MSc Program
Environmental Technology & International Affairs

Transformation of Ukrainian Energy System towards a Sustainable Future

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Vienna, 14.10.2014

Affidavit

I, **Tetiana Temniuk**, hereby declare

1. that I am the sole author of the present Master's Thesis, "TRANSFORMATION OF UKRAINIAN ENERGY SYSTEM TOWARDS A SUSTAINABLE FUTURE", 61 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

Ukraine has inherited a powerful and well-developed energy system from the USSR. However, it became dramatically inefficient. The lifetime of the majority of power plants has run out or will run out in the next several years. There is huge inefficiency in energy consumption among the population, which together with old heating systems cause enormous energy losses. The problem of corruption and unclear price and legal regulation in the energy field makes the process of investment attractions very complicated. That is why a full change in the energy system is absolutely vital for Ukraine.

It is clear that the problem cannot be solved in one or even five years. The whole transformation process will take several decades, but the first steps have to be done today. One of the most important ones is to reduce energy inefficiency and improve the legislation in the energy field. The other, more significant measures have to be taken in the near future. The goals, which have to be achieved by these measures, are divided according to a short run and a long run perspective.

By doing at least those actions, proposed in this thesis, Ukrainian energy system can be transformed from an old inefficient post-soviet condition to a sustainable and reliable system.

Contents

List of Abbreviations

ARES Alternative and renewable energy sources
BOT Build-operate-transfer
CHP Combined Heat and Power
EE Energy efficiency
GHG Greenhouse gases
GTS gas-transmission system
HPP Hydro Power Plant
LPG Liquefied petroleum gas
PPP Public–private partnership
TPP Thermal Power Planmt
UES United Energy System
UES JSC Joint Stock Company Ukrainian Energy System
WWII World War II

1. Introduction

Ukraine has a very complicated history and throughout its independence since 1991 this country is struggling with the difficult economic and political situation. One of the most problematic elements of Ukrainian economy is its energy system. It suffers from inefficiency, poor technological condition of its assets, corruption in this field and all the other problems, which consequently result from the mentioned ones. Different research have been made, which study this problem and most of them come to the conclusion that a modernization of the system is necessary including in the legislation and price regulation field. In my thesis I am focusing on strategic concept of such modernization. I believe that in that situation, in which Ukrainian energy system is at the moment, it is necessary to look in the future and to start building the platform for it today. To be more concrete I assume that the energy concept has to go in parallel with the general development strategy of Ukraine. Ukraine has always declared (which is stated in the legal documents) that its future is together with Europe. The energy sphere naturally has to be adapted to this strategy. It means all the legislation acts, which regulate energy and environment sphere need to be adopted and implemented in Ukraine, energy grids have to be connected and work in cooperation as well as other energy collaboration projects. All these transformations require huge financial resources and political will. The last one was even more complicated than the first one. There are a lot of obstacles before Ukraine on its way towards European future. However, it is possible and achievable in case the strategy is good and smart. The final aim in energy sphere: to increase the energy independence is one of the main priorities for national security of Ukraine. In this paper I try to analyse what are the steps of Ukraine towards its energy independence: whether it is increase of the renewable energy or decrease of inefficiency in industry and households or some other important decisions.

First of all we have to understand the current state of the energy in Ukraine. Ukrainian Energy system takes its roots from the united energy system of the USSR. In order to understand the nature of Ukrainian energy structure and the current challenges, which the state faces in this dimension, it is necessary to analyse the soviet heritage, which Ukraine received in 1991.

In the series of books “Energy: history, present and the future”, the authors gave an excellent characteristics of the energy system of Ukraine. One of the books from this series, which has the name “Development of nuclear energy and united energy systems” Denysevych et al (2011) describes the background of the energy

system of Ukraine. In the second half on the XX century on the territory of Ukraine there were 5 local energy systems formed. The first one was Donetska Energy system, which was created in 1926. In 1930 the next regional energy distributors (energy community) were created: Kyivenergo, Krymenergo and the Kharkiv energy system. One year later Dniproenergo was formed. The first step to unite the systems was made in 1940 via the electricity line with the power of 220 KV, which united Donbasenergo, Dniproenergo and Rostovenetgo. The system got the name united South energy system.

The WWII destroyed the energy system of the Soviet Ukraine. The post war period (1946-1950) was characterized by the renewal of the energy of Ukraine. The losses were huge, some of the objects were considered to be impossible to renovate. According to the foreign experts due to the enormous destruction of the Dnieper Hydro power station, it was impossible to be recovered. However, colossal work was done to restore the 'Dniprohes'. Despite pessimistic forecasts Dnieper HPP was restored and connected to the grid in the first half of 1950 (Denysevych et al., 2011). The recovering, development of the energy infrastructure lasted till the collapse of the USSR. As a result, according to the authors of the above named book, in 1990 the UES of Ukraine was a very powerful energy unity even on a global level. It was characterized by the following features: the installed capacity of electrical stations reached 55.4 GW, electricity generation – 269.3 billion KWh, electricity consumption was 268.2 billion KWh, and the export of electricity to other countries reached 28.1 billion KWh. The energy system of Ukraine reached its peak in 1990, and after that a period of 20-years recession followed.

Despite a powerful development of the energy infrastructure, the soviet system had a very big disadvantage, which influenced the development of the post-soviet energy system of Ukraine. T.Buryachok (2011) researches the problem of the low level of energy efficiency in Ukraine. Energy inefficiency is the main difficulty, which the country faced on its way to developing the economy. This thesis explores the problem in the chapter 3, however it is worth mentioning that the roots of this problem go back to the soviet times. Ukraine used to be an outpost of the industrialization, which was based on cheap fuel. Gas used to be cheap because of the artificial price regulation; it means that the prices were considerably lower than they were on the market. Ukraine's energy intensity of gross domestic product was 25% higher than in the other soviet countries and 150% higher comparing to the US. When the whole civilized world understood the importance and the necessity of

energy saving and energy efficient consumption, no efforts were made in the USSR towards this direction.

These factors were very important in influencing the current condition of energy system of Ukraine. The political nomenclatures, which have been on the political arena in Ukraine since 1991, have not done much towards the more sustainable energy consumption or development of energy power sector. All of them were successors of the soviet nomenclature and it appeared too hard for them to break the system and to switch to the new methods and approaches of managing the new economic and political situation.

After collapse of the USSR, Ukraine faced a great economic recession, which resulted in a decrease of electricity demand. This fact, obviously, influenced low level of electricity production both for inner consumption as well as for export. The condition of Ukrainian electrical system was quite difficult until 2000. After that the electrical engineers managed to stabilize and improve the condition of the UES. Major roles which help the energy of Ukraine to go out of crisis played two factors: the first one was the nuclear power plants of Ukraine and the second one was its powerful network voltage of 750 kV.

The nuclear power stations produced 50% of the electricity, while thermal power stations experienced lack of fuel and could not work on the level of the installed capacity (Denysevych et al., 2011: 279-280). The majority of nuclear power stations were built in the western part of Ukraine, while the East obtains thermal power stations, which are based on the use of organic fuel. The last ones provide with the electricity the major industrial centres of Eastern Ukraine. In case of organic fuel shortages, the East of Ukraine would be seriously endangered, however due to the existence of the high voltage network of 750 kV, it is possible to transfer to the scarce eastern regions the surplus of the electricity, produced in the western areas.

2. Energy system of Ukraine

2.1 Energy industry in Ukraine

The energy system of Ukraine is based on the following components: Electricity system, oil-gas system, oil-transport system, coal. The Ukrainian energy system used to be very powerful and good diversified, which goes back to the times of the USSR. The problem of today is the low technical condition of the system and non-correspondence to the current challenging in terms of sustainability and, what is more important, to the national security and energy security of Ukraine. First of all it

is essential to describe the condition of the current energy system and to make an overview of the reasons, which have the biggest impact on the development of the energy system.

The total installed capacity of power plants at the beginning of 2001 amounted to almost 53GW, among them there are thermal power plants (TPP), which accounted for 36.4 GW(or 68.8 %), nuclear power plants (NPPs) - 11.8 GW (22.3 %), hydropower plants (HPP) - about 4.7 GW (8.9 %), wind power plants (WPP) - 14 MW (0.026 %).

Ukraine inherited relatively powerful but at the same time very inefficient fuel and energy system. It has problems of structural formation; it is too much oriented on gas imports and is highly inefficient. “Ukraine is one of the top European energy consumers. Compared to Germany for example, it consumes almost double the energy per unit of GDP. Ukraine has a gas reserve estimated at about 1 tcm. Nevertheless, it still imports about 64% from Russia of the gas it consumes (2010). In addition about 80% of the Russian gas imports travel through Ukraine and thus Ukraine is a very important transit country, for basically all of Europe”[1].

