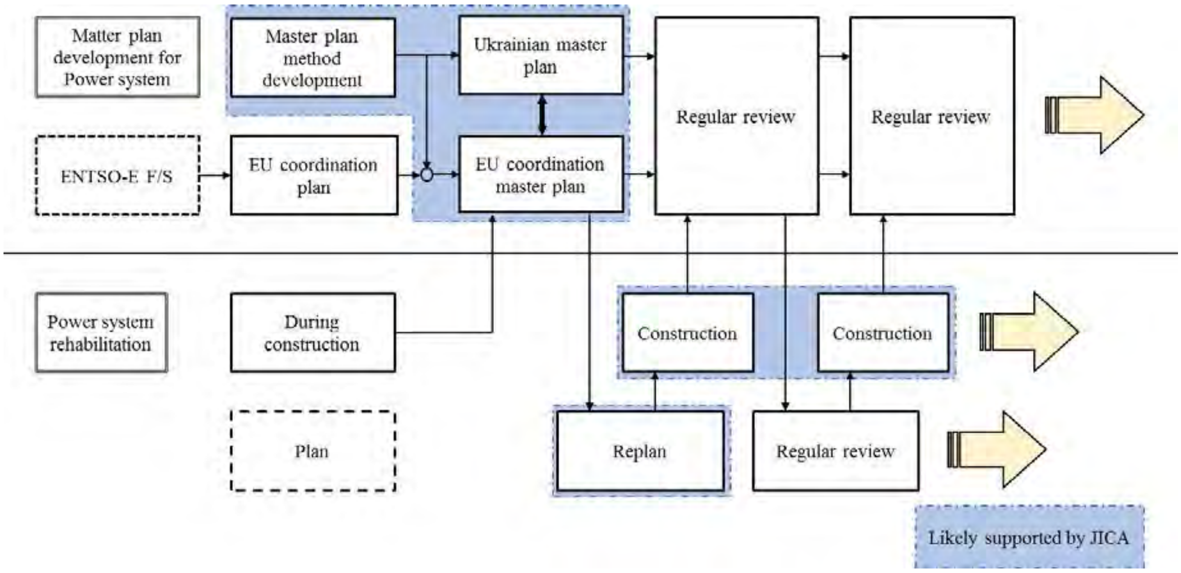
Investing on capacity without established methods for making master plans, it will not know whether the constructed facility will be operated properly. Establishment of the making master plan is most important for understanding the power supply-demand balance in Ukraine from a long-term standpoint. This is what is important to recognize also considering that output of nuclear power plants is restricted due to the transmission line capacity. Also, the master plan regarding coordination with the entire EU which is planned in Ukraine needs to be defined. The European consortium for power system operation is reviewing the roadmap including technical and system factors, and a relevant report is expected to be released soon (this was scheduled to be finished in December 2015, however, it still hadn't been announced at the time of the study in April 2016). Depending on that report, a complemental master plan for coordination with EU should be reviewed.

Overview of business flow and possibility of supporting by JICA are shown Figure 6.6-1.

For defining the power system development master plan, addition of economic development indicators to demand forecast is one of the important tasks for demand forecast that Ukrenergo recognizes. A demand forecast method using econometric models needs to be made. Supporting to make a new master plans while considering necessary improvements. For Ukraine, update plans for lifetime extension need to be covered, and therefore, facility diagnosis results and the priority based on the results should be included as important items for making master plans.

After that, make a careful judgment of whether the construction meets the master plan and move to the implementation phase.

Specific facility construction plans will be defined and enforced according to the master plan.



Source: JICA Study Team

Figure 6.6-1 Master Plan Establishment and Business Plan Flow

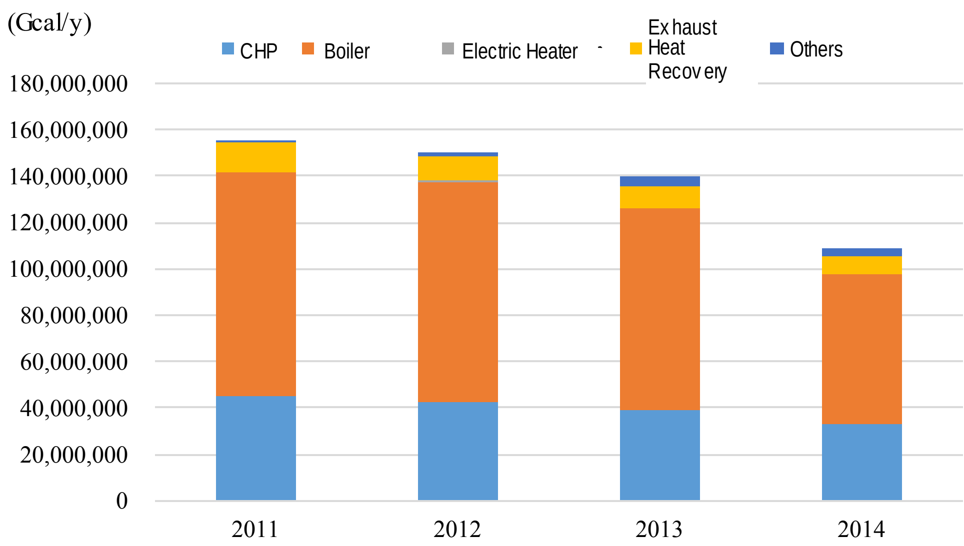
For construction and replacement of transmission/substation facilities, Japanese companies do not have advantage, and project selection needs to be carried out carefully.

7. District Heating Sector

Ukraine is located in a cold region, and DH plays an important role economically and socially since 43% or 7.5 million households out of the total of 17.5 million households are connected to the DH system as of 2011. The system mainly uses natural gas as fuel and the nation is in urgent need to reduce its reliance on the natural gas imported from Russia from the energy security standpoint. In 2011, 13 Bcm of natural gas was used to produce heat, and of which 9 Bcm was used for DH. The fuel used in the DH field needs to be reduced. However currently, many facilities are inefficient and past their design lives, and suffer large energy loss. The heat tariff is subject to approval. There are areas where the low heat prices are set, which prevent sufficient cost recovery as well as new investments for facility renewal, etc.

7.1 Current heat supply status

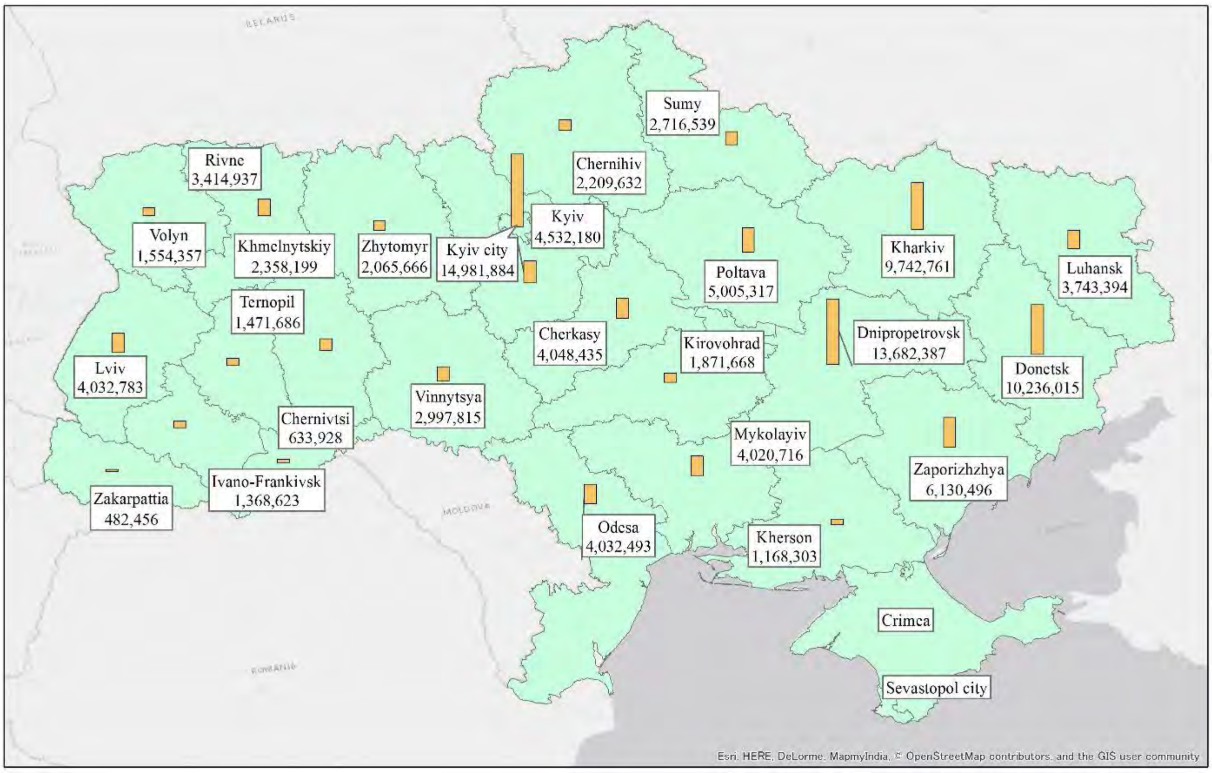
While the heat demand was 130,000 to 140,000 Gcal/h, the installed heat generation capacity was 162,000 Gcal/h as of 2011, with the installed boiler capacity being 120,000 Gcal/h. The heat producing capacity of CHP plants was about 22% or 36,000 Gcal/h. The change in the annual heat generation is shown in Figure 7.1-1. The production declined from 156 million Gcal in 2011 to 109 million Gcal in 2014. Approximately 60% of the heat was from the boiler facilities and about 30% from the CHP plants.



Source: State Statistics Service of Ukraine

Figure 7.1-1 Heat generation in Ukraine by facility type

Figure. 7.1-2 shows the heat supply by region for 2014. The region with the highest heat supply was Kyiv at 15 million Gcal, followed by Dnipropetrovsk oblast with 14 million Gcal and Donetsk oblast with 10 million Gcal.



Source: State Statistics Service of Ukraine

Figure 7.1-2 Heat supply in Ukraine by region (2014)

Table 7.1-1 shows the status of facilities that supply heat using boilers. The number of installed boiler is 3,510 and the capacity is 120,300 Gcal/h in 2011 as mentioned above. The heat generation was 104,700 Tcal, and the length of heat transport and supply pipes about 33,100 km. About 60% of the supplied heat was for residential use and the heat loss was 13,500 Tcal or about 14%.

Table 7.1-1 Heat supply in Ukraine

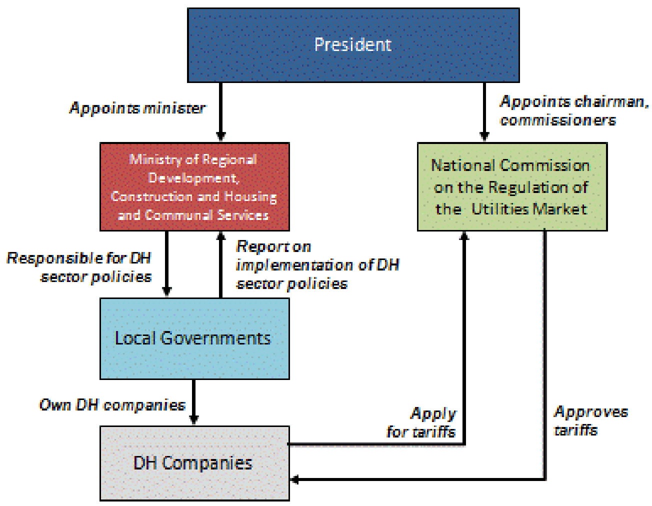
Item	2011	2012	2013	2014
Heat generation facility (1,000 units)	35.1	35.4	35.4	35.0
Installed heat generation capacity (Tcal/h)	120.3	117.8	114.0	96.1
No. of boilers for heat generation (1,000 units)	79.7	80.1	79.9	68.0
Length of heat transport and supply pipes (1,000 km)	33.1	32.4	31.3	25.6
Heat generation (1,000 Tcal)	104.7	104.1	96.5	73.0
Heat supplied from outside (1,000 Tcal)	9.6	9.2	8.6	6.5
In-house heat consumption (1,000 Tcal)	3.2	3.5	2.8	2.3
Heat supplied (1,000 Tcal)	97.6	96.0	89.1	67.4
➢ Residential use (1,000 Tcal)	54.7	55.0	51.9	39.5
➢ Public use (1,000 Tcal)	22.6	21.9	20.6	15.4
➢ Other use (1,000 Tcal)	20.3	19.1	16.6	12.5
Heat loss (1,000 Tcal)	13.5 (13.8%)	13.8 (14.4%)	13.2 (14.8%)	9.9 (14.7%)

Source: State Statistics Service of Ukraine

Note: figures exclude those for areas such as Crimea and Sevastopol

7.1.1 Organizational structure

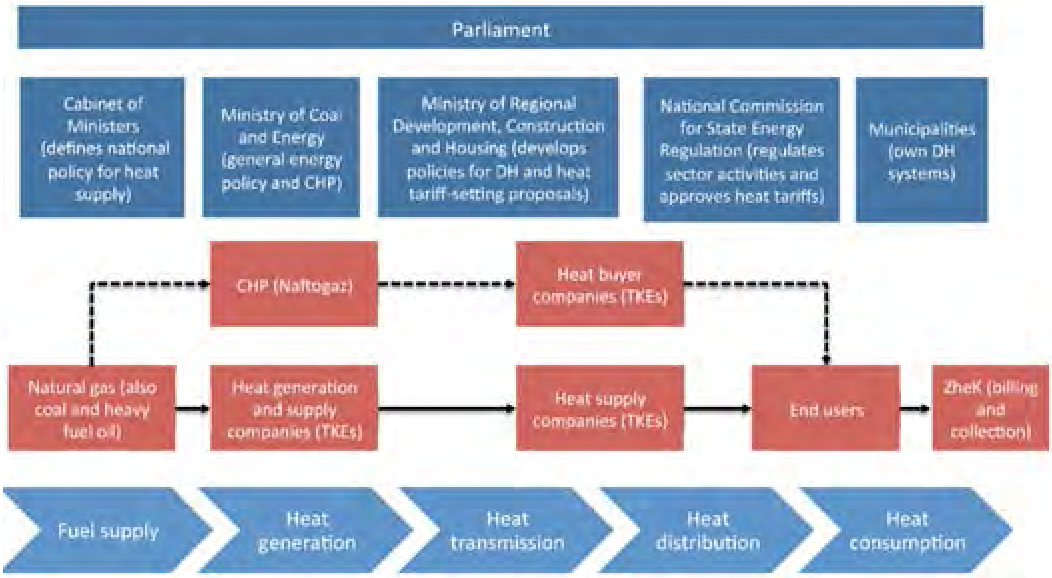
Ukraine has enacted "the Law of Ukraine on Heat Supply" (No 2633-IV dated June 2,2005) in 2005, which requires the DH companies to obtain license from MRDBH and approval on tariff from the National Commission on the Regulation of the Utilities Market, as shown in Figure 7.1-3.



Source: Modernization of the District Heating Systems in Ukraine: Heat Metering and Consumption-Based Billing, World Bank

Figure 7.1-3 Relationship between DH companies and the government in Ukraine

The operation is carried out by about 900 DH companies that are called TKEs (teplokomunenergos) and owned by the local government, which operate heat generation plants and supply and sell heat. The companies not only produce heat at their plants but also purchase it from CHP plants and other heat plants and supply it to the customers. In many cases, ZhEKs, public service companies, collect tariff. There is unbundling underway to separate heat generation and heat supply and sales to promote competition.



Source: Unlocking the Potential for Private Sector Participation in District Heating IFC

Figure 7.1-4 Organizational structure of DH-related entities in Ukraine

7.2 Current CHP status

Of the heat generated for Ukraine's DH, about 30% is supplied by CHPs, which fuel is 76 to 80% natural gas, 8 to 15% oil, and 5 to 6% coal. Figure 7.2-1 shows the locations, power generation capacity and heat output of the main CHP plants.

Source: JICA Study Team

Figure 7.2-1 CHP distribution in Ukraine

Table 7.2-1 List of CHPs in Ukraine

	Name	Capacity (MW)	Heat output (Gcal/h)	Start of operation
1	Lvivska CHP-1	20	800	1908
2	Kaluska CHP	200	590	1967
3	Bilotserkivska CHP	120	315	1971
4	Kyivska CHP-5	700	1694	1978
5	Kyivska CHP-6	500	1380	1981
6	Chernihivska CHP	210	500	1964
7	Pervomayska CHP	48	-	-
8	Odeska CHP	68	505 + 274	1950
9	Mykolaivska CHP	20	-	1939
10	Hersonska CHP	80	735	1958
11	Cherkasska CHP	230	430	1961
12	Kremenchutska CPP	255	1131	1965
13	Kryvorizka CHP	-	542	-
14	Sumska CHP	40	350	1957

	Name	Capacity (MW)	Heat output (Gcal/h)	Start of operation
15	CHP "Zaporizhstal"	25	-	-
16	Kharkivska CHP-5	540	1420	1979
17	Slovyanska CHP	800	-	-
18	Severodonetska CHP	260	600	1952
19	CHP "Styrol"	25	-	-
20	Sevastopolska CHP	33	202	1936
21	Simferopolska CHP	68	364	1958
22	Kamysh-Burunska CHP	30	103	1938
23	Dniprodzerzhinska CHP	61	330	1932
24	Kharkivska CHP-3	66	1353	1934

Source: Scientific Engineering Centre "Biomass" Ltd. (SECB) homepage

7.3 Outline of Kyivenergo

7.3.1 Line of business

Kyivenergo is involved in the generation, transmission and sales of heat and electricity as well as waste incineration for Kyiv, providing 100% of electricity and 75% of heat for the city. The amount of electricity sold in 2014 was 8.8 billion kWh and that of heat 10 million Gcal. 72% of its share is held by DTEK group and 25% by the Government. Kyivenergo has about 12,000 employees, assets of UAH 9,241 million, capital of UAH 4,493 million and liabilities of UAH 4,748 million and no loan.

The CHP facilities and waste incineration plant belong to Kyiv city, but the transmission /distribution facilities and substations are Kyivenergo's asset. The contract for managing Kyiv city's asset will expire at the end of 2017. After that, the operatorship is awarded based on the bidding, to which Kyivenergo plans to participate to keep the right to manage the asset. Kyivenergo's predecessor was a state-run company established in 1930. It was reorganized in 1995 and part of its share has been sold to the private sector since 1998. Nevertheless, the company has been involved in this endeavor on a continuous basis.