The information on the website of the EBRD shows that Ukraine has difficulties with energy efficiency and the main prerequisites for this problem are the consequences of centralised economy, ineffective dependence on heavy industry: “The legacy of central planning, with its absence of market signals, reliance on energy-intensive industry and, in some countries, abundance of energy resources, combined to make energy usage in the region wasteful and carbon-intensive” (European Bank for Reconsruction and Development n.d.)[2]. It is clear, that, being a Soviet state, Ukraine’s economy was based on a heavy industry, which, in its turn, consumed a lot of energy, because back in the soviet time energy used to be very cheap. Nowadays, when the prices for energy are very high, industry suffers and the economy of the country suffers as well.

2.1.1 Electricity System

The main key-players, who are in charge of managing the electricity sector of Ukraine are: the Cabinet of Ministers of Ukraine, the Ministry of Energy and Coal Industry of Ukraine (MECI), the National Electricity Regulatory Commission of

[1] Energy Delta Institute. Ukraine http://www.energydelta.org/mainmenu/energy-knowledge/country-gas-profiles/ukraine

[2] European Bank for Reconstruction and Development.
Securing sustainable energy in transition economies p.7
http://www.ebrd.com/downloads/research/brochures/sse.pdf

Ukraine (NERC)[3], the State Nuclear Regulatory Committee of Ukraine, and the State Agency for Energy Efficiency and Energy Conservation (SAEEEC) (Ministry of Energy and Coal Industry of Ukraine , 2012).

The electricity system is usually referred as united energy system of Ukraine and is integrated into the company “Ukrenergo”. National Power Company" UkrEnergo" is a vertically integrated, naturally created monopoly in electricity transmission. Enterprise is the state company of the electricity industry and acts as a government business enterprise established in the public domain, and is a subject to the Ministry of Energy and Coal Industry of Ukraine. The structure of the company is built on a regional basis and brings together 8 power systems (Dnieper, Donbas, Western, Crimea, South , South- West, North and Central power system), which control 32 subdivisions of the main and interstate electrical networks. "Ukrenergo" is a technological link that unites producers of electricity, which are nuclear power generating companies (NPP), thermal power plants and hydropower plants (HPP) and regional power distribution companies; the company interacts with the power systems of neighbouring countries, providing export and import of electricity. The level of per capita electricity consumption is an important indicator of living standards of the population. In countries with high living standards it is in the range of 6-12 MW hours per year. Thus, in France, where the population is about the same as in Ukraine, the figure is 8,200 kWh. Unfortunately, in Ukraine this figure decreases from year to year: in 1990 it was 5630, and in 2000 it was 3530 kWh, i.e. it was a decrease in 1.6 times.

The electricity consumption in Ukraine in 2007 was 3399.52 kWh per capita, primary consumption per capita in 2007 was 2973.24 kg? of oil equivalent (Konrad Adenauer Stiftung 2010). The electricity consumption per capita in 2009-2013 was 3662 kWh.

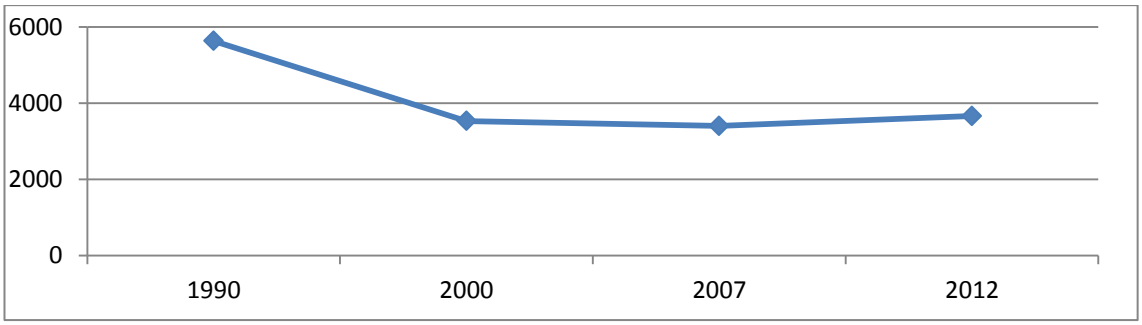

Figure 1. Electricity consumption per capita in Ukraine kWh

[3] NERC was abolished by the presidential decree from 27 August 2014. Instead it was created the National Commission for State regulation in energy and utilities.

The core of the Ukrainian power system is the united electrical system (UES) of the country, which provides electricity to domestic customers and conducts its exports and imports. UES has eight regional power systems, which are connected to each other by the transmission lines (Saprykin 2001). More than 1 million miles of power lines are in operation. The distribution of electricity is carried out in UES JSC by the 24 regional power distribution companies and companies in Crimea, Kyiv and Sevastopol. The unclear political situation in Crimea makes the things different as the peninsula is connected with the continental part of Ukraine by the electricity lines. The characteristics of the electricity supply system of Ukraine. The main suppliers of electricity in Ukraine are: electricity generation facilities, transformation and electricity transmission facilities, system of regulation of electricity supply. The basis of the electricity supply is the United Energy System of Ukraine (UES). UES is a set of power plants, electrical and heating systems and other energy facilities, which share a common mode of production, transmission and distribution of electric and thermal energy and are being controlled via centralized management. The transmission lines have the power of 220, 330, 400, 500 and 750 kV AC and 800 kV DC (Cabinet of Ministers of Ukraine, 2011). The Energy Strategy of Ukraine till 2030, which was revised and adopted on the 23.07.2013, states the following: “UES of Ukraine operates in parallel with EEC/UPS, except for so-called "Burshtyn Island" (includes Burshtyns'ka TPP, TPP Kalush and Tereble-Riksku HPP), which is synchronized with the European Network of Transmission System Operators for Electricity (ENTSO-E)” (Energy Strategy of Ukraine till 2030, 2013).

Figure 2. High-voltage transmission lines 750 kV

Source: http://energetika.in.ua/

"In 2010, the total volume of electricity consumption in Ukraine, which was 144.7 TWh, almost reached the pre-crisis consumption level of 2007 (147.4 TWh). A decrease of electricity consumption in 2010, as compared to 2007, was only 1.8%. At the same time, the decrease in electricity consumption by industry in 2010, as compared to 2007, was 6,.%. Electricity consumption by households increased by 29.4% during the same period. To sum up, the structure of electricity consumption in 2010, when compared to 2007, saw significant changes in weighed electricity consumption by power–intensive groups of customers. Weighed electricity consumption of industry decreased from 50.8% in 2007 to 48.2% in 2010, and that of households increased from 20.1% to 26.5 %."According to this data it is clear that due to different reasons, the electricity consumption by the industry decreased, at the same time the households increased their consumption. According to the forecast this number can increase to 47.7 % in 2015 (Ministry of Energy and Coal Industry of Ukraine 2012).

Ukraine is a country with powerful nuclear stations. Ukraine has the following NPP: Zaporizhzhya NPP, Khmelnitsky NPP, Rivne NPP, South-Ukrainian

NPP(Yuzhno-Ukrainsk), Tashlyk, Olexandrivsky NPP, "Chornobyl NPP". The hydro-power is represented by the 8 HPP: Kyiv HPSPP, Kyiv HPS, Kaniv HPS, Kremenchuk HPS, Dniepro HPS, Dniepro HPS-1, Kakhovka HPS, Dniester HPS. Two stations are in the construction: Dniester HPSPP and Kaniv HPSPP.

According to the data from the Ministry of Energy and Coal Industry of Ukraine (Ministry of Energy and Coal Industry of Ukraine 2012) and there the following power plants, which exist in Ukraine:

Table 1. Installed capacity of power stations of Ukrainian Energy System

Type of power plant	Installed capacity, MW	Percentage %
Thermal power plants (TPP)	30 536,1	61%
Nuclear power plants (NPP)	13 835,0	27.6%
Hydro power plants (HPP)	4 596,6	9.1%
Hydro storage plants (HSP)	861,5	1.7%
Renewable sources	156,1	0.3%
Total	49 985,3	

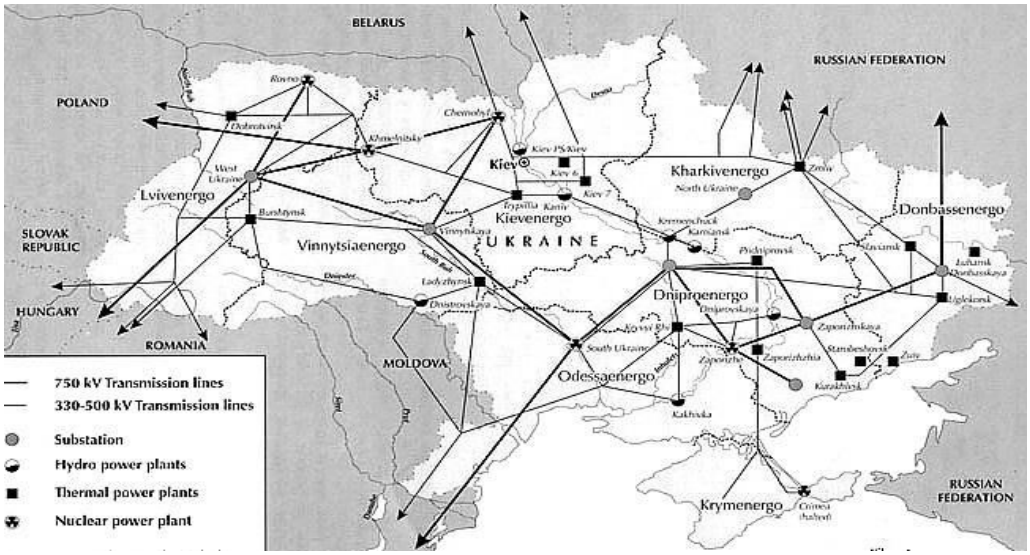

Figure 3. Energy grid of Ukraine

In the abovementioned statement it is said that there are five power-generating companies. They are: “Dnyproenergo”, “Donbasenergo”, “Tsentrenergo”, “Zahydenergo”, “Skhydenergo”. They integrate 14 powerful TPP with power blocks of individual capacity of 150, 200, 300 and 800 MW.

“The total number of power generating units at TPP and HPP equals to 102 units, including: with capacity of 150 MW – 6 units, 200 MW – 42 units, 250 MW – 5 units, 300 MW – 42 units and 800 MW – 7 units. The most powerful TPPs (Zaporyzhska and Uglegorska) have an installed capacity of 3 600 MW each.” The thermal power stations mostly use coal as the source of converting energy to heat and electricity

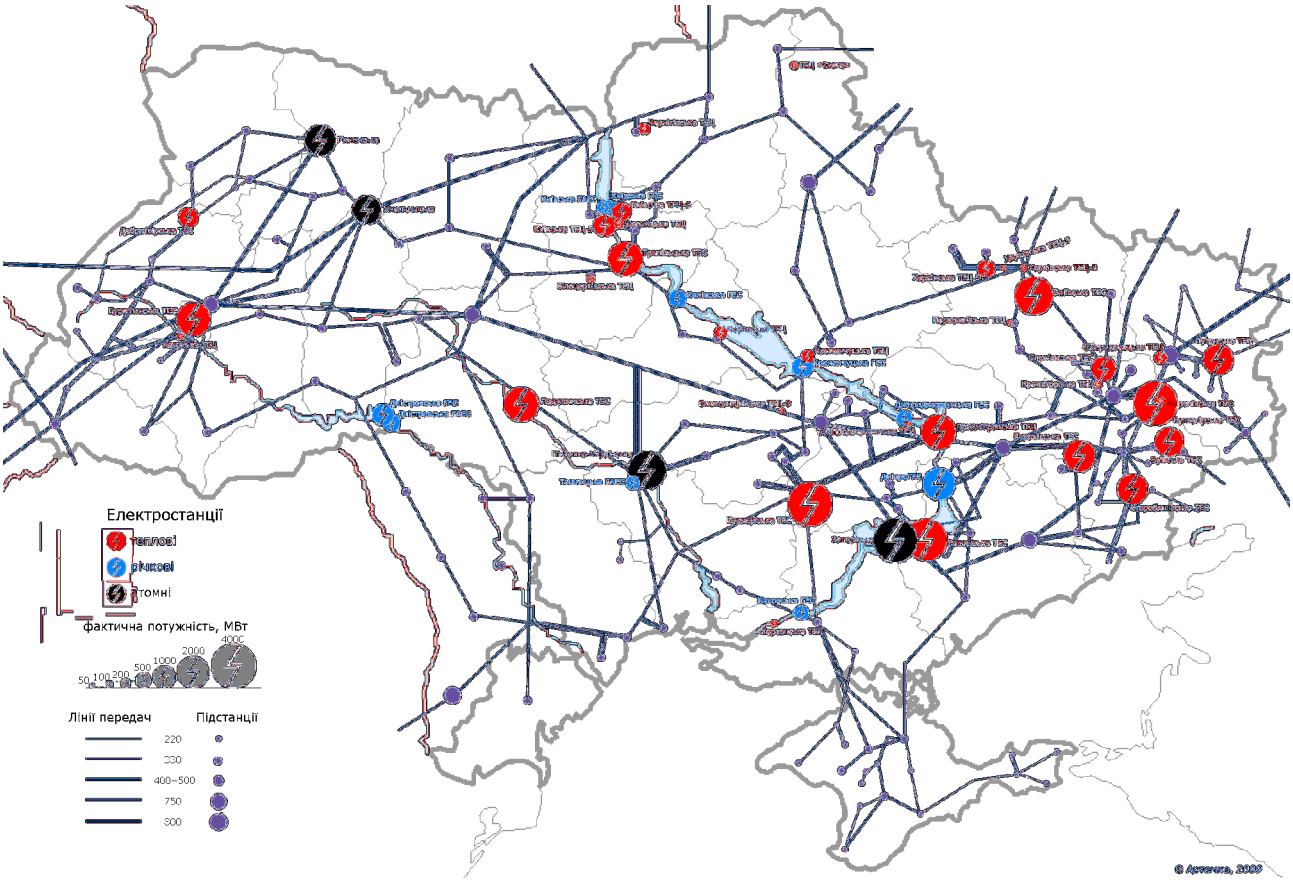

Figure 4.The map of power stations of Ukraine

2.1.2 Thermal power plants and the Coal industry

Coal industry is very important for Ukraine, especially in the reality of a high dependence on imported gas. Coal is used by thermal power plants as the main fuel and thus this type of fossil fuel is of a high significance for the energy system of Ukraine. Ukraine obtains considerable reserves of coal: according to the data from

the “Coal Information 2012” (International Energy Agency, 2012), Ukraine is the 14th world’s biggest producers of coal.

Table 2. Major coal producers* [Mt]

	2009	2010	2011e
PR of China	2 895.3	3 140.2	3 471.1
United States	987.6	996.1	1 004.1
India	566.1	570.4	585.9
Australia	411.6	424.1	414.3
Indonesia	291.2	325.0	376.2
Russian Federation	276.0	321.7	333.8
South Africa	249.5	254.5	253.1
Germany	183.6	182.3	188.6
Poland	135.2	133.2	139.2
Kazakhstan	100.9	110.9	116.7
Colombia	72.8	74.4	83.8
Turkey	79.5	73.4	78.1
Canada	62.9	67.9	67.1
Ukraine	55.5	55.4	61.8
Greece	64.9	56.5	58.8
Czech Republic	56.4	55.2	54.4
Other	*346.4*	*359.9*	*391.4*
World	**6 835.6**	**7 201.1**	**7 678.4**

* Production includes recovered slurries.

In the report made by the Baker Tilly International, a network of business advisory firms, it is stated that “Ukraine is the fourth-largest coal producer in Europe (85.8Mt excavated in 2012) after Russia, Germany and Poland. With PCRs of some 33.9 Billion tons, the Ukrainian coal industry accounts for 4% of the global coal reserves. This is enough to support the current levels of coal production in the country for more than 390 years” (Baker Tilly International, 2013). The structure of the coal reserves includes near all types of coal, beginning from brown and up to anthracite. In the report made by the Razumkov centre it pointed out that the hard coal in Ukraine is characterised by high percentage of ash content and significant sulphur content (content of ash —25%, sulphur — 2.5%). This fact says that the extracted coal requires treatment in order to make it marketable (Razumkov Centre, 2003). The main coal basins lie in the following regions of Ukraine: Donetsk, Luhansk, Dnipropetrovsk, Lviv, Kirovohrad and Volyn. Below there is a map with the graphically indicated regions (Razumkov Centre, 2003):