Table 7.3-1 Kyivenergo's business status

<table>
<tr><th></th><th>Form of business</th><th colspan="2">Facility/business status</th></tr>
<tr><td rowspan="2">Power supply facility</td><td rowspan="5">Business conducted using its own facility</td><td>Transmission lines of 110 kV or less
Distribution liens of 35 kV or less</td><td>Transmission/distribution line length: 13,000 km</td></tr>
<tr><td>Substations of 110 kV or less</td><td>Transforming capacity: 7,620 MVA</td></tr>
<tr><td>CHP facility</td><td>CHP-5
CHP-6</td><td>Power generation capacity: 1,200 MW
Heat supply capacity: 3,614 Gcal/h
(See Table 7.3-2 for details)</td></tr>
<tr><td rowspan="2">Heat supply facility</td><td>Heat supply pipe</td><td>Total length: 2,600 km</td></tr>
<tr><td>Boiler</td><td>182 locations in total
Heat supply capacity: 5,096 Gcal/h</td></tr>
<tr><td>Waste incineration facility</td><td>Business conducted under the operatorship awarded by Kyiv</td><td colspan="2">(Energia waste incineration plant)
➢ Treats about 25% of Kyiv's waste
➢ Annually treats 250,000 tons of waste</td></tr>
</table>

Source: JICA Study Team

Table 7.3-2 Installed capacity of Kyivenergo CHP-5 and CHP-6

		Facility name	Installed capacity (MW)	Start of operation / last large-scale inspection or facility remodeling	Cumulative operating hours
Electrical output	CHP-5	Unit 1	100	1971/2014	301,920
		Unit 2	100	1972/2012	297,232
		Unit 3	250	1974/2013	264,898
		Unit 4	250	1976/2014	216,639
		Total	700	-	11,080,689
	CHP-6	Unit 1	250	1982/2013	208,808
		Unit 2	250	1984/2012	198,399
		Total	500	-	407,207
Thermal output	CHP-5 (1,874 Gcal/h)	Unit 1	160	1971/2014	301,920
		Unit 2	160	1972/2012	297,232
		Unit 3	324	1974/2013	264,898
		Unit 4	330	1976/2014	216,639
		180 PTVM Boiler No. 1	180	1972/2008	32,866
		180 PTVM Boiler No. 2	180	1972/1994	24,532
		180 PTVM Boiler No. 3	180	1977/1997	41,089
		180 PTVM Boiler No. 4	180	1992/-	50,387
		180 PTVM Boiler No. 5	180	1998/-	36,593
	CHP-6 1,740 Gcal/h)	Unit 1	330	1982/2013	208,808
		Unit 2	330	1984/2012	198,399
		180 KVGM Boiler No. 1	180	1981/2010	55,828
		180 KVGM Boiler No. 2	180	1982/2011	49,978
		180 KVGM Boiler No. 3	180	1983/2011	51,116
		180 KVGM Boiler No. 4	180	1986/2010	46,021
		180 KVGM Boiler No. 5	180	1998/2013	10,859
		NAS-209-150 Boiler No. 6	180	2004/-	10,334

Source: DTEK 2014 INTEGRATED REPORT

7.3.2 Large-scape projects implemented

The CHP plants Kyivenergo owns was updated and expanded in a proper and timely manner to respond to the aging and the increase in heat demand, even though their facilities started the operations in the far past. The followings are main updating and expanding constructions which have been conducted recently.

- 11 km of heat supply pipelines was updated in 2011 to 2014.
- Facilities were renewed at 3 substations in 2011 to 2014.
- DH facility with hot-water boilers (2 x 100 Gcal/h) and steam boilers (2 x 25 t/h) was built in 2011.
- 330 kV indoor switching facility and transformer were built for the power supply to CHP-5 area.

7.3.3 Outline of heat supply facility (CT-1)

The first start of operation at this site was in 1937. The facilities were once called CHP-1, CHP-2 and CHP-3, since 2 x 22 MW units and 1 x 12 MW unit were installed in sequence to generate power. Although coal was burned to produce power until 1984, the fuel was converted from original coal to natural gas and the steam boilers have been used as hot-water boilers due to aging deterioration of the facilities, environmental issues (air pollution) and low price of natural gas. CHP-1 has been dismantled and CHP-2 and CHP-3 are used as hot-water boilers.

There are 7 boilers installed in total; more specifically, 3 x 100 Gcal/h units, 2 x 80 Gcal/h units and 2 x 55 Gcal/h units, with the total capacity of 570 Gcal/h and CHP-1 is now called CT-1 (means Heat Station-1 in Ukrainian) as it only has the hot-water boiler and produces no electricity.

Figure 7.3-1 Exterior of Kyivenergo CT-1

(Hot-water boiler)

(Hot water supply pump)

(Central control room)

(Gas receiving facility)

Figure 7.3-2 Facilities inside CT-1

WB credit approved in 2001 was used to procure the 3 sets of facilities as below. However, except for the stack, the facilities just sit in the premises due to lack of fund for installation.

- Chimney
- 4 boilers (2 hot-water boilers and 2 steam boilers)
- Water treatment system

Figure 7.3-3 Facilities produced with WB credit (uninstalled)

The operation of 4 out of 7 boilers suffices (2 x 80 Gcal/h and 2 x 55 Gcal/h) on only moderately cold days; but the remaining 3 boilers (100 Gcal/h) must operate on cold days. With more stringent emissions control, the units are not operated at full capacity; otherwise the NOx emission would exceed the standard. The temperature of the hot water leaving the plant is about 65°C and that returning to the plant is about 45°C. The water must be heated up to about 90°C in periods of extremely cold weather. The amount of water taken for water production is 200-250 tons/h. Sodium chloride (salt used industrially) instead of chemicals such as sulfuric acid or caustic soda is used for the regeneration of ion-exchange resin. The waste water from water treatment is diluted and discharged into the drainage ditch on the site.
Regarding environmental aspects, emissions are monitored quarterly by a national agency and maybe once a year by Kyiv city. No continuous monitoring is carried out. The only environmental facility currently installed is ESP. The boiler rehabilitation work includes the low-NOx burner installation, with which the EU standards will be met. Since the plant, CT-1 is located in an urban area, the conversion to coal use is not planned. However, the coal use is being considered for Heat Station-2 and CHP-6, for which F/S is underway.

As being aged equipment, asbestos is used to insulate pipes, etc. and found in hardened mortar. One of the conditions for WB projects was to avoid using asbestos.

7.4 Outline of Lvivteploenergo

Lvivteploenergo is a municipal heat supply company and serves 80% of Lviv city. The city holds 100% of the share of the company. The company owns 2 plants of CHP-1 and CHP-2, which supply heat to southern and northern parts of the city, respectively. The plants use natural gas as fuel. The pipes from CHP-1 and CHP-2 do not reach the center of the city, which is served by several small boilers installed at several locations.

CHP-1 is located in the downtown area of the city and has a limited site area, and due to its location, it uses natural gas for fuel. CHP-2 is in the northern part of the city. It was originally planned as a coal-fired plant in the era of the former Soviet Union. The construction stopped halfway through, leaving the facilities in the state. Currently, 2 hot-water boilers are in operation only using natural gas. The plant has railway, water pipe and currently-unused coal storage yard on its 160 ha site.

Figure 7.4-1 Exterior of CHP-1

Table 7.4-1 Heat supply status of Lvivteploenergo

	CHP-1	CHP-2
Natural gas consumption (m^3)	122,109,515	36,275,975
- For heat generation	103,014,870	36,275,975
- For power generation	19,094,645	-
Electricity generated (MWh)	96,406	-
Electricity sold (MWh)	65,691	-
Heat supplied (Gcal)	743,333	259,993
Installed heat supply capacity (Gcal/h)	800	200
Installed power generation capacity (MW)	41.3	-

Source: Collected from Lvivteploenergo

Table 7.4-2 Financial status of Lvivteploenergo

Income summary (UAH million)	2013	2014	2015
Income	521.1	672.5	862.9
Gross profit	(-65,8)	(-36,6)	(-16,8)
EBITDA	(-41,2)	(-11,9)	11.3
Net profit	(-81,7)	117.9	(-44,8)
Balance sheet (UAH million)	2013	2014	2015
Total assets	619.6	623.1	738.4
Capital	227.0	348.4	366.3
Liabilities	392.6	274.7	372.1

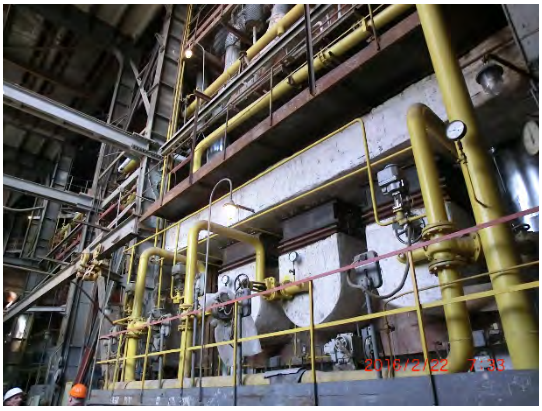
Source: Collected from Lvivteploenergo

7.4.1 Lvivteploenergo CHP-1

The plant started operation in 1937 and has 5 steam boilers (CHP) (1 by Mitsubishi with 100 t/h, 2 by Steinmuller of Germany with 50 t/h, and 2 by Borjeeg of Germany with 50 t/h (of which one was rehabilitated by Kharkiv and now has a capacity of 70 t/h)). 4 boilers supply heat based on the heat load while 1 boiler undergoes regular inspection. The boiler by Mitsubishi has the largest capacity; however, its operation has been suspended for 5 years due to leakage in boiler tubes, which is expensive to repair. The rated power generation for all units is 65 MW. However, the units operate at 50 to 60% of rated output depending on the heat demand, resulting in an output of 4 to 4.5 MW in summer when the demand is short.

The plant has 4 hot-water boilers (for heat supply only) which only operate to meet the peak heat demand.

The plant uses natural gas for fuel. As the boilers are maintained (once every 3 years) and burners, etc. are replaced properly, the plant easily meets the emissions standards and EU standards. The emissions are far below the current standards. However, due to its urban location, a fuel switch to coal, etc. is not possible. The boiler efficiency is about 93%.



(Rehabilitated boiler)

(Boiler made by Mitsubishi)

(Turbine generator)

Figure 7.4-2 Facilities at CHP-1

7.4.2 Lvivteploenergo CHP-2

CHP-2 (also called northern CHP) was originally planned as a 440 MW coal-fired plant for which the construction started in 1985. However, in 1989 in the middle of the construction phase, the specifications were revised due to the disintegration of former Soviet Union. Therefore, in its 160 ha premises, the plant has the building to house boilers for power generation, and its coal conveyer and other coal unloading or transporting facilities are left unfinished. The ESP /Pulverizer have been installed but not at the turbine building as well as turbine generator. Coal-related facilities are unused since their construction was not completed. On the other hand, the infrastructure is in place, including the area for ash disposal (57 ha), railway for coal transportation and transmission lines (110 kV and 130 kV).

The plant planned the use of bituminous coal from Chervonograd coal mine near Lviv.

At the beginning, the plant was to have 4 boilers for power generation and 7 hot-water boilers originally; however only 2 x 100 Gcal/h (equivalent to 120 MW) hot-water boilers (by Taganrog) were constructed. The hot-water boilers use gas as the main fuel but can also burn coal and diesel oil.

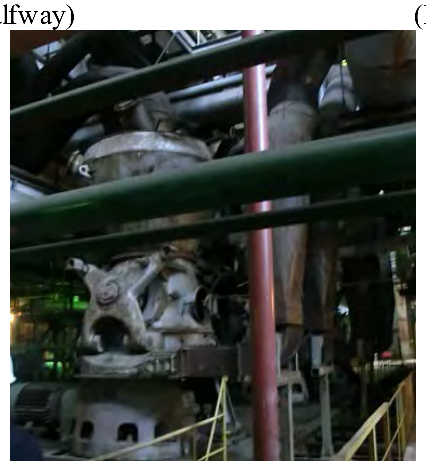
The heat generated at CHP-2 is supplied to 300,000 citizens in northern Lviv city. The main customers are residences and public facilities like schools.

(Exterior of CHP-2)

(ESP installed)

(Conveyer installed halfway)

(Hot-water boiler)



(Coal pulverizer installed)

Figure 7.4-3 Facilities at CHP-2

7.4.3 Rehabilitation Plan

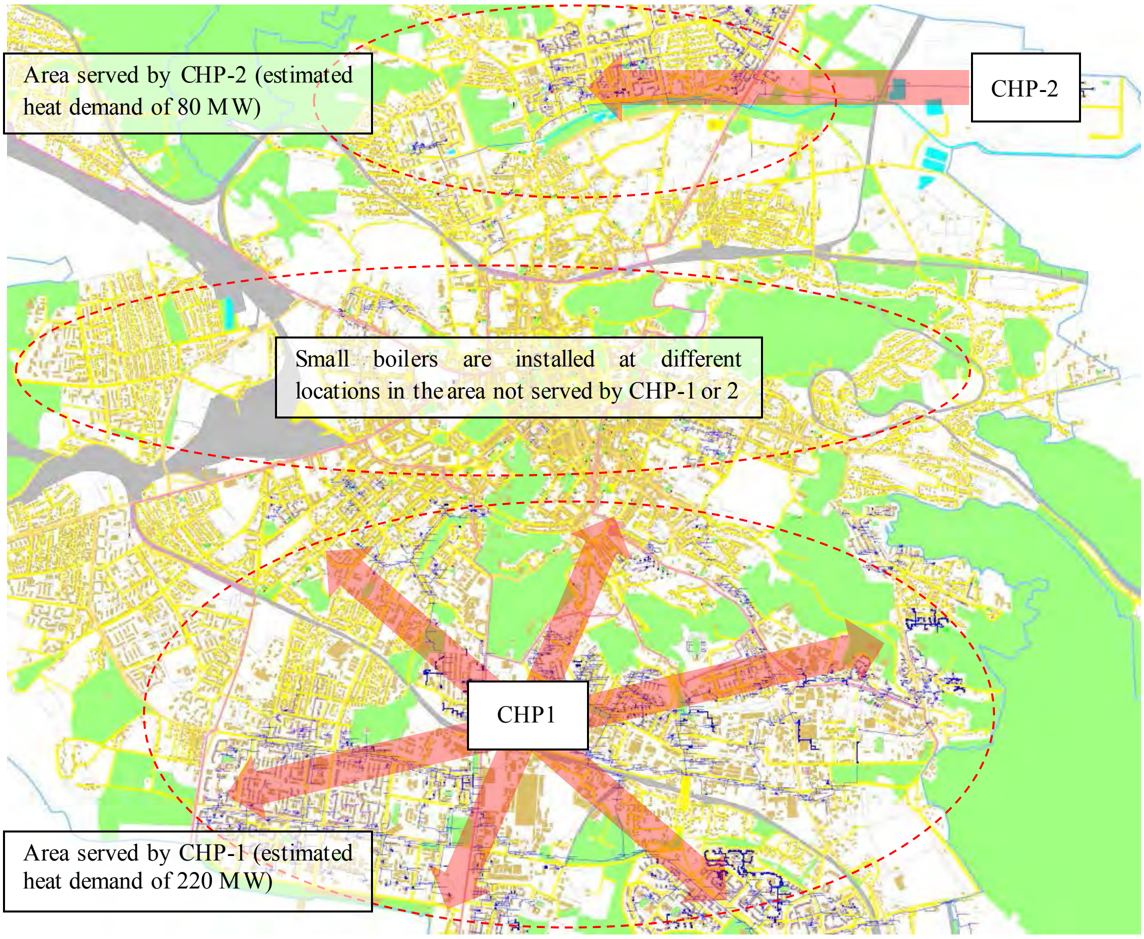
The heat demand for CHP-1 and CHP-2 is expected to be 80 MW and 220 MW, respectively. The investment is planned for facilities as described below:

(1) Step 1: Switch CHP-2's fuel to coal

- In the era of the former Soviet Union, the output of 440 MW was planned for CHP-2. However, about 150 MW of demand is assumed today, since the electric output may be much smaller.
- The fluidized-bed boiler type is considered for the plant so that waste could be mixed into the fuel at the rate of 10 to 15% after sorting the burnable waste.
- Overall, a switch to coal will be promoted to reduce the amount of gas burned.
- Facilities are needed to ensure the emissions meet the EU standards (ESP, desulfurization facility and denitrification facility are needed)
- Coal can be procured from a coalmine located 80 km northeast of Lviv. The mine is operated by a state-run company. The calorific heating value of the coal is about 4,000 kcal/kg.
- Limestone for desulfurization is found in abundance at areas about 100 km from the site.

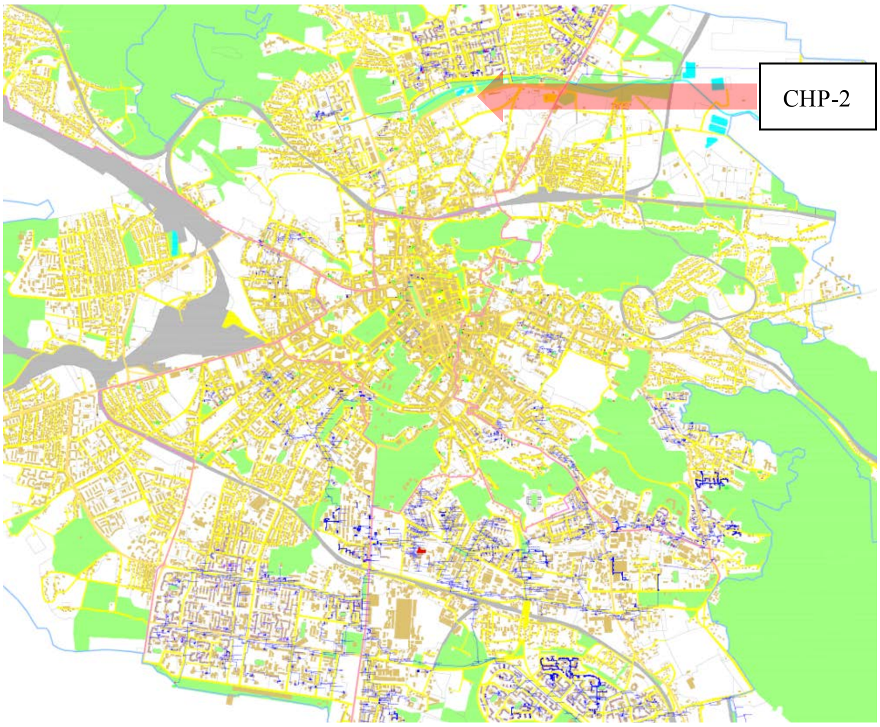
(2) Connect pipelines of CHP-1 and CHP-2

- Scrap CHP-1 and have CHP-2 supply heat solely to Lviv city.
- 11 km of piping will be needed for connection. Since CHP-1 is located at a higher elevation, the connection must be made over an 11 m difference in altitude.