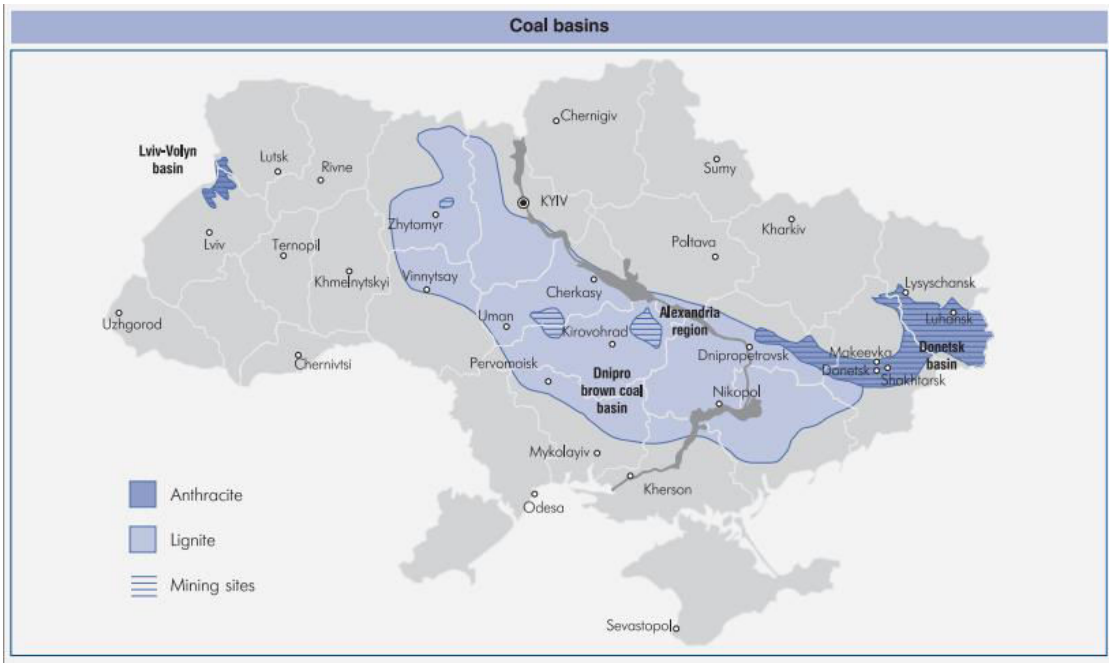

Figure 5.Coal basins of Ukraine

In the Baker Tilly International report the following trends in the inner market were stressed out:

“Over the last 12 years, the Ukrainian coal production volumes fluctuated from the minimum of 73.8Mt in 2009 to the maximum of 86.8Mt in 2011. The domestic coal consumption remained relatively stable at above 50% of the production volumes. Product-wise, the domestic coal market is made up of two key segments: steam coal, which is used primarily for energy generation and coking coal, which is used mainly for steel-making. The Ukrainian coal market is defined by a deficit of the coking coal, by an excess supply of the steam coal of anthracitic group and by the deficit of Grade ‘T’ lean coals demanded by the power generators” (Baker Tilly International, 2013).

Ukraine's coal industry is a diversified industrial-economic complex. It includes companies-holdings, industrial associations, independent mines, industrial associations of coal enrichment, mines construction plants, a developed a network of scientific and industrial associations, research, design and planning organizations (Bondarenko, 2006).

As it is seen from the above mentioned information, Ukraine has considerable resources of coal. One of the goals of my work is to show that that Ukraine being a large coal producer can decrease the gas dependence by the rational use of energy resources for energy production. The role of thermal power plants in the electricity production is near 50%, however the poor technical condition of the plants,

electricity lines, and equipment make the energy production inefficient, contributes to the ecological problems and does not solve the problem of the energy security of Ukraine. The main TPP were built in the period from 1940 to 1960s. Modernization or retrofitting will not solve the problem as the technology has gone far beyond since then. The old plants are very inefficient and cause a lot of ecological disturbances for the population and workers. The ideal option is to shut down the old stations and to build the new ones. This theory is elaborated more detailed in the next chapter.

Table 3.Thermal Power Plants of Ukraine

Name	Capacity, MWe	Units	Primary Fuel type	Otput	Year of construction
1. Kurakhovka thermal power plant	1,482	7x200	coal	electricity	1941
2. Severodonetsk Plant Powerplant	150	1	coal	Electricity and heat	1952
3. Myronivsky power plant	100	0	coal	electricity	1953
4. Luhansk thermal power plant	1,5	1x100+ 7x200	coal	electricity	1956
5. Dobrotvirska thermal power plant	600	3x100+ 2x150	coal	modern cogen	1959
6. Prydniprovska thermal power plant	1,765	4x150+ 4x300	coal	modern cogen	1959
7. Zmiivska thermal power plant	2,175	6x200+ 4x300	coal	modern cogeneration	1960
8. Kryvorizka thermal power plant	3	10x300	coal	electricity	1965
9. Trypilska thermal power plant	1,8	6x300	anthracite (oil fuel, natural gas)	electricity	1969
10. Ladyzhinska thermal power plant	1,8	6x300	Brown Coal	modern cogeneration	1970
11. Slovianska thermal power plant	800	1x800	coal	electricity	1971

12. Vuhlehirska thermal power plant	3,6	4x300+ 3x800	coal, natural gas	electricity	1972
13. Zaporizka thermal power plant	3,6	4x300+ 3x800	coal, natural gas	electricity	1973
14. Zuyiv thermal power plant	1,245	4x300	coal	electricity	1982
15. Starobeshivska thermal power plant	1,725	10x200	coal	electricity	1954-58
16. Burshtynska thermal power plant	2,4	12x200	coal	electricity	1965—1969

However, thermal power stations of Ukraine have a row of problems, which need to be solved. One of them is the high emission level of sulphur and nitrogen oxides. As it is stated in the Cabinet of Ministers Directive, the vast majority of thermal power plants in Ukraine were commissioned in 1960-1980 years. At that time, the concentration of pollutants in the flue gases was not a subject to restriction. The flue gases were cleaned only from the ash in the electrostatic precipitators or wet type devices. Approximately 92% of the units have exceeded their design life (100 thousand hours), 64% of which were below the limit resource and physical deterioration (200 thousand hours). The energy strategy of Ukraine foresees modernization of the existing plants. This issue requires careful consideration. “Knowing the fuel balance of Ukraine, the reconstruction and modernization of boilers with steam parameters of 10 MPa, 540 ° C and higher it is discussed a possibility to switch them to burning of a waste coal and high-ash coal. Gas fuel oil boilers of TPP and CHP should be modernized by low-cost measures (replacement of individual units, heating surfaces, installation of efficient burners, etc.), which aim at increasing their lifetime and improvement of environmental performance” (Bazeyev et al, 2013). Although this step will prolong the operation for additional 15-20 years and it does not solve the acute problems, such as ecological issues, moreover, the efficiency of these plants is still very small the average is not more than 35%. “At the same time during the last half century the new technologies in the field of thermal power have been developed. They were designed using the powerful steam at supercritical steam parameters, including sulphur purification systems, boilers with low-temperature fluidized bed, circulating fluidized bed and fluidized bed

under pressure for steam plants on solid fuel, etc. These new technologies can significantly raise efficiency of thermal power plants' units, and reduce harmful emissions to the environment, to engage waste coal in the fuel balance" (Bazeyev et al, 2013).

The idea of retrofitting of the old power plants cannot a good solution and the following arguments answer why:

1. It is questionable whether the costs invested into the old plants can be returned because of the possibility that the plant can stop functioning due to the poor condition
2. Recovery time cost vs benefit ratio is quite questionable
3. Absence of the parts for the old plants makes functioning of the plant problematic
4. No end-pipe technologies which leads to high pollution rates, etc.

The last statement is also of a high importance and needs to be studies very carefully. In Ukraine the average efficiency of the power plants is around 32%. Installing of the end-pipe technology on the low efficient power plants is economically not feasible due to increasing of the electricity consumption and lowering of the efficiency of the power units and due to the high operation costs. At the same time it should be said that the terrible environmental conditions in the area, where the power plants are situated, is the cause of severe diseases among population and employees, contamination of the soil, which makes it not usable for agriculture and other serious problems (Gazizullin et al., 2011).

2.1.3 The oil and gas system.

The oil and gas systems are operated by the state company Naftogaz of Ukraine. As it is stated on the company's website "Naftogaz of Ukraine produces one eighth of the gross domestic product of Ukraine and provides one tenth of the State budget revenues. Naftogaz of Ukraine processes gas, oil and condensate at the Company's five gas processing plants, which produce LPG, motor fuels and other types of petroleum products. The Company has its own brand filling station network."[4] The following information is also stated on the Internet-page of Naftogaz: The oil and gas energy industry is the basis for the sustainable economic and social development of the country. Since its foundation National Joint-Stock Company Naftogaz of Ukraine has had an important place in the fuel and energy sector of Ukraine. Naftogaz of Ukraine performs the complete cycle of operations from

[4] The National Joint Stock Company Naftogaz of Ukraine http://www.naftogaz.com/

exploration and development of deposits, exploratory and operational drilling, transportation and storage of oil and gas, to supplying natural and liquefied gas to consumers. Over 90% of oil and gas in Ukraine is produced by the company.

Ukraine currently produces 34% of its domestic demand for natural gas and 10-15% of its domestic demand for oil from its own natural hydrocarbon resources (2011). The rest must be imported. Natural gas is primarily imported from Russia, while oil and oil products are imported from Russia, Kazakhstan, Belarus, Azerbaijan, the Baltic states, and in minor amounts from other countries." The structure of the gas budget distribution (2011) within the country is the following (Energy Charter Secretariat, 2013):

Sector	Allocations, %
Industrial enterprises	46.5
Households	28.8
Municipal heat and energy companies	14.0
SC "Ukrtransgaz"	7.5
Oblgazi	1.7
Budgetary institutions (public entities)	1.5

Source: "Statement on Security of Energy Supply", Ministry of Energy and Coal Industry of Ukraine, Kyiv, January 2012

Figure 6. The structure of gas budget distribution

Ukraine is a large centre of gas and oil transit from Russia to Europe. Ukrainian gas-transmission system (Figure 1) was inherited from the USSR. The GTS is capable to accept a feed of up to 290 bcm of natural gas and to transfer 178 bcm to exits, including 142 bcm to Western and Central European countries. Approximately 80 % of Russian gas is supplied to Europe through Ukraine.