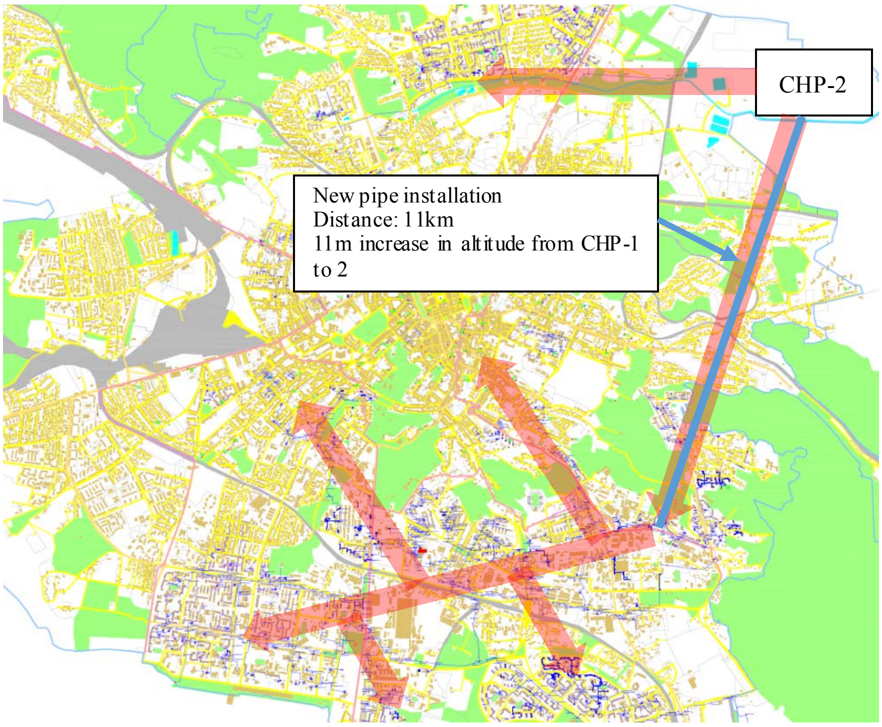
Source: JICA Study Team

Figure 7.4-4 Outline of the current heat supply system in Lviv



Source: JICA Study Team

Figure 7.4-5 First step for the future plan: CHP-2 fuel switch (gas to coal)



Source: JICA Study Team

Figure 7.4-6 Second step for the future plan: scrap CHP-1 after connecting CHP-2 and CHP-1

7.4.4 Support offered to Lvivteploenergo by EBRD

The support offered to Lvivteploenergo by EBRD consists of 5 items below as found out during the hearing of the company. The items most actively implemented are the "Individual Heat Point (IHP) installation" and "introduction of wood biomass cogeneration" based on the amount of money.

IHP is a heat exchanger installed near the customers, which can separate an upstream system starting and closing terminals of heat source like CHP plant with large capacity and long distance from downstream system in small close to end-customers. This system can make the design of upstream and downstream suitable individually, which will be more flexible, more controllable on flowrate and temperature, easier to detect bursting and leaking on the pipelines, and easier to limit the influence of the trouble when it occurs. These advantages will end up enhancing operability and reliability and reducing the maintenance cost.

In addition, EBRD is planning to introduce renewable energy as support measures to reduce dependency on natural gas, however, the conversion to coal is not out of their plan.

Table 7.4-3 Items of support offered to Lvivteploenergo by EBRD

	Item	Estimated cost	Content
1	Piping replacement near CHP	EUR 2 million	Replace pipes around CHPs. The work for the last fiscal year is complete.
2	Installation of heat supply monitoring system (SCADA)	EUR 1.2 million	Install sensors at major pipes and add a system to notify any pipe rupture or leak.
3	Local pipe replacement	EUR 4.3 million	With piping renewal, the 4-pipe system is switched to the 2-pipe system
4	IHP installation	EUR 10 million	Install IHPs in the area southwest of CHP-1, where no small boiler is installed. Originally planned 600 units were reduced to 411 units. With the IHP installation, the necessary pipes will be 2 instead of 4.
5	Introduction of wood biomass cogeneration	EUR 12 million	The initial plan was revised from gas cogeneration to wood biomass cogeneration as the natural gas supply from Russia became unstable. The plan is to use wood debris from thinning and other sources, straw, etc. within 100 km of the site for fuel. heat energy of 25 MW and power generation of 6 MW

Source: JICA Study Team

7.5 Outline of Kaluska CHP project

In addition to the aforementioned Kyivenergo and DH companies run by Lviv and other cities, Ukraine has the Kaluska CHP project, the only state-run CHP project. The Kaluska CHP was constructed in 1967 and operated as part of the business of Zakhidenergo, a state-run thermal power company in western Ukraine. However, the company's power generation business except for Kaluska CHP was sold to DTEK, a private entity, in 2000s. As a result, Kaluska CHP as a national project still supplies electricity in the surrounding area (heat supply is currently suspended).

7.5.1 Facilities and operation status of Kaluska CHP

Unit No.1 of Kaluska CHP was constructed in 1967, which was joined by a new unit every year with Units No. 1 to No.4 operating at present. Early on after the construction, the plant supplied steam to factories that produced chemicals for fertilizer and magnesium purification plants in Kaluska and heat to Kaluska city. The boilers were made by Burunoshokoida of the former Soviet Union (presently called Taganrog). With the fuel gas pipeline (44,000 m^3/h) in place, all Units No.1 to 4 operated using natural gas from Russia until 2008. Faced with a steep price rise in natural gas from Russia, Kaluska CHP converted Units No.1 and No.2 boilers to burn coal at its own expenses. They are still in operation using coal, while Units No.3 and No.4 boilers have ceased operation since they are not remodeled due to the lack of fund.

Kaluska CHP is the only CHP that uses coal in Ukraine, and unique in that it uses bituminous coal. It has an advantage of being able to procure bituminous and subbituminous coal from the Lviv -Volyn Basin in the western region instead of eastern Ukraine where the conflict with Russia continues. Units No.1 and No.2 turbines are extracting back-pressured turbines for supplying steam to factories, and Units No.3 and No.4 turbines are extracting, condensing turbines to supply heat. Another unique point is that a boiler can be paired with any turbines since main steam of the 4 boilers is led to one header to stabilize the heat supply.

The operating hour of the turbines ranges from 30,000 hours (for suspended Units No.3 and No.4) to 213,000 hours (Units No.1 and No.2). The boiler piping is to be replaced every 200,000 hours based on the MECI regulation. The high temperature pressure pipes including those on the heat-transfer surface of the boilers are renewed annually and 90% of applicable parts including the economizer have been replaced. The CHP has been maintained well overall.

Table 7.5-1 Outline of Kaluska CHP

	Item		Description
Boiler	Specification		Make: TP-87x 4 by Burunoshokoida (present Taganrog) of former Soviet Union Steam flow: 420t/h each, main steam pressure: 130 bar, main steam temperature: 560°C [Steam extracted for use outside the plant] Steam supplied to factories: steam flow: 540t/h, steam temperature: 280 to 300°C, steam pressure: 1.3 bar Steam for DH: 70 Gcal/h of heat supplied to Kaluska city, steam temperature: 120°C, steam pressure: 1.2 bar
	Fuel	No.1/2	Fuel: coal, heavy oil and natural gas (converted to burn coal) Bituminous and subbituminous coal from Lviv-Volyn Basin is used (calorific heating value of 5,000kcal/kg, ash content of 30% or less, volatile portion of 40% or less). Anthracite cannot be used since the boiler is a wet type (sludge temperate in excess of 350°C not allowed)
		No.3/4	Fuel: heavy oil and natural gas Heavy oil is used as emergency reserve and for startup. The storage tank capacity is 12,000 tons. Natural gas is received via pipeline (44,000 m^3/h). (heavy oil and gas pipeline shared with Units No. 1 and No.2)
Steam Turbine	Specification	No.1/2	Make: PT-50-130 by Skoda of Czechoslovakia Turbine type: double-casing reheat extracting, condensing type (internal extraction pressure control) Output: 50 MW each (load limited to 45MW during non-extraction due to the 120 t/h limit on the exhaust flow at the condenser inlet)
		No.3/4	Make: P-50-130 by LMZ of Russia Turbine type: double-casing reheat extraction back-pressured type

Source: JICA Study Team

(Exterior of Kaluska CHP (currently, No.2 is in operation, No.1 inspected and No.3 and 4 suspended))

(No.2 steam turbine (PT-50-130 by Skoda, from left to right, high pressure and intermediate-low pressure turbines, and generator)

(Coal conveyer)

(Boiler control panel (partially updated to digital representation))

Figure 7.5-1 Facilities at Kaluska CHP

7.5.2 Rehabilitation plan

Kaluska CHP has converted its Units No.1 and No.2 boilers to burn coal, and remodeled the cooling tower at its own expense. It is considering the switching of No.4 turbine from the extraction back-pressured type to the extraction-condensing type (110 MW), with the estimated cost of UAH 2.5 billion (approx. JPY 15 billion). However, since Kaluska CHP cannot pay for expensive rehabilitation, it has asked MECI to consider funding through financing by submitting the F/S report. At present, Siemens of Germany and Agran of Poland expressed their interest in the rehabilitation of Kaluska CHP, and submitted proposals. MECI has not responded regarding the rehabilitation or funding (including guarantee). Kaluska CHP believes that the fund invested in the rehabilitation can be recovered through power export, since it is linked to Burshtynska Island whose system is connected to Europe.

7.5.3 Progress in privatization

Kaluska CHP was managed as part of the business of Zakhidenergo, a state-run thermal power company in western Ukraine, right after the country won its independence. When Zakhidenergo was privatized, most of its power generation business (Burshtynska Power Station, etc.) was sold to DTEK, a private entity, in 2000s. However, the sale of Kaluska CHP was halted due to objection by the employees. All 4 attempts at privatization failed after the employees objected for their fear that the business might be restructured. The plant was operated by the province from 2004 to 2006. It was decided in 2006 that the plant will be totally owned and managed by the Government as a power generation project of Ukrinterenergo under the supervision of MECI. The arrangement has lasted to this day. Ukrinterenergo is a national company engaged in power generation engineering. It was established in 1993 to efficiently implement Ukraine's energy projects aimed for overseas. Kaluska CHP is the only power generation project of the company.

After the visit to Kaluska CHP, the Study Team interviewed SPF in Kyiv. The Study Team asked if the governmental guarantee will be available if Kaluska CHP is to secure fund through international financing. The response was that the governmental guarantee is not available as a rule, since the plant is still on the list for privatization even after it is placed under Ukrinterenergo. It appears that it will accept investments such as through sale to foreign investors.

7.6 Outline of Dniprodzerzhinska CHP

Dniprodzerzhinska CHP is the sole one which provides the electricity and heat to 250 thousand people of Dniprodzerzhinsk city located alongside Dniepr River in Dnipropetrovsk oblast. This CHP is a state-run company which the Government of Ukraine holds its stock of 99.9277% and operates directly, and has been already nominated in the privatization list. The current number of employees is 409.

Figure 7.6-1 Dniprodzerzhinska CHP

Figure 7.6-2 Location of Dniprodzerzhinska CHP

Table 7.6-1 Financial condition (UAH million, 2014)

Income	176	Assets	(23.3)
Gross profit	5	Liabilities	521.9
EBITA	14.2		
Net profit	0.5		

7.6.1 Facilities status of Dniprodzerzhinska CHP

Heat produced in 2014 was 323 thousand Gcal, and production of electricity generated in 2014 was 61.5 GWh in this CHP. This CHP commenced the construction in 1928 and the operation in 1932. During initial phase of the operation, the main fuel was gas and anthracite coal (pulverized coal), but was remodeled exclusively to gas in 1972. Therefore, the facility related to the anthracite coal has remained in this CHP.

This CHP has a feature which enables to operate combining boilers with turbines, without restraint, since there are 10 units of boilers and 4 units of turbines and the main steam pipe lines are connected to the header in a similar manner Kaluska CHP. The operation in Dniprodzerzhinska CHP varies depending on the climate, but has been operated limiting the season, namely, from the middle of October to the middle of April in following year.

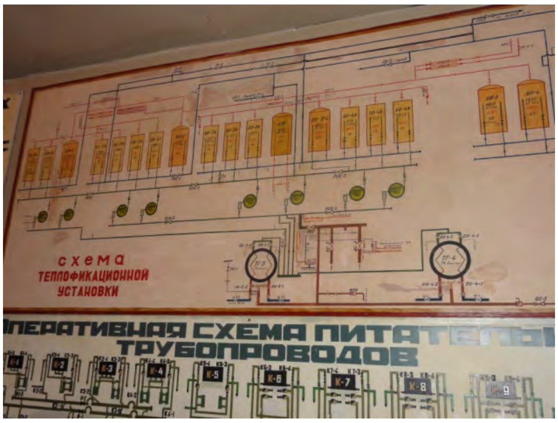
Table 7.6-2 Outline of Dniprodzerzhinska CHP

		unit	No.1/2	No.3/4	No.5 - 9	No.10
Boiler	Make	-	Babcock	Babcock	Taganrog	Taganrog
	Type	-	Drum type, natural circulation			
	Steam generation	t/h	55	110	150	220
	Fuel	-	Natural Gas			
Steam Pressure		bar	34			
Steam Temperature		°C	420 to 425			
			No.1/2	No.3	No.4	
Steam Turbine	Make	-	LMZ	LMZ	UTZ[29]	
	Type	-	Back pressured (originally, condensing)	Condensing	Condensing	
	Output	MW	14.0	16.5	16.5	
Heat output		Gcal/h	500 Gcal/h (current 330 Gcal/h, due to heat and electricity supply)			

Note: 16 heat exchangers in total, Maximum 500 Gcal/h (current 330 Gcal/h), hot water supply at 150 °C
Source: JICA Study Team based on information from Dniprodzerzhinska CHP

[29] UTZ: ZAO Ural Turbine Works

(Around Boiler)



(Steam Diagram)

(Turbine room)

(Central Control Room)

(Switchyard)

(Coal Handling Conveyer)

Figure 7.6-3 Facilities at Dniprodzerzhinska CHP

7.6.2 Rehabilitation plan

It is scheduled to construct newly a boiler used bituminous coal and sub-bituminous coal as main fuel, and a condensing turbine. The heat capacity is expected to 115 MW. Last year, application of commencement of F/S was submitted to the Cabinet Council via MECI, and has been under examination. After the approval of the application, F/S is planned to execute.
Trigger of conversion to the coal-fired is caused by the development of the coal mine in Pabloglad basin, and the perspective for a solution of transporting coal by railway. Transporting coal is expected to utilize the railway facility which has remained since commencement of the operation.
This has an advantage which enables to change from the current seasonal operation (October to April of following year) to annual operation. It is supposed that the manufacturer of the boiler is Kharkiv and the one of turbine is Turboatom.

7.7 Outline of Kharkiv CHP-3

There are CHP-2 to CHP-5 in Kharkiv city, and CHP-2 to CHP-4 are owned by Kharkiv city. Facility of CHP-4, which is almost the same as CHP-3, is utilized only for heat supply and is installed in Kharkiv Tractor Factory. CHP-5 is operated by the subsidiary of Naftogas. The plant named as CHP-1 has not been constructed.
Central heat supply occupies 70% of the all types of heat supply in Kharkiv city, and CHP-3 occupies around 25% in the total central heat supply. Heat supply from CHP-3 is implemented to 1,929 private houses, 63 schools, 47 kinder gardens and 41 hospitals. In past days, heat supply was also implemented to immediate Turboatom (Turboatom has utilized CHP-3 for the pilot test of their own turbine.)
There are total 6 heat supply facilities including CHP, and the length of heat supply pipeline in total is 3,000 km. The number of employees is 410 including operators, and the all is city employee.

Figure 7.7-1 Kharkiv CHP-3

7.7.1 Facility status of Kharkiv CHP-3

CHP-3 was commenced the operation on August 1, 1934, which signifies the one of oldest CHP in former Soviet Union. CHP-3 consists of 8 steam boilers, 5 hot water boilers for the purpose of the peak of heat supply and 4 steam turbines. Capacity of heat supply is 1,353 Gcal/h, and one of production of electricity is 66 MW in CHP-3. Natural gas is utilized as fuel. Generated steam is shared through header, and the steam both high pressure and middle pressure can be supplied to every turbine from respective boilers.

Facility of 2 units of turbine generators between Units No. 3 and No. 4 has left. One unit was the target for finance by WB, and its condensing turbine manufactured by Turboatom has stored as uncompleted condition which was on the way to install. Another was that its condensing turbine manufactured by Siemens was dismantled during 2nd World War, and its generator has remained as it is without dismantlement.

Table 7.7-1 shows the specification of Kharkiv CHP-3

		Unit	No.1 - 3	No.2 - 8	For Hot water (5)	
Boiler	Make	-	Taganrog	Taganrog	-	
	Type	-	Drummed type, Natural circulation		-	
	Fuel	-	Natural Gas (originally coal up to 1985)			
Steam Pressure		bar	34	86	-	
Steam Temperature		°C	425	535	-	
		Unit	No.1	No.2	No.3	No.4
Steam Turbine	Make	-	KTZ[30]	Kharkiv	LMZ	Siemens
	Type	-	Back Pressured	Condensing	Condensing	Condensing
	Output	MW	12	6	24	24
Heat output		Gcal/h	1,353			

Source: JICA Study Team based on information from Kharkiv CHP-3

[30] KTZ: Kaluga Turbineworks

(Around Boiler 1)

(Around Boiler 2)

(No.1/2 Steam Turbine)

(No.4 Steam Turbine)

(Turboatom-make Steam Turbine)

(Siemens-make Steam Turbine)

Figure 7.7-2 Facilities at Kharkiv CHP-3

7.7.2 Rehabilitation Plan

- Add-on of 20 MW generating facility to CHP-3
  In 2001, this plan had proceeded for modernization by private investment, but was not successfully done. In 2012, the loan agreement for USD 120 million was reached an agreement with WB and the tender related to its equipment purchase is currently under execution. The loan agreement was executed among WB, Ministry of Finance, Kharkiv city and heat supply company, and the governmental guarantee was obtained. Herewith, the uninstalled turbine, manufactured by Turboatom left between Units No.3 and No.4, is planned to remodel and add 20 MW
- Add-on of generator to CHP-4
  This plan is currently to add the generating facility to CHP-4 which has the sole function of heat supply. CHP-4 is located in industrial area, therefore, this plan is suited to the investment because the availability is expected to be high by adding generator.
- Rehabilitation of heat supply system
  This plan is to modernize 58 boilers located in city by finance of WB, and is currently under tender. This is scheduled to renewal of boiler and control equipment, and replacement of pipeline.
- Improvement of efficiency by exhaust gas heat recovery
  This plan is under consideration together with investors in Lithonia to improve the efficiency (6 to 8%) by recovering remaining heat included in the waste gas.

7.8 Outline of other DH companies whose stock is held by the Government

Ukraine has many DH companies aside from those 3 described above. From here on, the main DH companies whose share is held by the Government are outlined. The information is based on “Ukrainian State-Owned Enterprises: Privatization Opportunities.”