The role of Ukrainian gas-transmission system is very important, as it use to be the main transit route of the Russian gas to the European countries. In the article "Ukrainian Gas Transmission System "Renovation Project: Reliability and Efficiency of Gas Transit to Europe" the author Lokhman states: "Russian gas export to the countries of Western and Central Europe and Turkey is carried out by three basic routes: through the gas-transmission system (GTS) of Ukraine, by the Yamal-Europe gas pipeline over the territory of Belarus and by the Blue Stream gas pipeline across the Black Sea." Ukraine transports Russian natural gas to 18 European countries: Austria, Bulgaria, Bosnia, Greece, Italy, Macedonia, Moldova,

Romania, Germany, Poland, Serbia, Slovakia, Slovenia, Hungary, France, Turkey, Croatia and Czech Republic[5].

The gas-transporting system of Ukraine consists of 39.8 thousands kilometres of gas-pipelines, 74 compressed air plants, 1600 gas-distribution stations, 13 gas storage stations and the objects, which provide the functioning of the system. The gas storage system of Ukraine is one of the biggest in the World and consists of 13 objects. The active gas volume of the storage is 31.95 billion cubic meters. The gas storage daily capacity is 250 million cubic meters. Ukraine occupies the 3d place in the World and the 2nd in Europe according to the active gas volume capacity (State Emergency Service of Ukraine, 2013).

The main functions of Ukrainian GTS are:

- gas transit through the territory of Ukraine to European countries
- natural gas transmission to Ukrainian customers.

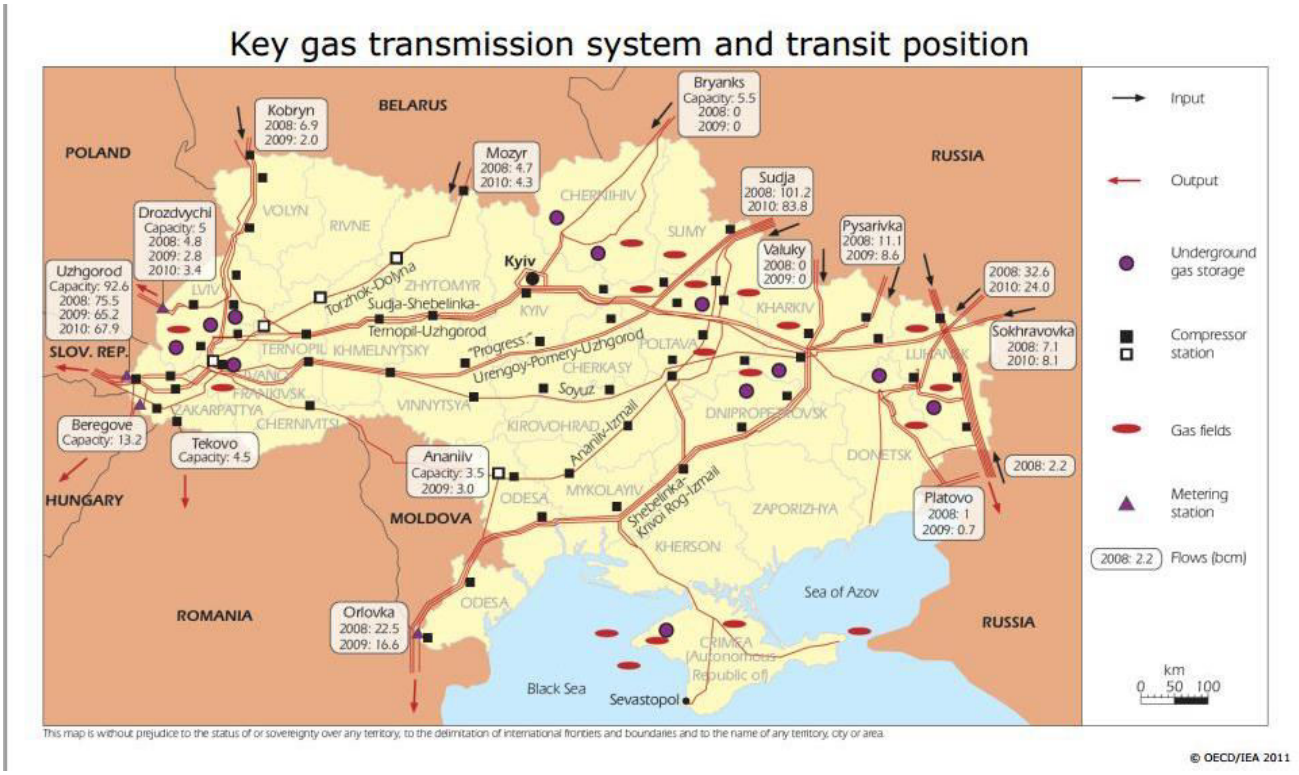

Figure 7. Gas Transmission System of Ukraine

Ukraine is one of the largest natural gas consumers Europe, its consumption is about 55-60 bln. m3 of natural gas per year, where the import constitutes 65-70%.

Certain rules, which were normally regulated by the state, have the tendency to be demonopolized and to switch to market-type of regulation. Thus, outlines

[5] The National Joint Stock Company Naftogaz of Ukraine http://www.naftogaz.com/

Kolbushkin in his article “Development of gas market of Ukraine”, “the industrial consumers got right to select independently the gas supplier since March 1, 2012 (while de facto they have this right since April 2011); governmental organization – since January 1, 2013; heat supply companies (only those which supply heat to household) – since 2014, and household users – since 2015” (Kolbushkin, 2013: 8). The author also states that sue to cancelation of the Resolution of the Cabinet of Ministers of Ukraine of March 5, 2008 "On the realization of imported natural gas in Ukraine", the new opportunity for the Ukrainian natural gas imports market was opened to other businesses. He makes a conclusion that “in case of proper compliance with national standards, consumer and environment protection, any company is free to trade natural gas at the domestic market of Ukraine.” (Kolbushkin, 2013)

2.1.4 Oil-transmission system

The oil-transportation system of Ukraine is a system of piplines, which transport oil. The network of pipelines is managed by the JSC UKRTRANSNAFTA and includes the following pipelines:

- Oil-trunk Pipelines “Druzhba”
- Pridniprovski Oil-trunk Pipelines
- Pivdenni Oil-trunk Pipelines

The pipelines total lengths is 4767 km with a throughput of 114 million tons per year (input) and 56.3 million tons per year(out) . It has 51 pumping stations, 11 tank-farms with total capacity of 1 083 thousand m3.

Figure 8. Current routes of oil supplies via oil pipelines

Source: http://www.encharter.org/

Ukraine is largely dependent on Russian oil. The official web-site of Naftogaz states the following: ”Crude oil from Russia is delivered to oil refineries in Ukraine and exported to Central and Western Europe via this network of Ukrainian pipelines. Ukrainian oil is also transported by main oil pipelines to Ukrainian oil refineries.”[6]

2.1.5 The energy strategy of Ukraine till 2030

The current Energy strategy of Ukraine was adopted in 2006. However, due to the row of issues it was revised after the public consultations and the amendments were adopted in 2013. The heaviest reasons for revising the documents are energy efficiency, competition for efficient resource utilisation and environmental protection. As it is stated in the Energy Charter Secretariat’s paper, the “strategy update was also driven by changes in the domestic economy of Ukraine and the recognition that the 2006 strategy was not delivering the targeted level of power station and transmission system upgrades. Other important reasons given were the accession to the EnC, and the impact of the financial crisis on the economy and on energy demand and supply” (Energy Charter Secretariat, 2013).

[6] Naftogaz. Hydrocarbons Production http://www.naftogaz.com/

The Strategy distinguished the following problems and challenges:

■ As of the situation by the end of 2012, 81% of the units of thermal power stations exceeded the limit of physical deterioration of 200 thousand hours of operating time and need modernization or replacement. Depreciation of equipment leads to over-consumption reduces operating capacity and has negative impact on the environment;

■ Nuclear power stations are approaching their operation time. More than 70% of nuclear power stations will require the extension of the operation in the next 10 years;

■ Balance of power grid is characterized by a deficit of manoeuvrable and regulatory capacity; share of hydro power plants does not exceed 9 %, when the optimal level is 15 %. As a result, thermal power stations and CHP are used to support variable load demand of the power system, although they were designed for the use in basic mode;

■ Today 42.2% of overhead power lines (EPL) 220-330 kW have been in operation for more than 40 years; 64.4 % of the basic equipment of transformer substations worked out their service life;

■ Significant problems arise because of the lack of capacity of power lines for the power output of the nuclear power plants (Rivne , Khmelnytsky, Zaporozhye) and transfer of excess energy from the Western region to the center and east of the country; there are problems with insufficient energy security in Crimea, Odessa and Kyiv ;

■ 40.5% of electrical networks and 37.6% of transformer substations require reconstruction or replacement.

The main ideas which characterize this version of the strategy are:

- The capacity of the renewable energy sources should reach 639 GW (excluding hydro power) by 2020, which is approximately 11.6% of total energy production.
- The new thermal power plants with the total capacity of 9 GW have to be constructed by 2030 and modernization of the current ones. The total investments should account 132 billion hryvnas (8.09 billion Euros as of the October 2014).
- The total amount of necessary investments is 1.821 trillion hryvnas.
- Increase of energy efficiency and decrease of the energy intensity of GDP by 54% till 2030

The Strategy is still far from perfection as even if all the statements are fullfilled Ukraine will still be the lagging in the row of European countries. However the strategy itself does not bind the governments with strict implementation, but is rather a guide for action.

2.2 Energy factor in political and economic relations

When talking about any economic transformation in Ukraine, it should be mentioned that there is a big influence of the political factor on this issue. Ukraine used to be an important part of the USSR. That is why the strong ties with Russia are still felt in all the spheres of economy and politics of the independent Ukraine. The political crisis in the relations between these two countries of 2014 has become the peak of the complicated history of these affairs since 1991.

The high dependence on energy import from Russia is an important factor of the political and economic relations of Ukraine with the EU and other countries. The EU has used the gas from the former USSR since 1970 and naturally hasn't stopped using it after the Soviet Republic has collapsed. The partnership between EU and Russia has involved an independent Ukraine as it transported the majority of the imported by the EU gas from Russia. However Ukraine used to be more an object in these relations rather than a subject. This status was influencing the role of Ukraine in the international arena, however now always in a good way. The most well-known events, which showed the problems in the triangle Ukraine-EU-Russia happened in 2006 and 2009.

The energy factor is very important on the European continent. This aspect of the multilateral relations plays the crucial role in arranging the relations among the countries and determined the roles of the state actors on international political arena. The tight bounds to Russian gas pushed the EU toward involving this country intro the common network of economic relations. The attempt to integrate Russia into the market, make investments and thus build a system of partner-cooperation was not really accepted by the Russian side. Russia wanted to limit the EU-Russia energy cooperation to "technical question and day-to-day issues" (Mangott and Westphal, 2008)

"Unlike in the case of exports, re-orientation of imports away from Russia has been less pronounced due to the country's high dependence on energy deliveries, and Russia has been consistently ranking as Ukraine's biggest source of imports, with a share of some 25-30% in the last few years. " (Astrov, et al. 2010)

Ukraine is quite rich in natural resources; however the poor condition of the technology makes the development and extraction of the resources sometimes inefficient and sometimes just does not allow starting even the exploration.

The exploration of the Black Sea shelf showed that Crimea is a very attractive region in terms of gas and oil resources. According to the analytical research made by Olexandr Laktionov in 2012 (Olexandr Laktionov 2012), the black sea shelf exploration near Crimea has quite considerable reserves of the fuel resources.

"Natural gas is the main fuel in the majority of combined heat and power stations. All electricity and heat generation (for all customer groups except households) at thermal power stations and combined heat and power stations is based on imported natural gas. The key aspect of Ukrainian energy policy is to increase the share of nuclear power and locally extracted coal in the energy budget, and to decrease the share of imported oil and gas." (Ministry of Energy and Coal Industry of Ukraine 2012)

The energy factor plays an important role in the relation between Ukraine and the EU. The geographical position and the fact that the majority of Russian gas travelled through the territory of Ukraine, forced European Union to integrate Ukraine into the bilateral cooperation programs in nuclear safety, the integration of gas and electricity markets, the security of energy supplies and the transit of hydrocarbons, the coal sector and energy efficiency. In the paper "In depth analysis" it is said the following: "Cooperation in the energy sector is a key element in EU-Ukraine relations within the framework of the Eastern partnership. A memorandum of understanding (MOU) was signed on 1 December 2005 in the context of the implementation of the EU-Ukraine Action Plan. The MOU establishes a joint strategy towards the progressive integration of the Ukrainian market with that of the EU: its substance is a series of five roadmaps covering i) nuclear safety, ii) the integration of gas and electricity markets, iii) security of supply and the transit of hydrocarbons, iv) the coal sector and v) energy efficiency " (Energy Charter Secretariat, 2013: 13,52).

2.2.1 The Ukraine crisis 2014 and the energy security problems

The political crisis in Ukraine apart the politics itself, has risen an important issue of energy insecurity and dependence on imported fossil fuel resources. Although the problem of energy security of Ukraine has been risen by the majority of Ukrainian and foreign experts, a almost nothing has been done during the last 20 years in

order to avoid the problms, which Ukraine eventually has faced. These are the steps, which can be done in order to lessen the political influence on energy security:

- LNG
- switch from gas to coal in industry;
- diversification of energy resources;
- gasification of coal;
- non-traditional gas (shale gas)
- reverse of gas
- investments into the energy efficiency
- Alternative energy as a long term strategy
- Renewal of alternative routes like “white stream” or similar

However, there are several issues, which may arise and influence implementation of the above mentioned plan:

- uncertainty in quantity of shale gas reserves
- resistance from Gazprom
- high prices on energy resources and low investments
- problems of low coal quality
- nuclear energy does not have the investments and is very cheap

One of the popular ideas how to lower the dependence on Russian gas is to import the liquefied natural gas from other countries. For example the United States could the country, which could export the natural gas to Ukraine. However, the difficulty is that the LNG terminal has to be built, which requires some significant investments and time. Although it is rather long term perspective than the today’s reality, Ukraine should definitely take steps towards building the terminals and thus prepare the alternative option for importing gas from Gazprom.

I suggest dividing the steps into two groups according to the priority and possibility of implementation: long term steps and short term.

3. Short term perspective for Ukrainian energy system

I will start will the short term tasks, whose main goal is to make the first steps toward energy independence and which are the most important in the current conditions of political and economic situation in Ukraine.

3.1 Increasing energy efficiency as a key factor to energy stability

The role of energy efficiency in energy strategies of countries is very important. Energy efficiency is considered to be the crucial component in realization of the strategies on energy independence. Ukraine is not an exception in this row of countries, willing to guarantee their energy security. In this regard I would like to mention that energy security and energy independence are not equivalents. However, in this chapter I would like to analyse the role of energy efficiency component in the energy system of Ukraine.

Primarily, it is necessary to understand the meaning of the terms, which we are going to use here. First of all, let us describe what energy efficiency and energy saving mean. Energy efficiency and energy saving are similar terms, but not identical. The European directive 2012/27/EU explains these two terms as follows: "*'energy efficiency'* means the ratio of output of performance, service, goods or energy, to input of energy; '*energy savings'* means an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of an energy efficiency improvement measure, whilst ensuring normalisation for external conditions that affect energy consumption" (Directive 2012/27/EU Of The European Parliament And Of The Council On Energy Efficiency, 2012). The Ukrainian Law on Energy Saving (1994) determines only the term energy saving and according to my best knowledge there is no term 'energy efficiency' in the legal documents. However you can easily see such terms as 'energy efficient project". '*Energy saving'* is understood as an "organizational, scientific, practical, informational activity, which aims at rational use and economical consumption of primary and secondary energy resources as well as natural energy resources in the national economy and which is implemented using technical, economic and legal methods;" (Verkhovna Rada of Ukraine, 1994). This definition is much wider than just simple saving of energy, this term has also elements of the energy efficiency meaning.

The short-term perspective for Ukrainian energy system is seen as a platform for preparation for innovative ideas and radical changes in the old inefficient structure. As the first steps I see the following:

- Improve the legislation and fight with corruption
- To increase the energy efficiency in households
- Study carefully the price regulation and adapt its implementation to the social situation in Ukrainian society

- Creation of special programs, negotiation with banks in order to develop social programs for funding energy efficient projects for households and business

3.1.1 Energy efficiency in Ukraine: legal regulation

Ukraine started working on the implementation of the energy efficient technologies after it received its independence in the beginning of 90s. However the Law on Energy Saving was adopted just in the 1994. The law focused on the conservation of energy, the term energy efficiency appears only in the context of energy efficiency products or projects, which aimed at decreasing of energy consumption. For the moment there is no separate legislative act on energy efficiency. Apart the mentioned law, energy efficiency is regulated by the following documents: Law of Ukraine "On Alternative Energy Sources", Law of Ukraine "On combined heat and power generation (cogeneration) and Waste Energy Potential" and the Law of Ukraine "On Alternative Fuels". The current legal basis of energy efficiency is amended by documents, which aim to adopt the EU legislative base:

- Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC;
- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC;
- Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings;
- 2010/30/ES Directive of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products;

According to the energy strategy of Ukraine in order to fulfil the Strategy's goals the necessary legislative actions should be developed and adopted:

- Regulatory framework for energy audits, establishing of progressive unit cost standards of energy for housing and communal services, budgetary organizations, business energy service companies;
- The Law "On energy efficiency of buildings";
- The law "On the efficient use of energy resources."