7.8.1 Outline of SE Kryvyi Rih District Heating Plant

It supplies heat to about 50% of the customers in Kryvyi Rih (650,000 households). The Government of Ukraine holds 100% of the stock. It has 1,382 employees and generated 1,342,000 Gcal of heat in 2014.

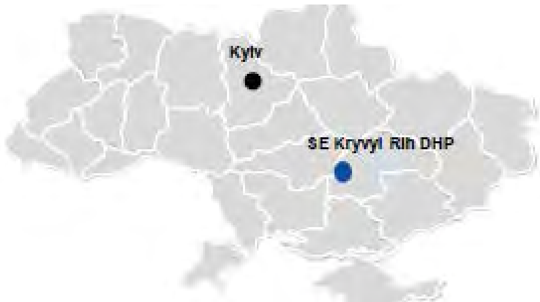


Figure 7.8-1 Location of SE Kryvyi Rih DHP

(1) Facility status

- It has 31 boilers in the 6 heat generation plants, with the installed heat supply capacity of 1,406 Gcal/h in total. The plants mainly use natural gas and some heavy oil.
- Heat supply pipe length is 382 km.

(2) Financial status (UAH million, 2014)

Income	297	Assets	896
Gross profit	-		
EBITA	-		
Net profit	(167)		

7.8.2 Outline of PJSC Odessa CHP

It is the only heat generation company in Odessa city, a city with a population of 1 million. The Government of Ukraine owns 99.989% of its share. Heat is supplied to the customers using the heat supply pipes of Odessa heating supply, a public enterprise. The electricity produced is sold to Energorynok. As with other CHPs, this CHP operates from October to April when heat is needed. The number of employees is 420, and the heat and electricity produced in 2014 was 398,000 Gcal and 58.9 GWh, respectively.

Figure 7.8-2 Location of PJSC Odessa CHP

(1) Facility status

- Total installed heat supply capacity: 779 Gcal/h
- Total installed power generation capacity: 68 MW

(2) Financial status (UAH million, 2014)

Income	266.4	Assets	331.8
Gross profit	(4.7)	Capital	(229.1)
EBITA	(107.0)	Liabilities	560.9
Net profit	(70.3)		

7.8.3 Outline of PJSC Kherson CHP

It produces both heat and electricity. It supplies heat to 50% of the 400,000 people in Kherson. The Government of Ukraine owns 99.8% of its share. The plant mainly uses natural gas supplied by Naftogaz. As with other CHPs, this CHP operates from October to April when heat is needed. The number of employees is 540, and the heat and electricity produced in 2014 was 203,000 Gcal and 72.9 GWh, respectively.

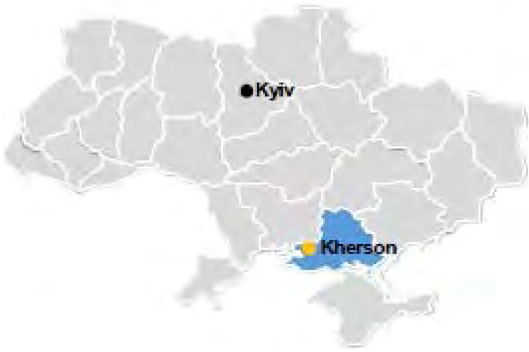


Figure 7.8-3 Location of PJSC Kherson CHP

(1) Facility status

- Total installed heat supply capacity: 735 Gcal/h
- Total installed power generation capacity: 80 MW

(2) Financial status (UAH million, 2014)

Income	189.5	Assets	222.8
Gross profit	(14.6)	Capital	(5.9)
EBITA	32.7	Liabilities	228.5
Net profit	15.6		

7.8.4 Outline of PJSC Mykolaiv CHP

It produces both heat and electricity. It supplies heat to over 40% of 500,000 people in Mykolaiv. The Government of Ukraine holds 100% of its share. The plant mainly uses natural gas supplied by Naftogaz. As with other CHPs, this CHP operates from October to April when heat is needed. The number of employees is 567, and the heat and electricity produced in 2014 was 344,000 Gcal and 94 GWh, respectively.

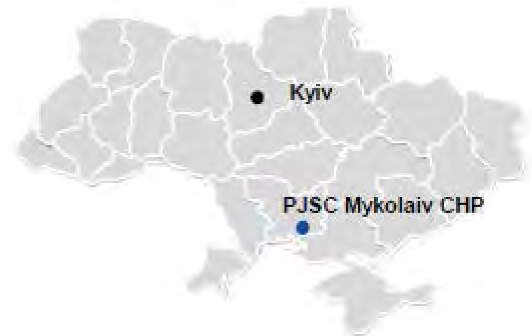


Figure 7.8-4 Location of PJSC Mykolayiv CHP

(1) Facility status

- Total installed heat supply capacity: 410 Gcal/h
- Total installed power generation capacity: 400 MW

(2) Financial status (UAH million, 2014)

Income	177.7	Assets	117.9
Gross profit	4.6	Capital	42.9
EBITA	26	Liabilities	74.7
Net profit	17.2		

7.8.5 Outline of Severodonetsk CHP

It supplies electricity and heat to the city of Severodonetsk. The Government of Ukraine holds 100% of its stock. The CHP also supplies heat and electricity to fertilizer factories. The company is near the ATO Zone (Anti-Terrorist Operation Zone).

Figure 7.8-5 Location of Severodonetsk CHP

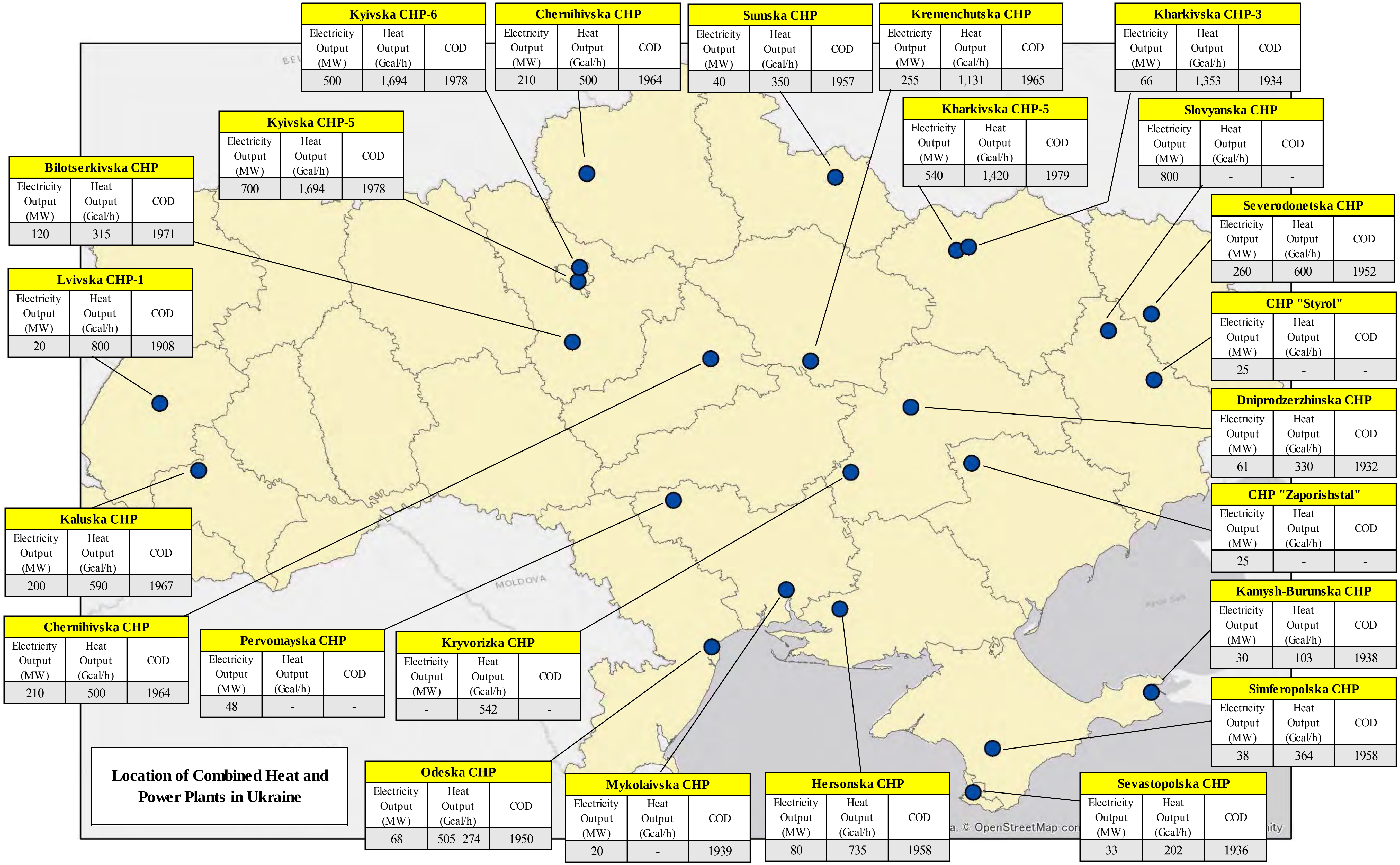
(1) Facility status

- Total installed heat supply capacity: 600 Gcal/h
- Installed power generation capacity: 260 MW

(2) Financial status (UAH million, 2014)

Income	365.7	Assets	296.8
Gross profit	-	Capital	-
EBITA	-	Liabilities	-
Net profit	0.2		

Major CHP location in Ukraine are shown as Fugure7.8-6 below,



Plant	Electricity Output (MW)	Heat Output (Gcal/h)	COD
Kyivska CHP-6	500	1,694	1978
Chernihivska CHP	210	500	1964
Sumska CHP	40	350	1957
Kremenchutska CHP	255	1,131	1965
Kharkivska CHP-3	66	1,353	1934
Kyivska CHP-5	700	1,694	1978
Kharkivska CHP-5	540	1,420	1979
Slovyanska CHP	800	-	-
Bilotserkivska CHP	120	315	1971
Severodonetska CHP	260	600	1952
Lvivska CHP-1	20	800	1908
CHP "Styrol"	25	-	-
Dniprodzerzhinska CHP	61	330	1932
CHP "Zaporishstal"	25	-	-
Kaluska CHP	200	590	1967
Kamysh-Burunska CHP	30	103	1938
Chernihivska CHP	210	500	1964
Pervomayska CHP	48	-	-
Kryvorizka CHP	-	542	-
Simferopolska CHP	38	364	1958
Odeska CHP	68	505+274	1950
Mykolaivska CHP	20	-	1939
Hersonska CHP	80	735	1958
Sevastopolska CHP	33	202	1936

Source: JICA Study Team

Figure 7.8-6 Location map of major CHP

7.9 Support Needs in the DH field

7.9.1 Kyivenergo

At Kyivenergo's CT-1, the purchased facilities are left uninstalled as described in Section 7.3.3 above, since the support from WB ended. The company wishes to follow through with the original plan with the support from outside. However, the purchased facilities are not kept in the original condition. During the time when there was no way to secure funds for construction, the facilities were left unused and their parts have been removed to maintain the existing facilities.

7.9.2 Lvivteploenergo

Lvivteploenergo originally started the construction of CHP-2, to use coal as explained in Section 7.4.2 above, but had to suspend the work, leaving part of the plant unfinished. The company wants to change fuel from natural gas that CHP-2 currently uses to coal. There is enough land space set aside to be utilized effectively for a coal-fired plant; thus the company hopes for the construction of a coal-fired, 100 to 150 MW class CHP. It also wants to burn municipal waste along with coal after sorting it.

7.9.3 Kaluska CHP

As stated in Section 7.5.2 above, it hopes to replace the No.4 turbine of the extraction back-pressured type to the extraction-condensing type (110 MW), with the estimated investment of UAH 2.5 billion (approx. JPY 15 billion). While the Units No.1 and No.2 boilers are converted to burn coal, it hopes to remodel Units No. 3 and No.4 boilers so that they can use coal instead of gas and heavy oil, in order to reduce fuel cost and improve utilization opportunity.

7.9.4 Dniprodzerzhinska CHP

This CHP is waiting for the approval from the Cabinet of Ministers concerning new installation of 115 MW CHP which are expected to Ukrainian manufacturers, so the support from Japan was not requested.

7.9.5 Kharkiv CHP-3 and Kharkiv oblast

As described in Section 7.7.2, Kharkiv CHP-3 has some concrete programs to remodel the part of their own facilities. Some of them is already ongoing. However, add-on of generator to CHP-4, which still remains untouched, and add-on of heat recovery system is under examination. Even though the plants are well-maintained for the aged condition, new installation is requested.
In addition, Kharkiv oblast is examining positively to construct 10 of small size CHPs which is mainly fired by biomass fuel, instead of existing fossil-fired CHP. Currently, 2 locations out of 10 are under the concrete plan where the fuel will be converted from gas to biomass fuel (with the capacity of 9.6 MW, EUR 40 million in total). The said small CHPs will fire chips and waste of wood and straw, etc., as main fuel.

7.10 Study of Candidates for Support

7.10.1 Kyivenergo

Kyivenergo does not expect help from outside in the field of heat supply; thus the Study Team could only visit CT-1, not other heat supply plants like CHP-5 and 6. As a result, the Study Team could not obtain further information on CHP. The installation of the facilities purchased for CT-1 using the WB credit could not be considered as a candidate since the facilities lack some parts and no main equipment will be delivered.

The candidates for supporting Kyivenergo are listed below and in Table 7.10-1. The items include the rehabilitation of facilities that Kyivenergo considers necessary as it operates the plant under the operatorship awarded by Kyiv city. However, this is not a field that Japanese technology could be applied, and the items could not be considered promising.

(1) Economizer installation

The installation of economizers at the 5 large hot-water boilers will reduce the natural gas consumption by 23.4 million m^3 annually since the economizer can heat the water using the exhaust gas. The estimated construction cost including tax is USD 17million.

(2) Introduction of hydraulic couplings to the heat supply pumps of 350 kW or more

The hydraulic couplings introduced at the 15 large heat supply pumps of 350 kW or higher will control power consumption. According to the trial calculation, 18.5 million kWh can be saved annually. The estimated construction cost including tax is USD 4 million.

(3) Renewal of local pipes not yet renewed

344 km of local pipes equivalent to 13% of the city will be renewed over 5 years. The local pipes will be thermal-insulated polyurethane pipes with an alarm and 50-year warranty, and the hot-water pipes will be thermal-insulated plastic pipes with 50 year warranty. This will improve the heat supply reliability and reduce heat loss, which will result in the reduction of natural gas consumption by 83 million m^3 per year. The estimated construction cost net of tax is USD 187 million.

(4) Elimination of central heat sources by creating local heat supply bases

1,700 individual heat supply units will be installed on the user-side over 5 years, and the 4 pipe system will be changed to the 2 pipe system. The temperature can be controlled at each household, which will help reduce heat loss. This will reduce the natural gas consumption by 82 million m^3 per year. The estimated construction cost net of tax is USD 168 million.

(5) Renewal of heat supply facility (CT-1)

This is a CT-1 renewal project implemented over 6 years. It includes the installation of 2 x 120 MW hot-water boilers, rehabilitation of three 120 MW (100 Gcal/h) hot-water boilers, replacement of water treatment system, and new construction or renewal of 6 kV electrical facilities. The estimated construction cost net of tax is USD 48 million.

7.10.2 Lvivteploenergo

This project aims to supply power and generate electricity by constructing a coal-fired CHP, instead of just supplying heat locally as is done at present. Converting fuel from gas to coal will lower the fuel cost and produce revenue from electricity sales. Since the plant will be 100 to 150 MW, supercritical to ultra-supercritical technology that Japanese companies have the superiority over cannot be adopted; instead, subcritical pressure facilities will be introduced. The company is looking into mixing general waste in fuel for combustion; however, burning waste could produce chlorine which could corrode the inside of the boiler. Based on the technical difficulty observed by the Study Team, the construction of a small boiler that only uses coal might be more realistic.
The candidate projects for support are as shown below and in Table 7.10-2

7.10.3 Kaluska CHP

The support Kaluska CHP requires is for the replacement of No. 4 turbine to the extraction-condensing type (110 MW). It is possible and will have room to apply Japanese technologies. However, the conversion of the boiler to allow coal use based on Japanese technologies will be difficult, since the boiler was made by the former Soviet Union, and the OEM's basic design and developmental concept must be followed. Further, it must be noted that the governmental guarantee will be hard to obtain if a yen loan is assumed, since Kaluska CHP is currently considered for privatization. Table 7.10-2 lists the candidate support projects.

7.10.4 Dniprodzerzhinska CHP

There was not a support candidate in this CHP.

7.10.5 Kharkiv CHP-3 and Kharkiv oblast

It seems possible to install new CHP as support from Japan. However, the assets of Kharkiv CHPs belong to Kharkiv oblast administration, so it is difficult to get governmental guarantee for local bodies. Small size CHPs is expected to fire a variety of biomass fuel, which is likely suitable to apply Circulating Fluid Bed boiler which can be supported through Japanese technology.
Table 7.10-2 shows the candidate for support in this field.

Table 7.10-1 Candidates for support for the Kyivenergo CT-1

Item	(i) Installation of Economizer	(ii) Introduction of hydraulic couplings to heat supply pumps of 350 kW or higher	(iii) Renewal of local pipes not yet renewed	(iv) Elimination of central heat sources by creating local heat supply bases	(v) Renewal of the heat supply base (CT-1) (part of the plan based on World Bank credit)
Target (Equipment Owner/Business Operator)	CT-1 (Kyiv city/Kyivenergo)	CT-1 (Kyiv city/Kyivenergo)	Local pipes (Kyiv city/Kyivenergo)	Local heat supply bases (Kyiv city/Kyivenergo)	CT-1 (Kyiv city/Kyivenergo)
Outline of the Project	➢ Install economizers, which heat water using exhaust gas, at the 5 large hot-water boilers.	➢ Introduce hydraulic couplings at the large heat supply pumps (350 kW or higher)	➢ Renew 344 km of local pipes equivalent to 13% of the city	➢ Install 1,700 individual heat supply units on the user-side. ➢ Change the 4-pipe system to 2-pipe system	➢ Renew CT-1 including the installation of 2 x 120 MW hot-water boilers ➢ Rehabilitate 3 x 120 MW (100 Gcal/h) hot-water boilers ➢ Replace water treatment system ➢ Construct newly or renew 6 kV electrical facilities
Background of Project Selection and Supporting Request from Counterpart	➢ Support need was collected through interview with counterpart	Same as left	Same as left	Same as left	Same as left
Work Period (short, medium or long term)	Short (approx. 1 to 3 years)	Short (approx. 1 to 3 years)	Medium (approx. 4 to 5 years)	Medium (approx. 4 to 5 years)	Long (approx. 6 to 10 years)
Estimated cost	USD 17 million (assumed by Kyivenergo)	USD 4 million (assumed by Kyivenergo)	USD 187 million (assumed by Kyivenergo)	USD 168 million (assumed by Kyivenergo)	UAD 48 million (assumed by Kyivenergo)
Availability of Japanese Technology (Technical Superiority/Interest in Ukraine)	➢ Japanese technologies cannot be applied to particular advantage.	Same as left	Same as left	Same as left	Same as on left
Expected Project Effectiveness	➢ The effective use of waste heat can save the natural gas consumption by 23.4 million m^3 annually.	➢ Using the hydraulic coupling makes it easy to control pump load, which lead to reducing power consumption.	➢ This will help to reduce heat loss.	➢ Adopting the 2-pipe system (feed/return) and installing the heat sources can help to reduce heat loss.	➢ Efficiency improvement by renewal can be expected since the facilities suffer from aging deterioration.
Possibility of Governmental Guarantee	➢ Unknown whether the governmental guarantee is offered to a local municipality.	Same as left	Same as left	Same as left	Same as left
The steps to be taken next and pending issue, etc.	➢ Sub-sovereign loan system/its scheme must be established.	Same as left	Same as left	Same as left	➢ The facilities have left uninstalled after its delivery, which makes it difficult to install whole package due to lack of parts.