In order to regulate the energy efficiency sphere, the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE) was established. Its goal is

to execute the state policy on efficient use of energy resources, energy saving, renewable energy sources and alternative fuels (SAEE, 2011).

3.1.2 The role of energy efficient technology

I would like to dedicate some of my research to the role of the energy efficiency technology. First of all EE technology reduces the GHG emissions, which apart the direct decrease of negative environmental impacts, allows the countries to sell their quotas according to the Joint Implementation principle to other countries. As it is said in the paper by Ashok and Jas (2010):

"According to the IEA, the implementation of EE policies could result in nearly 36% of avoided GHG emissions by 2050. And, more than two-thirds of these GHG reductions could come from demand-side (end-use) EE interventions across different sectors in developing countries" (Ashok and Jas 2010).

The authors also claim that even with the current technologies it is possible to save up to 50% of energy used in the industrialized countries. The introduction of the EE technologies guarantees the investments return as well, moreover it creates the job places and usually associated with economic growth (Ashok and Jas 2010, 2). This is the point, where I would like to stop and elaborate whether it is possible to apply these statements to the realities of Ukraine. Is it really true that using of the energy saving, energy efficient technologies it will be possible to achieve a decrease of the energy demand, create jobs, to see the economic growth, to reduce the energy dependence on fossil fuels and, possibly, other results.

However, this sphere requires investments, which can have some barriers. Ashok and Jas (2010) define the folowing probable obstacles on the way of receiving the investments into EE technolgy:

- policy regulations
- equipment and service providers
- end user
- financiers

Each of these issues may really have impact on increasing the use of EE in Ukraine. The complicated and not transparent investment market in Ukraine has always been one the main reasons for the foreign investors. However, some world leaders of the EE-equipment/service market are present in Ukraine. Among them there are ABB, DuPont, Schneider Electric and other companies. These companies can be great partners of governmental programs of social energy efficiency projects.

The problem, which they may face, is the low demand for these technological innovations. Ukraine used to be a large industrial country in the times of the USSR and even now is a significant player in this sphere. Such industries as metallurgy, coal, chemistry, oil refining and other are present in the country. However, we have to remember, that Ukrainian industry as a part of the USSR uses gas as fuel, which was a very cheap one at that time. As it was already mentioned, Soviet Union did not pay much attention to the energy efficiency. The modernization of the industry thus requires some significant investments. There is also a physiological aspect as well, since people were raised with the understanding that everything is cheap, including energy, it is sometimes hard to explain the role of energy saving, rational consumption of energy. So, the problem of public awareness should be raised and solved in near future if we want to be sustainable on our way to reduce energy demand. At the same time, the industry does not belong to the state any more. It is private equity in most cases. Businessmen, even those who were born in the USSR, know very well the cost of energy. So to my mind, this segment is the best one to work with on the issue of implementation of energy saving technology.

If in the segment of industry the EE technologies are successfully used, in the segment of households this problem looks quite pessimistic. The situation in this sphere is very different. The buildings are not a private equity of a businessman. The overall understanding of saving energy or installation of energy efficient technologies is developing slowly. Such simple, but at the same time important issue as changing of the windows sometimes cannot be affordable for the big part of the population. In this case there should be state programs, which should subsidy energy efficiency programs. For the clear and evident reasons, which are political and economic crisis in 2014, such programs will lack funding in near future. However, I see it as a challenge for the people as well. According to the new laws, the prices for energy will become higher. And if people do not pay attention at the simple, but rational measures how to reduce energy consumption (in this case by increasing energy efficiency), they will have to pay a lot more than they were used to. In the article “Utility payments in Ukraine: Affordability, subsidies and arrears” the authors claim: “Affordability constraints have been masked so far by unrealistically low energy and water prices (and, in some cases, poor payment discipline). Tariffs will have to go up substantially to make the underfunded networks financially viable again and finance the extensive rehabilitation needs.” (Fankhauser, Rodionova and Falcetti 2008).

The evidence of the efficiency from implementing of EE-technology can be seen on real examples. In the frameworks of the DemoUkrainaDH program, there was implemented a project, which showed high results in reducing energy inefficiency. The project was realized in Odessa Municipality, which consisted of a reconstruction of "boiler house, new burners, modernization of the controls, new pre-insulated distribution pipes, and district heating substations to each multifamily house"[7]. The result of the project is more than satisfying: prior to the modernization the district heating system needed 6.2 million m3 of natural gas per year. The implementation of the district heating substations and the introducing of the energy savings measures, the fossil fuel contribution in the system fell down to by 32%. This fact made available the supply of comfortable heating and warm water to the same quantity of households as (Alfa Laval , n.d.)

In the project it was implemented the 3-circuit system, which consists of hot water along with heat exchangers, condensers, circulation pumps, water treatment equipment and instruments for supervision and control. Hot water (130°C) is used as a medium to carry the energy.

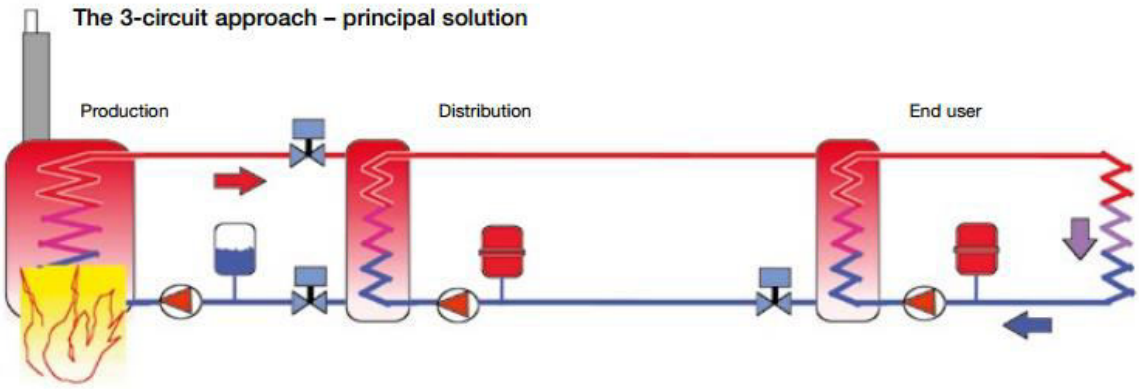

Figure 9. The 3-circuit system

source: http://www.alfalaval.com/

3.1.3 Energy inefficiency problems in Ukraine

Ukraine was one of those post-soviet countries, which did not start modernization in 1990s. "Ukraine is the world's most energy intensive country and the sixth largest per capita CO2 emitter, requiring investment for modernization of

[7] 50% energy savings in district heating project in Odessa, Ukraine http://www.alfalaval.com/industries/hvac/reference-library/search-by-application/district-heating/Pages/District-heating-Ukraine.aspx

production processes and policy changes." (UNDP n.d.) The World Bank characterizes the situation in Ukraine as follows: "Ukraine is one of the most energy inefficient countries in the region and restructuring and upgrading its energy sector continues to be one of the key development challenges for the Government. The sector faces problems maintaining security, reliability and quality of supply due to delays in energy sector reform, poor financial condition of energy sector enterprises, lack of investments, and deferred maintenance in aging infrastructure. These factors threaten the sustainability of economic growth, degrade the environment and increase the cost of social services. Improving them is among Ukraine's top strategic priorities." (World Bank 2014)

The World Bank report also states that there is a problematic issue with the district heating systems, which are operating inefficiently, but have been reliable: boilers have limited metering and temperature controls, which are common in the supply system. "At the same time a big part of customers have no metering or temperature controls. With no controls and costing based on the size of consumer apartments, there is no incentive to avoid wasting energy at the consumer end." (World Bank 2011)

The project of the World Bank to give the loan to Ukraine of USD$200 million indented to increase efficiency not only within the heavy industry, but also on the mid-size level company level as well as municipality. "Finally, the Project is expected to help achieve savings of at least 1 million tons of CO2 emissions annually. It is estimated that at least 1 million tons in GHG emission reduction will come from investments in industries through transformation of the sector." (World Bank 2011)

World Bank is not the only source of the institutions, which finance EE projects. Among them such organizations as EBRD, IFC, EIB, USAID, there are also projects, financed by the EU and even special bilateral projects between Ukraine and other EU countries, among them Germany, Poland.