Source: JICA Study Team

Table 7.10-2 Candidates for support for Lvivteploenergo, Kaluska CHP and Kharkiv oblast

Item	(i) Livivteploenergo Construction of 100 to 150 MW, coal-fired CHP	(ii) Kaluska CHP No. 4 turbine (110MW) replacement	(iii) Kharkiv CHP-3 Renewal of Kharkiv CHP-3	(iv) Kharkiv oblast Construction of small CHPs biomass-derived fuel
Target (Equipment Owner/Business Operator)	CHP-2 (Lviv city/Lvivteploenergo)	Kaluska CHP (Ukrinterenergo)	CHP-3 (Kharkiv city/Kharkiv CHP-3)	Kharkiv oblast (implementing body unknown)
Outline of the Project	➢ Construct subcritival coal-fired plant equipped with back-pressured turbine and generator instead gas-firing.	➢ Install No. 4 turbine with extracting-condensing type (110 MW) instead of current back-pressured type.	➢ Renew the existing aging CHPs regarded as one of the oldest plants among Ukraine.	➢ Construct 8 of small size CHPs firing biomass-derived fuel, to replace the gas with the said fuel.
Background of Project Selection and Supporting Request from Counterpart	➢ Support need was collected through interview with counterpart.	Same as left	Same as left	➢ Biomass field is one of the most interested part in Kharkiv oblast.
Work Period (Short-, Medium- or Long-Term)	Long (approx., 6 to 10 years)	Short (approx. 1 to 3 years)	Long (approx. 6 to 10 years)	Medium (approx. 4 to 5 years)
Estimated cost	Unknown	USD 2.5 billion (approx. JPY 15 billion) (estimated by Kaluska CHP)	Unknown	Unknown
Applicability of Japanese Technology (Technical Superiority/Interest in Ukraine)	➢ Since the plant will use a small boiler, subcritical pressure technology which Japanese companies don't boast of technical superiority. ➢ Japanese companies seem to have low interest in Ukraine.	➢ There seems to be room to apply Japan's technologies when changing the turbine to the extraction-condensing type (110 MW). ➢ It is unknown if Japanese companies' interest in Ukraine is high based on scale and transportation, etc.	➢ Same as (i), small scale boiler offers subcritical technology, so Japanese companies don't boast of their technical superiority. ➢ Japanese companies seem to have low interest in Ukraine.	➢ Japanese technology can offer such a wide range of biomass fuel in a Circulating Fluid Bed boiler. ➢ Japanese companies don't boast of their technical superiority, and seem to have low interest in Ukraine.
Expected Project Effectiveness	➢ Converting fuel from gas to coal can help avoid political risk.	➢ Higher revenue from electricity sales and profitability are expected with better turbine efficiency and greater output.	➢ Converting fuel from gas to coal can help avoid political risk.	➢ Converting fuel from gas to coal can help avoid political risk.
Possibility of Governmental Guarantee	➢ Unknown whether the governmental guarantee is offered to a local municipality.	➢ Since the plant is considered for privatization, the governmental guarantee is unavailable.	➢ Unknown whether the governmental guarantee is offered to a local municipality.	➢ Unknown because the detailed overview of the project and ownership information was not obtained.
The steps to be taken next and pending issue, etc.	➢ Sub-sovereign loan system/its scheme must be established. ➢ Interest toward Ukraine from Japanese companies is being waited for.	➢ Sub-sovereign loan system/its scheme must be established.	➢ Sub-sovereign loan system/its scheme must be established. ➢ Interest toward Ukraine from Japanese companies is being waited for.	➢ Sub-sovereign loan system/its scheme must be established. ➢ Ownership, Scale of project, biomass distribution should be examined closely. ➢ Interest toward Ukraine from Japanese companies is being waited for.

Source: JICA Study Team

7.11 Laws, regulations and procedures upon implementing support measures

Table 7.11-1 lists the Ukrainian laws enacted to meet the EU requirements in the DH field as well as the EU requirements. See Appendix, List of Laws and Regulations related to Energy Sector in Ukraine.

Table 7.11-1 Main laws and regulations on rehabilitation/construction of DH facilities

Ukrainian laws and regulations	EU Directive
➢ Protocol on Ukraine's accession to Energy Community Treaty ➢ Cabinet of Ministers Order No.733-P on approval of a plan to implement the obligations under the Energy Community Treaty, effective as of Aug.3, 2011 and revised Oct.7, 2015 ➢ Cabinet of Ministers Order No.1080-p on amending the financing agreement for the continuous support programs for the realization of Ukraine's energy strategy, and signing of the additional agreement No. 1 between EU represented by EC and Ukraine, effective as of Dec.20, 2013 and revised Oct. 13, 2015 ➢ Ukrainian law on rules for operating the power market in Ukraine	➢ Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants, effective as of Oct.23, 2001 ➢ Directive 2006/32/EC on energy end-use efficiency and energy services, effective as of Apr.5, 2006 ➢ Directive 2009/28/EC on the promotion of the use of energy from renewable sources, effective as of Apr.23, 2009 ➢ Directive 2009/73/EC concerning common rules for the internal market for natural gas, effective as of Jul.12, 2009 ➢ Regulation (EC) No.715/2009 on conditions for access to the natural gas transmission networks, effective as of Jul.13, 2009

Source: JICA Study Team

7.12 Possibility of entry of Japanese companies

Currently, the CHP facilities in Ukraine mainly use natural gas from Russia for fuel. The operating companies want to convert to coal due to high prices of natural gas; however, CHPs in urban areas do not have the kind of site or transportation infrastructure that will allow for the construction of coal-fired facilities, and are forced to use natural gas continuously. There are heat supply companies that have the site on which new coal-fired facilities can be constructed. In such cases, the construction of new coal-fired facilities is possible. However, the necessary installed capacity will be equivalent to about 100 to 150 MW class of electrical output at most, for which the subcritical pressure boiler is required. Japanese companies' technological superiority lies in supercritical and ultra-supercritical technologies, which can only be applied to facilities of 500 MW or more. For this reason, Japanese companies have little technological advantage in this situation and their participation might be difficult.

7.13 Conclusion

7.13.1 Financing for rehabilitation or construction of DH facilities

The DH facilities are not the assets of state-run companies; instead, they generally belong to municipalities or private companies, except for some facilities (Kaluska CHP, CHPs owned by Energoatom, etc.). The funds necessary for the rehabilitation or construction of DH facilities can be financed. However, regular bank financing will be impossible since the current lending interest rate exceeds 20%. Therefore, international financing from EBRD or WB is often utilized. When requesting international financing for the rehabilitation or construction of DH facilities, the project must go beyond the renewal of aged facilities and satisfy the conditions below:

(1) Humanitarian measure
(2) Energy conservation measure
(3) Environmental measure
(4) Fuel conversion (from gas to coal, or from anthracite to bituminous coal under the national policy, etc.)
(5) Profitable to recover investment through the improvement of performance or utilization rate, etc.

With regard to items (1) and (2), the project might be eligible for tax exemption under the Ukrainian laws on national tax and customs, and be exempt from transfer tax (upon transfer to a state-run company) and corporate tax. As for (3) and (4), the governmental guarantee might be obtained if the project is in alignment with the national or municipal policy and the upper-level regulatory agency, cabinet and a sovereign assembly (parliament) gave an approval or reached resolution. With the guarantee, more advantageous international financing can be obtained. Either case, it is necessary to ensure (5) based on the terms of loan by conducting F/S in advance. To obtain the governmental guarantee, items in Figure3.2-2 must be implemented up to Step 4 of the Figure and the validity of F/S confirmed.

7.13.2 Interest in Ukraine by Japanese companies

The Study Team has been conducting hearings with Japanese companies that handle small boilers. The Study Team found that the companies generally have low interest in Ukraine. Further, as Japanese companies do not have particularly high level of technology in this field, it might not be easy to solicit Japanese companies' participation.

7.13.3 Points to be noted regarding environmental and social consideration (DH field)

(1) Environmental Regulation

Projects that can be supported under the district heating sector include installation of a calorimeter, improving the efficiency of boiler for ordinary household, renewal of heat transport pipes and heat supply conduits, and renewal of hear source equipment. Corresponding to only a slight development, there is no need to develop an EIA report according to Ukraine's law. However, there is a need to confirm with MENR, the agency responsible for the EIA system. According to Ukraine's EIA system, associated facilities of a power plant that use 200 kW or more of fossil fuel, are required to prepare a detailed EIA.

In particular, since heat supply facilities are located near urban areas which have the large population, in terms of environmental and social consideration, it is necessary to pay attention air pollution by atmospheric discharge including the case that fuel is converted to coal, and the impact of dust and noise arose by dismantlement and rehabilitation works. And also, as long as Study Team had heard from the concerned persons in the site survey of the Study Team, scattering asbestos had been used as heat insulation materials in heat supply facilities. Therefore, it is required to take necessary countermeasures to prevent scattering them when carrying out dismantlement and rehabilitation work.

(2) Other consideration

Generally, DH facilities in Ukraine are old and are located nearby the urban areas, in order to minimize energy loss from transporting hot water to the consumers. Also, in mid-1980's, local heat source facility, which includes CHP of Kyiv city, used coal as fuel. Due to importation of cheap natural gas from Russia and environmental considerations (e.g. air pollution), coal has been replaced with the use of natural gas. However, since the supply of natural gas from Russia is unstable in the recent years, Ukraine is looking at updating its energy strategy by returning to the use of coal as primary energy source. The Government is still in the process of re-examining the situation.

8. Waste Energy Sector

In Ukraine, waste incinerators were planned in 4 areas (Sevastopol, Kharkiv, Dnipropetrovsk and Kyiv) between 1985 and 1992. However, waste incinerator in Kyiv is the only one which went into actual operation and the plans of other 3waste incinerators were left halfway due to lack of human resource or finance (In Dnipropetrovsk and Kharkiv, the construction of their facilities wasn't be initiated, and in Sevastopol, the reason to be suspended is not confirmed). Kyivienergo which is subsidiary of DTEK is commissioned by Kyiv city for the operation of waste incinerator in Kyiv. Operatorship of Kyivenergo will expire by the end of 2017 and new operator will be selected through bidding process.

8.1 Kyiv City

8.1.1 Municipal Solid Waste (MSW) generations in Kyiv

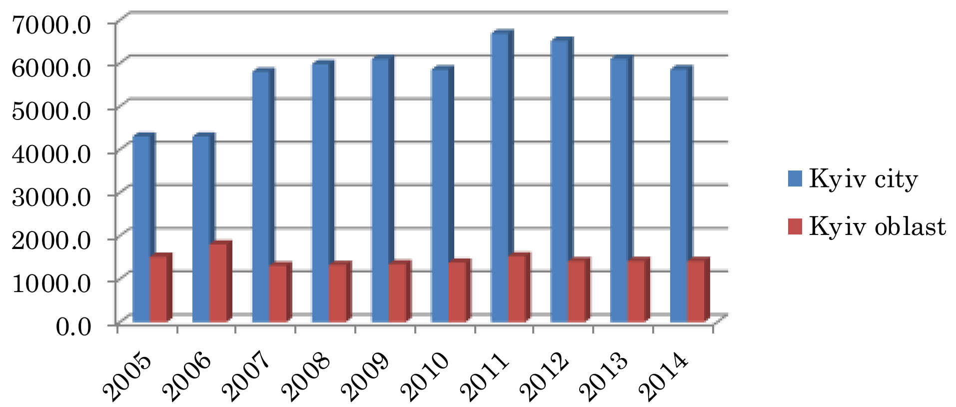
Waste survey covers Kyiv area, including Kyiv city and Kyiv oblast. According to MRDBH, waste generation in Kyiv is as Table 8.1-1 below.

Table 8.1-1 Waste generation in Kyiv city and Kyiv oblast

Municipality	Population (Year 2015)	Population Density (Persons/km^2)	Area (km^2)	MSW Generation (ton) (Year 2014)
Kyiv city	2,893,822	3,445	840	1,089,000
Kyiv oblast	1,729,234	61	28,121	263,000

Source: JICA Study Team

It is a general tendency on increasing of MSW generation during 2005 to 2014 although amount of generation has been decreasing slightly since 2011. On the other hand, there is no clear trend to an increase in volumes of MSW in Kyiv oblast (See Figure 8.1-1).



Source : MRDBH (unit : thousand m^3)

Figure 8.1-1 MSW generation in Kyiv city and Kyiv oblast (2005 to 2014)

8.1.2 Characteristic of MSW in Kyiv

As part of framework of the preparing the Scheme of Kyiv city sanitary cleaning project, the survey on characteristic of MSW was conducted by the public enterprise scientific research and Technology Institute of Municipal Economy. Table 8.1-2 shows the Morphological composition of MSW in Kyiv city in 2010.

Table 8.1-2 Morphological composition of MSW in Kyiv city, Year 2010

	MSW components	Residential multi-apartment buildings	Residential individual buildings	MSW from enterprises, organizations, institutions, (administrative sector)	Trading (commercial sector)	Weighted average of unsorted MSW
1	Paper	4.04	3.15	17.36	8.39	5.46
2	Cardboard	6.21	2.51	19.11	9.18	7.78
3	PET bottles and boxes	2.07	2.16	1.82	2.61	2.09
4	Plastic (polymer) film	3.97	5.27	3.10	5.69	4.11
5	Plastic	2.63	4.61	8.06	3.12	3.07
6	Tetra PAK packaging and similar packaging	0.86	1.5	1.25	1.13	0.96
7	Ferrous metals	1.03	1.92	0.68	0.7	0.94
8	Nonferrous metals	0.15	0.16	0.13	0.25	0.17
9	Glass	12.09	14.95	18.45	15.83	13.01
10	Leather, rubber	1.12	2.14	1.55	0.43	1.07
11	Textile	2.39	3.27	2.18	0.65	1.72
12	Wood	0.89	1.07	2.35	4.53	1.35
13	Food and garden waste (for compost)	42.32	27.78	16.55	31.61	39.26
14	Hazardous waste	0.0066	0.00	0.00	0.02	0.0067
15	Unsorted combustible residue	15.21	14.61	11.65	11.86	14.68
16	Unsorted incombustible mineral	4.42	8.12	2.2	4.01	4.31

Source: The public Enterprise Scientific and Design and Technology Institute of Municipal Economy

The average density of mixed municipal solid waste is 186 kg/m^3, moisture 39.04%. Chemical composition in percent (by weight) is: carbon (C) 18.54%, hydrogen (H) 2.62 %, oxygen (O) 16.06%, nitrogen (N) 0.50%, sulfur (S) 0.13%, ash (A) 23.12%. The calorific heating value is 1,500 kcal/kg. After removing recyclable materials on the sorting line the moisture increases to 48.3%, the calorific heating value decreases to 1,300 kcal/kg. In general, the more moisture the waste contains, the more calorific energy the waste contains will be consumed for evaporating at burning and the poorer quality of waste as fuel deteriorates. After the selection of recyclable materials and incombustible mineral components and food waste (biodegradable waste), which is indicate that such waste could be suitable as fuel. In Japan, range of moisture accepted for waste energy is 24 to 50% (the caloric heating value is 1,700 to 3,300kcal/kg). Therefore, the caloric value of waste in Kyiv can compare favorably with one in Japan.

8.1.3 Waste management system and waste treatment practice

In Ukraine, each municipality has a responsibility for the collection, transportation, treatment and recycles of waste, and has authority to select waste management vendor through bidding process for each area.

In Kyiv city, relevant waste law as well as Kyiv city ordinance (No.582, 2008/10/30) stipulates the waste management. Kyiv city established Kyiv Commune Service (KCS) in 2004 as executing institution for waste management. KCS is in charge of management of waste generated from multi residential apartment managed by municipality. On the other hand, other residential facility (apartment managed by public utilities service provider or individual building), commercial sector and industrial sector is not managed by KCS, but treated through private market. Kyiv city currently have a contract with 8 companies for waste management who was selected through bidding process. Waste under management of KCS is managed, transported and treated by these 8 companies. Other wastes are collected and transported and disposed by private waste contractors who directly make contract with waste generators.

According to KCS, out of amount of waste generated in Kyiv city in 2014 (about 1.1 million tons/year), 0.7 million is from collective residential apartment managed by municipality and remaining 0.4 million is from others. The waste collected by KCS (0.7 million tons) was treated as following methods, incinerator (230,000 to 240,000 tons/year), recycle (70,000 to 80,000 tons/year) and landfill (360,000 tons/year). Figure 8.1-2 shows the overview of waste management in Kyiv city.

Source of waste generation	Residential Multiple residential apartments managed by municipality	Public utilities service provider Individual Commercial Industrial
Waste management player	Kyiv city (KCS)	Private market
Waste management contractor	Vendors contracted with Kyiv city (7)	Vendors directly contracted with generator (30)
Waste generation	0.7 million tons/year	0.4 million tons/year
Treatment method	Incinerator : 230,000 - 240,000ton/y (35%) Recycle : 70,000 - 80,000 ton/y (12%) Landfill : 360,000 ton/y (53%)	Detail unknown. Most are dumped illegally.

Source : Interview to KCS

Figure 8.1-2 Overview of waste management in Kyiv city

8.1.4 Waste recycling in Kyiv

There are total 21 waste recycling facilities in 2014 in Ukraine. Out of 21, 6 facilities are located in Kyiv City. Waste recycling is carried out by small manual sorting lines with a total capacity of about 100,000 to 120,000 tons per year. Working at full capacity at these facilities have the potential to recycle 10% of the total amount of MSW generated in Kyiv city.

8.1.5 Final landfill site

There are total 2 final landfill sites in Kyiv as below. Landfill No.5 is for municipal waste and Landfill No.6 is for construction waste. Both landfill sites reach its capacity and improvement of waste management system is an important issue in Ukraine.

Table 8.1-3 Final landfill site in Kyiv

Final Landfill site	Overview	
Landfill No.5	Area : 63.7 ha Commencement of operation : 1986	Operated by Kyiv Spets Trans (KST) which is jointly established by Kyiv city (51%) and Private (49%). General municipal wastes are treated and total 5.5 million tons of waste has been disposed. Now, the capacity is overloaded.
Landfill No.6	Area : 6.8ha (1st Stage) 2.5ha (2nd Stage) Commencement of operation : 1992 (1st Stage) 1995 (2nd Stage)	Construction wastes are disposed. Now, the capacity is overloaded.

Source: JICA Study Team

8.1.6 Waste management tariff

Municipal waste management service companies provide its services according to the established tariffs which are approved by the Kyiv city council. Waste management tariff is established for (i) waste transportation and (ii) land filling. The financial source of tariff is composed with tax income and subsidy from Kyiv city. In 2014, the average tariff for waste management for Kyiv city population was UAH 18.69 per m^3 for landfilling, which is about 60% of the tariff for the waste transportation services. Like similar to other cities, low tariffs for waste landfilling in Kyiv does not allow for the modernization and modification on site.

Table 8.1-4 Waste management tariff in Kyiv

Tariff		2010	2011	2012	2013	2014
Waste transportation (UAH/m^3)	Municipal waste	42.3	42.2	44.2	44.2	44.02
	Industrial waste	44.5	44.27	47.5	47.5	47.05
	Other	56.6	56.5	56.39	56.39	56.39
Landfill (UAH/m^3)	Municipal waste	13.32	19.7	18.69	18.69	18.69
	Industrial waste	14.58	19.1	17.81	17.81	17.81
	Other	17.72	19.8	18.69	18.69	18.69

Source : MRDC

8.1.7 Overview of Energia waste incineration plant

The Energia waste incineration plant is capable of treating about 20 to 35% of general waste from Kyiv (250,000 to 300,000 tons per year), leaving the rest of the general waste to be buried in landfills. The situation calls for 2 more waste treatment facilities of similar scale.

Figure 8.1-3 Exterior of the Energia waste incineration plant

Up until 2015, 6,000 to 8,000 Gcal of heat generated from waste incineration was supplied to 13 large customers around the plant; however, in actuality, tens of times more heat was generated and could have been used, but was instead released into the atmosphere without being utilized. For this reason, in 2014, the plant was connected to the supply system in Kyiv to provide heat to the city.

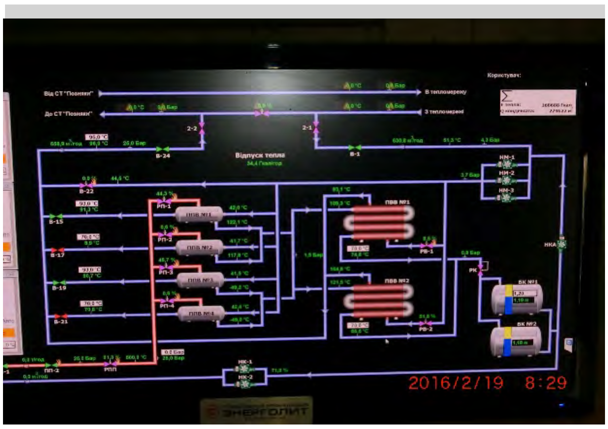


Figure 8.1-4 Energia's CRT screen for supplying heat

As a result, 167,000 Gcal of heat became available for use. 2 out of 4 heat exchangers were in operation on the day of Study Team's visit, heating warm water from 50°C to 93°C and returning it to the system at the rate of 630 t/h (monitored by CRT as shown in Figure 8.1-4).

Table 8.1-5 shows the specifications for Energia waste plant. The plant was designed by Kharkiv Design Agency and the boilers were procured from Czechoslovakia and crane from Uzbekistan.

Table 8.1-5 Specifications for Energia waste incineration plant

Item		Specification
Number of waste treatment lines		1 waste storage reservoir and 4 treatment lines
Type of furnace		Stoker
Design condition	Calorific heating value of waste	2,400 kcal/kg
	Amount of waste loaded	15 t/h
	Temperature of generated steam	250°C
	Pressure of generated steam	13 bar
	Amount of generated steam	40 t/h

Source: JICA Study Team

In the actual waste treatment operation, the calorific heating value of waste is smaller at 1,600 to 1,650 kcal/kg compared to the design value, and the amount of waste that can be loaded remained around 10 t/h. As a result, the actual steam generated is 22 to 23 t/h compared to the planned 40 t/h. Even though the facilities come off as old, they are well maintained and operated normally with no foul odor. The central control room was large with space to accommodate future expansion. However, the waste storage reservoir is full and seemed to lack adequate capacity.

(Control Room)

(Stoker incinerator side view)

(Waste storage reservoir)

Figure 8.1-5 Situation at Energia waste incineration plant

8.2 Dnipropetrovsk city

8.2.1 Municipal Solid Waste (MSW) generations in Dnipropetrovsk

Table 8.2-1 shows the generation of MSW in Dnipropetrovsk in 2014. The population in the city amounts to about 1 million, however, recently, about 60 thousand people have flown into the city because of the conflict occurred in the eastern area of Ukraine. The population have kept constant generally, while MSW has been increasing gradually. Dnipropetrovsk city finds less than 800 tons' generation of MSW a day, which is as much as the nationwide of Ukraine.

Table 8.2-1 Waste generation in Dnipropetrovsk city and Dnipropetrovsk oblast

Municipality	Population	Population Density (Persons/km^2)	Area (km^2)	MSW Generation (ton)
Dnipropetrovsk city	999,250 (Year 2011)	2,467	405	307,000 (Year 2013)
Dnipropetrovsk oblast	3,290,786 (Year 2014)	102	31,974	2,593,000 (Year 2014)

Source: JICA Study Team based on information of State Statistics Services of Ukraine, JASE working group material

8.2.2 Characteristic of MSW in Dnipropetrovsk

Solid waste properties and calorific values as basic data necessary for waste energy generation have not been analyzed so far in Dnipropetrovsk. Table 8.2-2 shows the contents of waste generated in the city.

Table 8.2-2 Morphological composition of MSW in Dnipropetrovsk city (Year 2016)

	MSW components	Percentage (%)
1	Food waste	26
2	Street waste	15
3	PET, Plastic	13
4	Inert waste	12
5	Paper, cardboard	10
6	Textile	8
7	Wood	5.5
8	Glass	4
9	Metals	1.5
10	Leather, rubber	1.8
11	Hazardous waste	0.2
12	Oher types of waste	3

Source: JICA Study Team based on information from Dnipropetrovsk

8.2.3 Waste management system and waste treatment practice

Dnipropetrovsk city appoints the waste collecting company in a bidding competition manner, after divided into 8 area of the city. Nowadays, Dneprokommutrans, as a waste collecting company covers 90% of Dnipropetrovsk city

Waste management tariffs are set separately for collective apartment residents and private house residents. The waste collecting company have respective contracts with all the citizen. However, payment of the population is about that of 60 to 70 % or less, the debt impossible to recover continues actually to be owed to the contracted waste collecting company.

8.2.4 Waste recycling in Dnipropetrovsk

The buyback price of solid waste derived from plastic products has increased from UAH 3,000 to 12,000 /ton, which often drives the citizen to collect separately at collecting end. However, the city administration has not promoted the separate collection and recycling at collecting end so far.

8.2.5 Final landfill site

Dnipropetrovsk established the final landfill site at Pravoberezhny in November, 2011. It is located 5 km away from the center of the city, which belongs to municipal company "ECO DNEP". Actual landfill work is outsourced to "Alter ECO". This final disposal site was designed by EU regulations, i.e., installation of collection pipes of generated methane gas and monitoring after landfill, etc. The specific information of the former landfill site at Kulebovka which was used municipally before the establishment of Pravoberezhny site is kept confidential because it belongs to a private company.

(Distant view of Landfill site)

(Collecting pipes of generated methane)

(Waste collecting trucks)

Figure 8.2-1 Condition of Pravoberezhny Landfill site

8.2.6 Waste management tariff

Waste management tariff in Dnipropetrovsk is calculated out by average generation multiplied by each tariff (transportation plus landfill). The components of tariff are shown in Table 8.2-3.

Table 8.2-3 Waste management tariff in Dnipropetrovsk

		Transportation (UAH/m^3)	Landfill (UAH/m^3)	Combined tariff (UAH/month per person) (2011 to 2016)
Residents in apartment (average generation: 2.01 m^3/year)	solid waste	35	13.08	9.36
	bigger size of solid waste	65		
Residents in individual house (average generation: 2.42m^3/year)	solid waste	35	13.08	11.26
	Bigger size of solid waste	65		

Source: JICA Study Team based on information collected from Dnipropetrovsk city

8.3 Kharkiv city

8.3.1 Municipal Solid Waste (MSW) generations in Kharkiv

The survey targeted Kharkiv city and oblast in the Kharkiv region. Table 8.3-1 shows the waste generation in the area.

Table 8.3-1 Waste generation in Kharkiv city and Kharkiv oblast

Municipality	Population	Population Density (Persons/km^2)	Area (km^2)	MSW Generation (ton)
Kharkiv city	1,430,885 (Year 2014)	4,676	306	443,000 (Year 2013)
Kharkiv oblast	2,720342 (Year 2015)	86	31,415	2,172,000 (Year 2014)

Source: JICA Study Team based on State Statistics Service of Ukraine, JASE WG material and website of Kharkiv oblast

Waste generation in Kharkiv oblast is tracking around between 2.1 million to 2.6 million tons in 2010 to 2014. The trend doesn’t curve in a unilateral way.

8.3.2 Characteristic of MSW in Kharkiv

No data is available for characteristic of waste, including calorific heating value which is required as basic data for waste energy project since no such analysis has been done so far. Table 8.3-2 shows the morphological composition of MSW in Kharkiv.

Table 8.3-2 Morphological composition of MSW in Kharkiv (Year unknown)

No.	MSW components	Percentage（%）
1	Kitchen scraps	15.12
2	Papers	26.92
3	Polymers	20.70
4	Glass	17.64
5	Ferrous metal	1.02
6	Non-ferrous metal	0.16
7	Textiles	3.44
8	Woods	1.38
9	Hazardous wastes	0.65
10	Leather and rubbers	1.90
11	Other	11.06

Source: EX Research Institute Ltd.

8.3.3 Waste management system and waste treatment practice

In general, the wastes in Kharkiv is treated and disposed at land filling sites similar to other cities in Ukraine. It is reported that there are waste incinerators in Kharkiv city and Lyubotyn city to incinerate wastes generated from railway project. However, there is no waste incinerator for general wastes generated from residential or commercial facilities.

8.3.4 Waste recycling in Kharkiv Oblast

It is reported that there is sorting facility in Rohan city in Kharkiv oblast, however no information on actual recycling performance was not available. Kharkiv oblast is considering to recycle plastic or glass as secondary resource at landfilling sites to make a profit.

8.3.5 Final landfill site

Kharkiv oblast have 2 final landfill sites now in use (Dergachi, and Kharkiv) and 2 construction disposal sites (Lyubotyn (60% of progress), Bogoduhov (90% of progress)). In addition, 6 sites are now under planning, as well as 2 of gas and liquid waste disposal sites.

Thus, Kharkiv oblast regards landfilling as the basic policy of waste management. They concluded there were no advantages to introduce the incineration plant in Kharkiv. Instead, they are examining to recover the plastic and the glass collected at landfill site as secondary resources and treat for sale.

Figure 8.3-1 shows the final landfill site of Dergachi in the suburbs of Kharkiv. Separate recovering facility financed by World Bank with USD 45 million will be installed there. Bidding scheduled around June, 2016 will decide the EPC contractor.

(Distant view of Landfill site)

Figure 8.3-1 Condition of Dergachi landfill site

8.4 Overview of draft legislation on waste management

As of the end of 2015, 12 draft laws related with waste management are registered. Some of these include legislation related with such as providing responsibility of producer for the recovery of waste of end use product (plastic bottles, etc.) and introducing environmental tax on producing and import of packaging and product in packaging. However, there are no guaranties that some of those laws will be adopted.

8.5 Support Needs in the waste energy Field

8.5.1 Energia waste incineration plant in Kyiv

The first issue of this existing plant to be solved over a short period is the lack of environmental facility to treat flue gas. The ESP is installed, which meets the Ukrainian standard but fail to comply with the EU standard. Additional flue gas treatment facility is necessary.

The second issue is that the energy is not utilized efficiently. Although the heat exchangers are installed to provide heat to the heat supply system, fair amount of heat is released into the atmosphere without being utilized. Overall, the heat is not utilized efficiently. The solution could be the installation of the back-pressured turbine generator, which is capable of using the currently-unrecovered heat to produce electricity and enhancing the energy utilization efficiency.

The third issue is the need for an additional waste incineration facility in the premises. In 2014, Japanese Consortium ITOCHU Corporation and Hitachi Zosen Corporation worked together and created a plan that utilized the Green Investment Scheme (70 to 80% contributed by the fund and the rest covered by Kyiv city or the national budget). The plan boasted the annual waste treatment capacity of 132,000 tons and the power generation capacity of 7 MW with the construction cost of USD 1.4 million. However, it was not adopted by the Government of Ukraine and is still left undiscussed.

Kyivenergo proposed the support measures in the waste field as listed below based on the issues above:

- Installation of a 4 MW turbine generator in the existing plant
  The plant is capable of treating 300,000 tons of waste a year. Since the maximum thermal output is 30 MW, the aim is to use energy more efficiently by installing a 4 MW back-pressured turbine generator. The electricity generated will be used at the plant and the rest will be sold to the grid. If the Green Tariff can be applied, the economic performance will improve more. The Green Tariff system is currently being deliberated in the parliament along with waste power generation and biomass. The estimated construction cost net of tax is USD 2.5 million.
- Installation of the flue gas treatment facilities in the existing plant
  In order to meet the EC standard (CO-50 mg/Nm^3, NOx-200 mg/Nm^3, and suspended particulate -10 mg/Nm^3), the flue gas treatment facility is installed to all 4 boilers by 2018. The estimated construction cost net of tax is USD 15 million. If the plant fails to meet the standard, it will have to keep paying the penalty.
- Add-on of a waste treatment line to the existing plant

A waste incineration facility with a capacity of 100,000 tons per year is installed adjacent to the existing plant. A facility with a thermal output of 30 MW and power generation capacity of 8 MW will be built at the same time. One of the advantages might be that it could be easy to obtain the consent of the administration and the residents since the waste treatment is already carried out in the area. The estimated construction cost net of tax is USD 90 million.

- Creating a new waste treatment plant at 3rd point

  A waste incineration facility with a treatment capacity of 350,000 tons per year is created in a new site. A facility with a thermal output of 120 MW and power generation capacity of 40 MW will be built at the same time. This proposal is feasible since out of the over 1 million tons of waste Kyiv creates each year, only 25 to 30% is incinerated today. However, the construction of a new incineration facility will require the development of laws and approval by the citizens, even though the city is to provide a new site if the need for it could be explained.

8.5.2 Dnipropetrovsk City

The officials of Dnipropetrovsk city Administration are very positive to waste incineration disposal. They showed an interest in construct the waste incineration plant to the Study Team. They don't have any of data of calorific value of solid waste and the blue plan of the plant. The Study Team felt like they still stay in a first step for future incineration disposal.

During the Study Team's visit in Dnipropetrovsk, a lot of discussions about waste management in Japan like how to collect and separate and/or how frequent to collect, were exchanged. Their interest was focused on the Japanese waste management.

8.5.3 Kharkiv Oblast

Kharkiv oblast concluded internally that the treatment tariff coming from separate collection of waste should increase after the introduction of waste incineration. And they are now planning the new landfill sites in parallel, which are now under construction and/or preparation. Their basic concept to continue this landfill disposal will be kept from now on. However, they are under consideration that collected and recycled materials from waste will be sold as secondary resources by installing recycling facility not at collecting point but at landfill site.

8.6 Study of Candidates for Support

(1) Kyiv city

Table 8.6-1 shows the Project candidates screened after site tour at the Energia incineration plant and discussions with the plant staff.

Table 8.6-1 Candidates for support for the Energia waste incineration plant

Item	(i) Installation of a 4MW steam turbine generator	(ii) Installation of flue gas treatment facilities	(iii) Add-on of a new waste treatment line	(iv) Installation of a new treatment facility at 3rd point
Target (Equipment Owner/Business Operator)	Energia waste incineration plant (Kyiv city /Kyivenergo)	Same as left	Same as left	Same as left
Outline of the Project	➢ Recover the unused energy to produce electricity by installing a steam turbine.	➢ Add flue-gas treatment facilities in the existing plant in order to meet the EU standards.	➢ Enhance the waste treatment capability by adding a waste treatment line. (e.g.100,000 tons/year)	➢ Increase the waste treatment capability by newly installing a waste incineration plant which is capable of treating 350,000 tons of waste a year (thermal output of 120 MW, power generation capacity of 40 MW).
Background of Project Selection and Supporting Request from Counterpart	➢ Support need was collected through interview with counterpart.	Same as left	Same as left	Samea as left
Construction period (short, medium or long term)	Short (approx.1 to 3 years)	Short (approx. 1 to 3 years)	Long (about 6 to 10 years)	Long (approx. 6 to 10 years)
Estimated cost	USD 2.5 million (estimated by Kyivenergo)	USD 15 million (estimated by Kyivenergo)	USD 90 million (estimated by Kyivenergo)	USD 315 million (augmented proportionally based on cost of (iii))
Availability of Japanese Technology (Technical Superiority/interest in Ukraine)	➢ Japanese technology can be applied. ➢ Japanese companies seem to have low interest in Ukraine.	Same as left	Same as left	Same as left
Expected Project Effectiveness	➢ Income by selling generated electricity will be obtained by unused heat recovery.	➢ Atmosphere contamination will be prevented by releasing less emissions.	➢ Expanding capacity of treatment can contribute to make the residual life of final landfill prolong.	Same as left
Possibility of Governmental Guarantee	➢ Unknown whether the governmental guarantee is offered to a local municipality.	Same as left	Same as left	Same as left
The steps to be taken next and pending issue, etc.	➢ Sub-sovereign system/ its scheme must be established. ➢ It is necessary to establish tariff system that can be recovered enogh to maintain and retrofit the facilities.	Same as left	Same as left	Same as left

Source: JICA Study Team

(2) Dnipropetrovsk city

Table 8.6-2 shows the Project candidates screened after an interview with city officials.

Table 8.6-2 Candidates for support for Dnipropetrovsk city

Item	(i) Capacity building concerning waste administration in Japan	(ii) Installation of new waste incineration plant
Target (Equipment Owner/Business Operator)	Dnipropetrovsk city	Same as left (Implementing body unknown)
Outline of the Project	➢ Present waste management in Japan and train officials of Dnipropetrovsk through seminars and plant tour in Japan.	➢ Utilize the surplus heat generated by waste incineration to local heat supply effectively.
Background of Project Selection and Supporting Request from Counterpart	➢ Support need was NOT confirmed from the city officials. However, during the Team's visit, the way in Japan to treat waste was much asked to the Team.	➢ Support need was collected through interview with counterpart.
Construction period (short, medium or long term)	-	Long (approx. 6 to 10 years)
Estimated cost	N/A	Unknown due to project scale unidentified
Availability of Japanese Technology (Technical Superiority/interest in Ukraine)	➢ Japanese municipal officials in charge of waste management could advise in detail.	➢ Japanese companies can provide this technology, but don't have superiority compared with overseas supplier.
Expected Project Effectiveness	➢ Prior to proceeding to (ii), the basic information about waste incineration should be obtained.	➢ Waste incineration can supply surplus heat to local pipeline network. ➢ Waste incineration can extend the residual life of landfill by reducing the volume of waste after incineration.
Possibility of Governmental Guarantee	-	➢ Unknown whether the governmental guarantee is offered to a local municipality.
The steps to be taken next and pending issue, etc.	-	➢ Sub-sovereign system/ its scheme must be established. ➢ It is necessary to establish tariff system that can be recovered enogh to maintain and retrofit the facilities.

Source: JICA Study Team

(3) Kharkiv oblast

As described in Section 8.5.3, the Study Team didn't find there were needs to introduce waste-derived generation plant in Kharkiv, because the administration is looking for secondary utilization of recycled and collected materials at landfill site.

8.7 Law, regulations and procedures upon implementing support measures

Table 8.7-1 lists the Ukrainian laws enacted to meet the EU requirements in the field of waste power generation as well as the EU requirements. See Appendix, List of Laws and Regulations related to Energy Sector in Ukraine.

Table 8.7-1 Major laws and regulations related to waste power generation

Ukrainian Laws and Regulations	EU Directive
➢ Protocol on Ukraine's accession to Energy Community Treaty ➢ Cabinet of Ministers Order No.733-P on approval of a plan to implement the obligations under the Energy Community Treaty, effective as of 3 Aug, 2011 and revised 7 Oct, 2015 ➢ Cabinet of Ministers Order No.1080-p on amending the financing agreement for the continuous support programs for the realization of Ukraine's energy strategy, and signing of the additional agreement No. 1 between EU represented by EC and Ukraine, effective as of 20 Dec, 2013 and revised 13 Oct, 2015 ➢ Ukrainian law on rules for operating the power market in Ukraine	➢ Directive 2001/80/ EC on the limitation of emissions of certain pollutants into the air from large combustion plants, effective as of 23 Oct, 2001 ➢ Directive 2006/32/EC on energy end-use efficiency and energy services, effective as of 5 Apr, 2006 ➢ Directive 2009/28/ EC on the promotion of the use of energy from renewable sources, effective as of 23 Apr, 2009 ➢ Directive 2009/73/ EC concerning common rules for the internal market in natural gas, effective as of 12 Jul, 2009 ➢ Regulation (EC) No.715/2009 on conditions for access to the natural gas transmission networks, effective as of 13 Jul, 2009

8.8 Possibility of entry of Japanese companies

The Energia waste incineration plant uses the stoker furnace, which is the type commonly used in this field. Many Japanese companies handle the stoker furnace and have delivered many products. However, Japanese companies' technology in this type of furnace is not particularly superior, and there are a number of competing companies in Europe and the rest of the world. On the other hand, Ukraine is in urgent need to comply with the environmental regulations in the field of thermal power generation as well as waste incineration facilities. Given the situation, the Japanese companies might be able to take part by proposing a comprehensive solution appealing the points appealing high-efficiency energy use combined with stoker furnace, back-pressured turbine generator, securing environmental performance to comply perfectly with EU standards, or appealing the high construction quality that adhere to schedule. However, it is unknown whether the content such as these could be adopted as the PQ requirements in international competitive bidding, or whether it is accepted by the bidding authority of Ukraine. If the bidding could go beyond the sale of the facility and include O&M after the start of operation as an option, it might give the Japanese companies a competitive edge in winning the contract; however, it is doubtful if any Japanese company will show any interest since there has been hardly any contract granted to a facility manufacturer or O&M consultant in Ukraine.

8.9 Conclusion

8.9.1 Possibility of granting governmental guarantee

Kyivenergo, the subject of hearing that the Study Team conducted this time, is only an operator that runs the Energia waste incineration plant under the operatorship awarded by Kyiv city. Since the facility belongs to Kyiv city, the governmental guarantee must be obtained from the Government of Ukraine for Kyiv city in order for a yen loan to be granted for the facility. As described in Section 7.13.1, a yen loan might be offered for the asset of Kyiv city; however, a wider range of support could be expected if a scheme for sub-sovereign loans (loan to municipalities) is created. The same is referred to Dnipropetrovsk city.

8.9.2 Interest in Ukraine by Japanese companies

The Study Team has been conducting hearings with Japanese companies that handle facilities capable of waste incineration. The Study Team found that the companies generally have low interest in Ukraine, even with a project for which a yen loan is assumed. Further, as Japanese companies do not have particularly high level of technology in this field, it might not be easy to solicit Japanese companies' participation.

8.9.3 Preparation of Master Plan concerning waste-derived generation

The Study Team after visiting 2 cities of Dnipropetrovsk city and Kharkiv oblast found the both municipal bodies who don't have any waste incineration facilities have been placing their basic policy that the waste generated from the citizen's life is to be landfilled so far and from now on, because they have large vacancies enough to landfill the waste. However, with awareness of environmental-consciousness and extension of landfilling life by reducing the volume of waste, and compliance with external request (i.e. EU regulations), more enhanced treatment for waste will be tackled. To install new waste incineration, reasonable treatment tariff which can pay maintenance and renovation expenses of waste incineration should be prevailed widely among citizens under the condition that the tariff will increase after the installation. The approval for the utility cost is controlled by the Government of Ukraine, who must promote the campaign of tariff hike for Ukrainian people. The master plan which describes the waste administration condition of nationwide Ukraine as well as potential needs to construct the facilities would help the activities by the Government of Ukraine.

In addition, as described in Section 8.8, there is few Japanese companies who have an interest in Ukraine and there is also little superiority in waste incineration technology among Japanese companies. The master plan concerning waste incineration generation would be a good motivator, which may help them to appear in Ukrainian market, if it would be provided as a next step through international cooperation from Japan.

8.9.4 Points to be noted regarding environmental and social consideration (waste generation field)

(1) Environmental Regulation

Based on the country's law, construction of waste incinerator, which is included in projects that can be supported, needs a detailed EIA and following steps will be considered; development of an EIA report, implementation of stakeholder consultation, and obtaining permit from the relevant agency.

In Ukraine, no special standards specific for air emissions for waste incinerators have been set and general air emission standards are referred when comparing the emission concentration from waste incineration. At present, 37 substances (e.g. NOx, SOx, HF, HCL) are being monitored for emission of Kyiv waste incineration plant which is the only incineration under operation in Ukraine and it has been reported that the monitoring result meet the standards set by the Government of Ukraine. However, it becomes a concern whether the emission can meet air emission standards particular for waste incinerators set by Directive 2010/75/EU, which Ukraine must follow in future.

(2) Other consideration

In Ukraine, most of wastes are generally transported and disposed at landfill sites or disposed illegally, and incineration, separation and recycling is not common practice because there is lack of regulation and management system regarding to waste management to be placed in Ukraine, resulting in the lack of finance for waste management. Therefore, environmental measures for waste management such as air pollution control, odor control or soil and groundwater contamination prevention measure has not been implemented and it is required to improve this situation in order to meet EU standard.

For example, waste management in Kyiv city is not uniform. While the local government manages waste generated from multi residential apartment managed by municipality, management of other wastes generated in the city is no properly confirmed and it is assumed that most of these wastes are illegally dumped at somewhere. Also, there are only 2 landfill sites that are operating (one for general waste and one for construction waste) and the amount of waste exceeds the capacity of both waste disposal sites. Moreover, modernization and upgrading of the waste facilities have not forwarded due to lack of financial resources. Environmental problems (e.g. leakage into water pipes and offensive odor) have not been addressed. Thus, improvement of waste management in Kyiv city is a big issue. It is expected that the construction of a new waste incinerator can contribute in addressing waste disposal problem in the city.

Appendix List of Laws and Regulations related to Energy Sector in Ukraine

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	1	2694-XII	Law	1992/10/14	On labor protection	Y	Y	Y	Y	Y	Y	Y
	2	74/94-BP	Law	1994/7/1	On energy saving	Y	Y	Y	Y	Y	Y	Y
	3	334/94-BP	Law	1994/12/28	On Company's Profit Tax (Invalid 2013/1/1)	Y	Y	Y	Y	Y	Y	Y
	4	282/95	Decree	1995/4/4	On the restructuring of the power generating complex of Ukraine	Y	Y	Y	Y	-	Y	Y
	5	192/96-BP	Law	1996/5/15	On pipeline transport	Y	Y	Y	-	-	Y	-
	6	15	Regulation NERC	1996/6/13	On approval of the Terms and Rules for business activities in the area of electricity transmission to local power networks	-	-	-	-	Y	Y	Y
	7	15/1	Regulation NERC	1996/6/13	On approval of the Terms and Rules for business activities in the area of power supply at a regulate rate	Y	Y	Y	-	-	Y	Y
	8	28	Regulation NERC	1996/7/31	On approval of the rules for power	Y	Y	Y	-	Y	Y	Y
	9	929	Regulation	1996/8/7	On strengthening control over the modes of power and heat energy consumption	Y	Y	Y	-	-	Y	Y
	10	36	Regulation NERC	1996/8/12	On approval of the Terms and Rules for business activities in the area of power supply at an unregulated rate	Y	Y	Y	-	-	Y	Y
	11	152	Regulation NERC	1996/10/11	On approval of the Terms and Rules for business activities in the area of power transfer through main and interstate power grids	-	-	-	-	Y	Y	Y
	12	148	Regulation	1997/2/5	On approval of the complex state program for energy saving of Ukraine	Y	Y	Y	-	-	-	Y
	13	731	Regulation	1997/7/10	On the complex measures for National energy program of Ukraine implementation	Y	Y	Y	-	-	Y	Y
	14	575/97_BP	Law	1997/10/16	On power generating industry	Y	Y	Y	Y	-	Y	Y
	15	575/97-BP	Law	1997/10/16	On Electricity	Y	Y	Y	Y	Y	Y	Y
	16	147/98-BP	Law	1998/3/3	On transfer of objects of state and municipal property	Y	Y	Y	Y	Y	Y	Y
	17	1094	Regulation	1998/7/15	On state examination in energy saving area	Y	Y	Y	-	-	-	Y
	18	189	Regulation	1999/2/15	On approval of the state supervision order in power generating sector	Y	Y	Y	-	Y	Y	Y
	19	997-XIV	Law	1999/7/16	On Concessions	-	-	-	-	-	-	-
	20	1357	Regulation	1999/7/26	On approval of the rules for power use for the population	Y	Y	Y	Y	Y	-	Y
	21	1456	Regulation	1999/8/9	On implementation of the "Rehabilitation of Hydropower stations" project and management in the system	-	-	-	Y	-	-	Y
	22	1305	Regulation NERC	1999/10/6	On approval of the Instruction for the order of issuance of licenses by the National Electricity Regulatory Commission for certain types of business	Y	Y	Y	Y	Y	-	Y
	23	1127-XIV	Law	1999/10/6	Mining Law of Ukraine	Y	Y	-	-	-	Y	-
	24	1391-XIV	Law	2000/1/14	On alternative fuel types	Y	Y	Y	-	-	Y	Y
	25	1682-III	Law	2000/4/20	On natural monopolies	Y	Y	Y	-	-	Y	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	26	1775-III	Law	2000/6/1	On Licensing of Certain Types of Economic Activity	Y	Y	Y	Y	Y	Y	Y
	27	922	Regulation	2000/6/5	On approval of the Statute of the state enterprise "Energorynok"	-	-	-	-	Y	Y	Y
	28	1139	Regulation	2000/7/19	On approval of the sanction for violation of law in the area of power generation	Y	Y	Y	-	-	-	Y
	29	29-p	Instruction	2001/1/31	On transfer of the heat and power plants (ТЕЦ) and heating supply networks to the ownership of the local community of Kyiv City	-	-	Y	-	-	Y	Y
	30	2665-III	Law	2001/7/12	On Oil and Gas	Y	Y	Y	-	-	Y	-
	31	1169/2001	Decree	2001/12/3	On additional measures for reforming the power generating sector of Ukraine	Y	Y	Y	-	-	-	Y
	32	555-IV	Law	2003/2/20	On alternative sources of energy	Y	Y	Y	-	Y	Y	Y
	33	999-IV	Regulation	2003/6/19	On adoption as a basis of the draft law of Ukraine on combined heat and power generation (cogeneration) and waste energy potential use	-	Y	Y	-	-	-	Y
	34	794	Decree	2004/6/22	On establishment of National Joint Stock Company "Energy Company of Ukraine"	Y	Y	Y	Y	Y	-	Y
	35	1869-IV	Law	2004/6/24	On national program of reforming and development of housing and public utilities sector for 2009-2014	Y	Y	Y	-	-	-	Y
	36	1875-IV	Law	2004/6/24	On housing and public utilities services	Y	Y	Y	-	-	Y	Y
	37	648-p	Instruction	2004/9/8	On arrangements for reconstruction and modernization of the heat and power plants (ТЕЦ) and thermal power plants (ТЕС) during the period till 2020	Y	Y	Y	-	-	-	Y
	38	173	Regulation	2004/12/23	On approval of the Order for the use of funds for the creation and implementation of thermal power cogeneration modules for coal bed methane utilization in 2004	Y	Y	-	-	-	-	Y
	39	2509-IV	Law	2005/4/5	On combined heat and power generation (cogeneration) and waste energy potential	-	Y	-	-	-	Y	Y
	40	2633-IV	Law	2005/6/2	On heat supply	Y	Y	Y	-	-	Y	Y
	41	148	Regulation	2005/6/16	On approval of the order of installation of temporary consumption rates, quality standards and modes of housing and public utility services	Y	Y	Y	-	-	Y	Y
	42	630	Regulation	2005/7/21	On approval of the rules for district heating services provision, cold and hot water supply and the standard contract for district heating services provision, cold and hot water supply	-	-	Y	-	-	Y	Y
	43	---	Credit A	2005/9/19	Credit agreement ("Rehabilitation of Hydropower stations" project) between Ukraine and International Bank for Reconstruction and development	-	-	-	Y	-	-	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	**44**	3256-IV	Law	2005/12/21	On ratification of the Credit Agreement ("Rehabilitation of Hydropower stations") between Ukraine and International Bank for Reconstruction and development	-	-	-	**Y**	-	-	**Y**
	45	47	Order	2006/1/21	On approval of the rules for connection of cogeneration units to power networks	-	**Y**	-	-	**Y**	**Y**	**Y**
	46	113-p	Instruction	2006/3/1	On approval of the feasibility study for the second phase of the reconstruction of hydropower station Ukrhydroenergo, LLC	-	-	-	**Y**	-	-	**Y**
	47	145-p	Instruction	2006/3/15	Energy Strategy of Ukraine 2006 (Invalid2013/7/24)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	48	540	Regulation	2006/4/26	On approval of the Terms and regulations (license conditions) for heat generation activities at heat and power plants, thermal power plants, nuclear power plants, co-generation and non-conventional or renewable energy sources installation	**Y**	**Y**	**Y**	-	**Y**	**Y**	**Y**
	49	695	Regulation	2006/5/18	On approval of the provision for loans at preferential rate for investment projects on implementation of energy saving technologies and technologies on alternative fuel sources manufacturing	**Y**	**Y**	**Y**	-	**Y**	-	**Y**
	50	183	Order	2006/5/24	On approval of the order for preparation and financing of the projects for implementation the plan for reconstruction and modernization of the thermal power plants	**Y**	-	-	-	**Y**	**Y**	**Y**
	51	1670	Regulation	2006/11/29	On approval of the Order for validation of the cogeneration installation	-	**Y**	-	-	-	**Y**	**Y**
	52	419	Regulation	2007/3/7	On approval of the use of funds in 2007 allocated in the state budget to reduce the cost of loans for the construction of nuclear power, pumped storage hydropower and other power stations, transmission, mountainous and rural power lines, as well as the stockpiling of solid fuel for thermal power plants	**Y**	-	-	**Y**	**Y**	**Y**	-
	53	877-V	Law	2007/4/5	On Principles of State Supervision (Control) of economic activity	**Y**	**Y**	-	-	**Y**	**Y**	**Y**
	54	59	Order	2007/4/17	On approval of the agreement procedure by State energy efficiency company of Ukraine of innovative and investment projects on energy saving technologies and technologies of alternative fuel sources, performed by economic entities under the loans at preferential rate	**Y**	**Y**	**Y**	**Y**	**Y**	-	**Y**
	55	408-p	Regulation	2007/6/13	On approval of the action plan for reforming and development of energy sector	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	56	1198	Regulation	2007/10/3	On approval of the rules for thermal power usage	**Y**	**Y**	**Y**	-	-	**Y**	**Y**
	57	75	Regulation	2008/2/22	On approval of the criteria for the division of business entities according to risk of their activities in the field of power and heat supply and determining the frequency of the state supervision (control)	**Y**	**Y**	**Y**	-	-	**Y**	**Y**
	58	601-VI	Law	2008/9/25	On Amendments to the Law of Ukraine "On Electrical Power Industry"	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	59	102-p	Instruction	2009/2/4	On measures of alternative energy sources use	Y	Y	Y	-	-	-	Y
	60	126	Regulation	2009/2/19	On peculiarities of the connection of power facilities that generate electricity from alternative sources to power grids	Y	Y	Y	-	Y	Y	Y
	61	401	Regulation	2009/4/2	On approval of the order of regional development programs for heat supply systems modernization	-	-	Y	-	-	-	Y
	62	682	Regulation	2009/5/20	On the measures for heat supply system s modernization	-	-	Y	-	-	-	Y
	63	1391-VI	Law	2009/5/21	On Amendments to Certain Laws of Ukraine as to Support of Production and Use of Biofuel Types	-	Y	-	-	-	Y	Y
	64	1392-VI	Law	2009/5/21	On Coalbed Methane	Y	-	-	-	-	-	Y
	65	771-p	Instruction	2009/7/8	On the involvement of the International Bank for Reconstruction and Development loan for additional financing Hydropower Rehabilitation Project	-	-	-	Y	-	-	Y
	66	223	Order	2009/7/24	On approval of the rules for connection of cogeneration units to heating networks	-	Y	Y	-	-	-	Y
	67	159/2009-p	Instruction	2009/7/27	Issues of the conclusion of credit agreement (Additional financing for the implementation of the "Rehabilitation of Hydropower stations") between Ukraine and International Bank for Reconstruction and development	-	-	-	Y	-	-	Y
	68	---	Credit A	2010/2/3	Credit Agreement (Additional financing for the implementation of the "Rehabilitation of Hydropower stations") between Ukraine and International Bank for Reconstruction and development	-	-	-	Y	-	-	Y
	69	151	Regulation	2010/2/17	On approval of the order for recalculation the tariffs for district heating services provision, cold and hot water supply and sewer in the case of the failure to provide the services or reducing the volume or quality of the service	-	-	Y	-	-	Y	Y
	70	MECI 75	Order	2010/2/25	Standard Specification on Modernization of 200 MW and 300 MW thermal power plant for Regulation Frequency and Power	Y	-	-	-	Y	-	Y
	71	243	Regulation	2010/3/1	On approval of the State target economic program on energy efficiency and development of energy production from renewable energy sources and alternative fuels for 2010-2016	Y	Y	Y	-	-	Y	Y
	72	2437-VI	Law	2010/7/6	On ratification of the Credit Agreement (Additional financing for the implementation of the "Rehabilitation of Hydropower stations") between Ukraine and International Bank for Reconstruction and development, Letter-annex No.1 to the Credit agreement (regarding financial and economic data), and Letter-annex No.2 to the Credit agreement (regarding the monitoring and assessment indexes)	-	-	-	Y	-	-	Y
	73	2467-VI	Law	2010/7/8	On the Principles of the Natural Gas Market Functioning	Y	Y	-	-	-	-	Y
	74	2479-VI	Law	2010/7/9	On the state regulation in the area of public utility services	Y	-	-	Y	Y	Y	Y
	75	2480-VI	Law	2010/7/9	On land of electric powers and the legal status for special zones of power engineering facilities	Y	Y	Y	-	Y	-	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	76	2624-VI	Law	2010/10/21	On peculiarities of renting or concession of district heating, water supply and sanitation facilities that are in communal ownership	-	-	Y	-	-	Y	Y
	77	2755-VI	Law	2010/12/2	The Tax Code of Ukraine	Y	Y	Y	Y	Y	Y	Y
	78	2358-p	Instruction	2010/12/22	On approval of the project and title structure of the second stage of hydropower plants reconstruction of Ukrhydroenergo, LLC	-	-	-	Y	-	-	Y
	79	2787-VI	Law	2011/2/1	The Protocol of joining the Energy community treaty by Ukraine	Y	Y	Y	Y	Y	Y	Y
	80	560	Regulation	2011/5/11	On approval of the order for approval of construction projects and their examination, and recognition some regulations of the CMU as invalid	Y	Y	Y	-	Y	Y	-
	81	869	Regulation	2011/6/1	On ensuring a unified approach to the formation of tariffs for housing and public utility services	Y	Y	Y	Y	Y	Y	Y
	82	---	Credit A	2011/9/29	Credit Agreement ("Rehabilitation of Hydropower stations") between Ukraine and European Bank for Reconstruction and Development	-	-	-	Y	-	-	Y
	83	105	Order	2011/10/6	On approval of the order of competitive selection of energy efficient projects for state support at the expense of the state budget for implementation of the State Target Economic energy efficiency program and development of energy production field for energy carrier from renewable energy sources and alternative fuels for 2010-2015	Y	Y	Y	-	Y	-	Y
	84	4434-VI	Law	2012/2/23	On amendments to some laws of Ukraine regarding the regulation of investment activity in the area of living and public utility services	Y	Y	Y	-	Y	-	Y
	85	250	Regulation	2012/3/28	On approval of the list of the energy objects, the construction and reconstruction of which is performed in 2012 using the funds, allocated in the state budget for construction of energy installations at nuclear power plants, pumped storage hydropower station, heat and power plants, construction and reconstruction of transmission lines and substations, as well as for the loan reduction for the creation of solid fuel stockpile for thermal power plants	Y	Y	Y	Y	Y	Y	Y
	86	5021-VI	Law	2012/6/22	On amendments to some laws of Ukraine concerning the fee for joining the networks of natural monopolies	Y	Y	-	-	Y	-	Y
	87	418-p	Instruction	2012/7/2	On organizational measures for the servicing of power plant equipment, heat and power networks to a stable work in fall-winter period	Y	Y	Y	-	-	Y	Y
	88	519-p	Instruction	2012/7/25	On attracting loans from the European Investment Bank for the implementation of the project "Rehabilitation of Hydropower stations	-	-	-	Y	-	-	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field: Thermal generation	Type of field: Co-generation Biomass, waste generation	Type of field: Local Heat Supply	Type of field: Hydro generation	Type of field: Transmission/ Distribution	Type of work: New Installation	Type of work: Modification
Ukraine Law Decree Regulation Order Instruction	89	284	Regulation NERC	2012/8/10	On approval of the Procedure for monitoring compliance with license conditions of the economic activities of heat production (except of heat production at heat and power plants, thermal power plants, nuclear power plants, and cogeneration and non-conventional or renewable energy facilities), heat transportation by transmission and local (distribution) heat networks, heat supply	-	-	Y	-	-	Y	-
	90	276	Regulation NERC	2012/8/10	On approval of the license conditions for the economic activities of heat production (except of heat production at heat and power plants, thermal power plants, nuclear power plants, and cogeneration and non-conventional or renewable energy facilities)	-	-	Y	-	-	Y	-
	91	5255-VI	Law	2012/9/18	On ratification of the Agreement between Ukraine and European investment bank ("Rehabilitation of Hydropower stations" project)	-	-	-	Y	-	-	Y
	91	---	Finance A	2012/9/21	Financial Agreement between Ukraine and European investment bank ("Rehabilitation of Hydropower stations" project), Brussels, 21.09.2012	-	-	-	Y	-	-	Y
	92	5485-VI	Law	2012/11/20	On Electricity" to stimulate the production of electricity from alternative energy sources	Y	Y	Y	-	-	-	Y
	93	32	Regulation NERC	2013/1/17	Rules for connection of power installations to power networks	Y	Y	Y	-	Y	Y	-
	94	115	Regulation NERC	2013/2/12	The method of fees calculation for connection of power installations to power networks	Y	Y	Y	Y	Y	Y	-
	95	671-p	Order	2013/6/15	On the launch of the pilot project “Energy Bridge “Ukraine - European Union	-	-	-	-	-	-	-
	96	744	Regulation NERC	2013/6/27	On approval of the Order for determining the local volume for energy facilities, including commissioned building power plants (launch area), which generate electricity from alternative energy sources (except for blast furnace and coking gases)	Y	Y	Y	-	-	-	Y
	97	1071-p	Instruction	2013/7/24	On approval of the Energy Strategy of Ukraine for the period till 2030	Y	Y	Y	Y	Y	-	Y
	98	771	Regulation	2013/7/24	On approval of the order of issuing, use and termination of guarantees of origin for electricity generated from alternative energy sources	Y	Y	Y	-	-	-	Y
	99	948	Regulation	2013/10/17	On approval of the Program for heat supply system modernization in 2014-2015	-	-	Y	-	-	-	Y
	100	663-VII	Law	2013/10/24	On the Principles of electricity market of Ukraine functioning	Y	Y	Y	Y	Y	Y	Y
	101	886	Regulation	2013/11/13	On approval of the methods for definition of the technological minimum consumption of natural gas for district heating facilities	-	-	Y	-	-	Y	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	**102**	685-VII	Law	2013/11/19	On ratification of the financial agreement ("Rehabilitation of Hydropower stations" project) between Ukraine and European Bank for Reconstruction and Development	-	-	-	**Y**	-	-	**Y**
	103	504/2014	Decree	2014/6/6	On the decision of the National Security and Defense Council of Ukraine, dated 28 April 2014 "On the cancellation of some decisions of the National Security and Defense Council of Ukraine" and declaring some decrees of the President of Ukraine as expired	**Y**	**Y**	**Y**	-	-	**Y**	**Y**
	104	589-p	Instruction	2014/6/18	On improvement of the system of payments for electricity from alternative energy sources	**Y**	**Y**	**Y**	-	-	-	**Y**
	105	294	Regulation	2014/7/9	On approval of the State Architectural and Construction Inspectorate of Ukraine	**Y**	**Y**	**Y**	-	**Y**	**Y**	**Y**
	106	449	Regulation	2014/9/3	On amendments to the state target economic program on energy efficiency and the development of energy production field from renewable energy sources and alternative fuels for 2010-2015	**Y**	**Y**	**Y**	-	-	-	**Y**
	107	MECI680	Instruction	2014/9/29	NEW ENERGY STRATEGY OF UKRAINE: SECURITY, ENERGY EFFICIENCY, COMPETITION	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	108	902-p	Instruction	2014/10/1	NATIONAL RENEWABLE ENERGY ACTION PLAN UP TO 2020	**Y**	**Y**	**Y**	**Y**	**Y**	-	**Y**
	109	1532/26309	Decree	2014/12/1	Order of plan preparation system operator United Energy Systems of Ukraine for the next ten years	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	110	222-VII	Law	2015/3/2	On Licensing of economic activity	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	111	222-VIII	Law	2015/3/2	On Licensing of economic activity	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	112	514-VIII	Law	2015/6/4	On amendments to some laws of Ukraine to ensure competitive conditions for the production of electricity from alternative energy sources	**Y**	**Y**	**Y**	-	-	-	**Y**
	113	1792	Regulation NERC	2015/6/30	On approval of the establishment of the investment programs licensees for power transmission through main and interstate power grids, and heat and/or power generation on nuclear power plants, hydropower stations, and pumped storage hydropower station	-	-	-	**Y**	-	-	**Y**
	114	765-p	Instruction	2015/7/24	On complex measures regarding the stabilization of the operation of the energy generating companies and heat and power plants (ТЕЦ) to ensure the reliability of the integrate energy system of Ukraine in the fall-winter period of 2015/16	**Y**	**Y**	**Y**	-	-	-	**Y**
	115	733-p	Order	2015/10/7	On approval of the action plan for implementation the obligations under the Energy Community Treaty establishment	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
Ukraine Law Decree Regulation Order Instruction	116	1080-p	Order	2015/10/13	On signing an additional agreement No.1 between Ukraine and the European Union, represented by the European Commission, on amending the Agreement on financing the program "Continue to support the realization of the Energy Strategy of Ukraine	Y	Y	Y	Y	Y	Y	Y
	117	929	Regulation	2015/11/11	On the extension of the state target economic program on energy efficiency and development of energy production from renewable energy sources and alternative fuels for 2010-2015	Y	Y	Y	Y	Y	Y	Y
	118	---	Instruction	2015/11/11	STATEMENT ON SECURITY OF ENRGY SUPPLY OF ULRAINE	Y	Y	Y	Y	Y	Y	Y
EU	119	2000/76/EC	Directive	2000/12/4	on the incineration of waste	Y	Y	Y	-	-	Y	Y
	120	2001/80/EC	Directive	2001/10/23	on the limitation of emissions of certain pollutants into the air from large combustion plants	Y	Y	Y	-	-	Y	Y
	121	2003/4/EC	Directive	2003/1/28	on public access to environmental information	Y	Y	Y	-	-	Y	Y
	122	2004/8/EC	Directive	2004/2/11	on the promotion of cogeneration based on a useful heat demand in the internal energy market	-	Y	-	-	-	Y	Y
	123	2006/32/EC	Directive	2006/4/5	Energy Community	Y	Y	Y	-	-	Y	Y
	124	2008/1/EC	Directive	2008/1/15	concerning integrated pollution prevention and control	Y	Y	Y	-	-	Y	Y
	125	2008/50/EC	Directive	2008/3/21	on ambient air quality and cleaner air for Europe	Y	Y	Y	-	-	Y	Y
	126	2008/98/EC	Directive	2008/11/19	on waste and repealing certain Directives	-	Y	Y	-	-	Y	-
	127	2009/28/EC	Directive	2009/4/23	on the promotion of the use of energy from renewable sources and amending and subsequently	Y	Y	-	Y	-	-	Y
	128	2009/72/EC	Directive	2009/7/13	concerning common rules for the internal market in electricity	Y	Y	Y	Y	-	Y	Y
	129	2009/73/EC	Directive	2009/7/13	concerning common rules for the internal market in natural gas	Y	Y	Y	-	-	Y	Y
	130	2010/75/EU	Directive	2010/11/24	On Industrial Emissions (Integrated Pollution Prevention and Control)	Y	Y	Y	-	-	Y	Y
	131	2013/0301	Decision	2013/10/24	on establishing the European Union position within the Ministerial Council	Y	Y	Y	-	-	Y	Y
	132	(EC)714/2009	Regulation	2009/6/13	Conditions for access to the network for cross-border exchanges in electricity	Y	Y	-	-	Y	Y	Y
	133	(EC)715/2009	Regulation	2009/7/13	on conditions for access to the natural gas transmission networks	Y	Y	Y	-	-	Y	Y
	134	(EU)838/2010	Regulation	2010/9/23	Laydown Guideline to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging	Y	Y	-	-	Y	Y	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
EU	135	SWD/2013/0451	COMMISSION STAFF WORKING DOCUMENT	2013/6/11	ENERGY EFFICIENCY OBLIGATION SCHEMES	Y	Y	Y	-	-	Y	Y
	136	(EU)347/2013	Regulation	2013/4/17	Guidelines for trans-European energy infrastructure	Y	Y	-	Y	Y	-	Y
DBN	137	A.2.2-1-2003		2004/4/1	DBN A.2.2-1-2003 Design. Composition and content of impact assessment (EIA) in the design and construction of plants, buildings and structures ua	Y	Y	Y	-	Y	Y	Y
	138	A.2.2-1-2008		2014/7/28	DBN A.2.1-1: 2014 Engineering survey for construction	Y	Y	Y	-	Y	Y	Y
	139	A.2.2-3-2014		2014/10/1	DBN A.2.2-3: 2014 Structure and contents of project documentation for construction of the Ukrainian	Y	Y	Y	-	Y	Y	Y
SOU	140	SOU N MPE 40.1.17.401:2004	Life	2004	Control of metals and service-life extension of the basic elements of boilers, turbines, and pipelines of thermal power plants	Y	Y	-	-	-	-	Y
	141	SOU N MPE 40.1.03.310:2005.	Fire & Safety	2005	Regulations. The rules of construction of electrical installations. Fire protection installations. NAPB V.01.056-2005 / 111. Instructions	Y	Y	Y	-	-	Y	Y
	142	SOU N MPE 40.1.12.103:2005	Fire & Safety	2005	Training / Testing of knowledge workers the power industry on safety, fire safety and technical operation. Position	Y	Y	Y	Y	Y	Y	Y
	140	SOU-H MPE 40.1.02.307:2005	Emission	2005	Combustion plants with thermal power plants and boiler room. Organization of monitoring of emissions to air	Y	Y	Y	-	-	Y	Y
	141	SOU 45.2.00018112.021: 2007	Emission	2007	Sampling and determination of the parameters of the gas-dust flow of industrial emissions of pollutants enterprises Road area. Appendix A to E.	Y	Y	Y	-	-	Y	Y
	142	SOU D.2.2-01383865-002: 2008	Fire & Safety	2008	Resource elemental estimate standards for construction work. Airfields. With the change in number 1	Y	Y	Y	-	-	Y	Y
	143	SOU N EE YEK 04.160:2009	Fire & Safety	2009	Methods and recommendations to verifying the readiness of thermal power plants, hydro and nuclear power plants to participate in the regulation frequency-power and Ukraine OES Guidance	Y	Y	-	-	-	Y	Y

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						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
SOU	144	SOU N EE YEK 04.156:2009	Frequency	2009	Basic Requirements for frequency regulation and OES-power in Ukraine. Guidance	Y	Y	-	-	-	Y	Y
	145	SOU N EE YEK 04.157:2009	Frequency	2009	Methods and recommendations of primary and secondary frequency and capacity regulation at thermal power plant (TPP)	Y	Y	-	-	-	Y	Y
	146	SOU 41.0.21677681 -25: 2010.	Fire & Safety	2010	Instructions for storage and use of primary fire extinguishing equipment at the enterprises of the Ministry of Energy of Ukraine (NFPA 05.026-2010)	Y	Y	Y	-	-	Y	Y
	147	SOU 41.0.21677681 -34: 2010	Fire & Safety	2010	(2010 NAPB 05.031) Instruction on fire safety and security systems automatic fire extinguishing cable constructions PDF	Y	Y	Y	-	-	Y	Y
	148	SOU 41.0.21677681 -37: 2010	Fire & Safety	2010	(NFPA 05.025-2010). Instructions for use of automatic fire extinguishing systems	Y	Y	Y	-	-	Y	Y
	149	SOU MHC 75.2-00013528 -002: 2010	Fire & Safety	2010	Safety in emergencies. The filter personal respiratory protection of the population in emergency situations. Classification	Y	Y	Y	Y	Y	Y	Y
	150	SOU MHC 75.2-00013528 -004: 2010	Fire & Safety	2010	Safety in emergencies. Means cleaning of air defense equipment of civil protection (civil defense). Classification and general	Y	Y	Y	Y	Y	Y	Y
	151	SOU MHC 75.2-00013528 -005: 2011	Fire & Safety	2011	Safety in emergencies. Complexes of personal protective equipment rescuers. Classification and general requirements	Y	Y	Y	Y	Y	Y	Y
	152	SOU MHC 75.2-00013528 -006: 2011	Fire & Safety	2011	Safety in emergencies. Mode of operation of rescuers utilizing personal protection in the aftermath of accidents	Y	Y	Y	Y	Y	Y	Y
	153	SOU 40.1.21677681 .60: 2012	Fire & Safety	2012	Fire protection power turbine hall. Rules of design and operation of fire-fighting equipment (NFPA V.01.061.2011 / 111)	Y	Y	Y	-	-	Y	Y

Items	No.	Code Number	Type of law	Effective Date	Title	Type of field					Type of work	
						Thermal generation	Co-generation Biomass, waste generation	Local Heat Supply	Hydro generation	Transmission/ Distribution	New Installation	Modification
SOU	**154**	SOU N EE 40.1-21677681 -88: 2013	Fire & Safety	2013	Rules for Electrical. Fire safety installations. Instruction (NFPA V.01.056-2013 / 111)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Remarks

Items	Type	Description
Ukraine	Law	Issued based on proposals by the Cabinet of Ministers or parliamentary members and approved by the Supreme Council
	Decree	Issued in cases where urgency is required by President
	Regulation	Executed based on approval by Ministers, heads of oblast administration and/or autonomous bodies
	Order	Executed based on approval by the Cabinet of Ministers
	Instruction	Executed based on approval by Ministers, heads of oblast administration and/or autonomous bodies
EU	Directive	Resolution at EU Council
	Regulation	Regulation at EU Council
DBN	-	National Architectural Standard
SOU	-	National Technical Standard