The problem of energy efficiency is the core problem in the energy security of Ukraine. As it was already stated in the previous chapter, Ukraine is highly dependent on the imported energy resources. It is a threat not only to the energy security, but to the national security of the country, especially taking into account political relations with Russia. Even in case Ukraine could find a possibility to substitute the imported fossil fuel resources by other resources, like to switch to coal and nuclear energy, the high energy demand will always be a source of incompatibility to guarantee energy stability and security.

Ukraine has a very high energy demand and high energy losses. According to the data from the World Bank's report, in 2009 total heat production was 97.9 million Gcal. More than 50% of the total produced amount (52 million Gcal) was consumed by households. The average energy use in heat production resulted in 179.41 kg of coal equivalent per Gcal. Characterizing the heating supply system of Ukraine, it should be said that it is built on the district heating. It is used heat boilers with Combined Heat and Power plants. However the CHP plants require retrofitting as they are outdated. The fuel used in CHP units is as follows: 76-80% - natural gas; 15-18% - oil; and 5-6% - coal. The other weak point is that 20% of all boilers have been in use for more than 20 years. The majority of boilers use aged technologies and the efficiency is about 70-80%. Consequently, they use about 20% more fuel than in boilers used in Western Europe (World Bank 2011).

The work "In-Depth Review of the Energy Efficiency Policy of Ukraine", published by the Energy Charter Secretariat, outlines that the utilities are faced with necessity "to carry out the following actions:

- Invest in modern energy conversion CHPs or district heating plants
- Renew and repair an ageing heat distribution pipe work infrastructure
- Implement a satisfactory consumer metering system
- Collect sufficient billed revenue from cash strapped consumers to finance energy purchases and fund the necessary investment" (Energy Charter Secretariat, 2013)

3.1.4 State Energy Efficiency Economic Program for 2010-2015

The goals of the State Energy Efficiency Economic Program for 2010-2015 (Cabinet of ministers of Ukraine 2010) are:

- Creation of conditions for approaching of Ukraine GDP's energy intensity to the level of developed countries and EU standards, reducing GDP's energy intensity level during the Program for 20% in comparison with 2008 (for 3,3% annually), rising of efficient use of fuel-energy resources and strengthening of national economy's competitiveness;
- Optimization of structure of energy balance of Ukraine by the means of reducing the share of imported organic fossil types of energy resources in it, for example, natural gas, and their substitution with secondary energy resources and with other types of energy resources, including those that were obtained from alternative energy sources. (Austrian Energy Agency n.d.)

3.1.5 Prices regulations

One of reasons for low investments into the EE technology implementation in Ukraine is the low prices for energy. Especially it is relevant in the household sector, where the prices do not cover the net costs. The prices for energy was raised several times, however it did not solve the problem. The reason for this is that the power generating companies, which operate under a regulated tariff, have to sell their products at substantially reduced prices, which do not allow these companies to develop and maintain the capital stock. The main reason of retaining higher prices for natural gas for households is the government's attempts to preserve social stability due to the fact that a significant share of population with a very low level of well-being (Smenkovsky et al., 2012).

Table 4. Structure of total expenditures of the population Ukraine

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Expenditures in average per month per household, UAH	658	737	904	1229	1443	1722	2590	2754	3073	3361
Total Expenditures in average per month per household, Euro	120	111	125	205,9	216,9	232	238,6	240,6	290,6	326,4
Structure of total expenditures of households	**Percentage %**									
housing, water, electricity, gas and other fuels	10,5	10,4	9,7	8,5	9,6	10,9	9,1	9,4	9,3	10,2
including separate payments for housing, utility products and services	9,2	8,7	7,7	6,4	7,1	8,5	6,6	7,7	7,6	8,9
including separate payments for energy and energy services in the residential sector	–	–	–	–	–	–	4,7	5,5	5,5	6,4
transportation	3	3,3	3	3	3,7	3,4	4	3,8	3,7	3,8
including separate payments for fuel for transportation (max prices)	–	–	–	<1,9	<1,8	<1,4	<1,7	<2,0	<2,0	–
including the percentage of total household expenditure spent on fuel and payment of services to provide energy (estimated maximum value)	–	–	–	–	–	–	<8,9	<9,2	<9,2	–

Source: State Statistics Service of Ukraine and the National Bank of Ukraine

“Industrial electricity prices are determined by the NERC and they are set monthly. The industry sector effectively subsidises the household sector at a penalty of prices that are 22% higher to meet the cost of the subsidy. It is through Ukraine’s high reliance on state-owned nuclear power for 47% of its electricity and the fact that these plants are fully depreciated that it is possible to maintain subsidies. However, it is in the heating sector where the crisis is most acute. The rise in energy prices and the earlier failure to pass though these costs has become manifest in a loss of competitiveness and an increased dependence on subsidies that the state and, more directly, Naftogaz can no longer afford.” (Energy Charter Secretariat, 2013)

The National Institute of Strategic Studies of Ukraine made a research (2013), where the following conclusions were done: the problem of unclear tariffs for the population is a source of various problems in energy system: system of pricing of energy is unclear, non-transparent and complicated. People do not really understand whether the price is objective or not. No reforms were made. This fact results in the situation when the companies-energy-producers cannot find the funds for modernization and maintaining the boilers and their equipment. The poor condition of the equipment, absence of meters – all these facts justify the price for the energy, which is paid by the people. Sometimes it is even more than people pay, especially in regards to the thermal energy, which is quite high, and the level of the provided service is low. In different regions of Ukraine, despite the paid service, the radiators in the apartments are hardly warm. (Zemlianiy 2013).

The obvious solution of the problem is to raise the prices to the market level. However, this is the most controversial issue as the monthly wages of people in Ukraine will not allow people to make these payments. Moreover, the absence of adequate metering systems makes this idea inefficient. According to the intentions of the current government to increase the tariffs for energy for the households, the urgent measures that need to be done are: to equip all the energy routes with the meters and control, including the end users; to substitute the subsidies-system of the people by subsiding only the poorest (Zemlianiy 2013).

The problematic issue may be the social response to the energy price increase. In order to answer the question what can be the reaction of people, when the tariffs for energy rise, we can look through the report “Modernization of the District Heating Systems in Ukraine: Heat Metering and Consumption-Based Billing” (Semikolenova et al., 2012), where it is said the following:

“Building level heat metering, coupled with technical solutions to improve efficiency of heat delivery to households, has demonstrated mutual benefits for

customers, DH companies, and the Government. Installing equipment which allows heat supply to be matched with demand reduces final heat consumption. Consumption-based billing allows households to benefit from this decrease, as average household expenditure on heating goes down, making DH more affordable." However, the metering technology will not solve the problem itself, as it is pointed out in the report,

"Other important reforms, including energy efficiency improvements in buildings, efficiency improvements in DH networks, and regulatory reform will be needed to improve affordability and quality of service in the sector." (Semikolenova et al., 2012: 1)The World practice to pay for what you have consumed seems to be the most rational and effective. According to the logical assumptions, the billing system based on consumption can be beneficial for both the heat suppliers as well as for the consumers. However, let us analyse this assumption and check which obstacles or problems may arise. There was made an experimental research, which aimed to understand the pros and cons of the implementing the billing system. According to the report, which I have already mentioned above, there are the following issues of concern (Le Houerou et al., 2012):

- Higher costs
- Transparency and fairness within buildings

These two problems relate to the fact, that the post-soviet system is based on a principle, when the state carries the responsibility of supplying, providing of all the services. Although the level of the service is quite low, people are used to the fact that they do not have to care about heat supply, modernization of technology or any other activity, which foresees personal participation. This is not a rule, of course, as there is a strong tendency towards decentralization, establishing of independent organizations "condominiums", which prove to be more efficient that the state institutions. The other problem is a low trust to the newly established organizations such as condominiums. As it was already stated, people were used to the fact that the only reliable institution is the state institution. They do not feel much trust to the commercial organizations and the fact that government does not have any responsibility to care about them anymore – makes them be very careful.

At the same time, according to the information from the Ministry of regional development, the number of condominium associations (condominiums) in Ukraine is growing each year. In the beginning of December 2013 there were 16.847 condominiums, representing 21.1% of the country's multi-storey buildings (79.7 thousand homes). There were 1.132 association established during the period of

January-November 2013. The largest amount of established condominiums in 2013 was in such regions: in Donetsk (141), Kherson (133), Kharkiv (85), Mykolayiv (77), Luhansk (75) regions. There is also another tendency, which is establishment of private companies, whose goal is providing services of maintenance of buildings and structures and adjacent areas. Today in Ukraine there are 466 operating private enterprises (PE).The largest quantity of PE was established in the Crimea (4), Donetsk (4), Ternopil (3), Kirovograd (3) and Khmelnitsky (3) oblasts. There is another type of organization, aiming to fulfil the functions of providing the same type of service. It is so called “single customer service”, which aim to improve the efficiency of utility services. Today in Ukraine there are 161 single customer services, 95 of which were established in 2013.The largest number of the established organization of this type were in Kiev (102) and the Donetsk region (29). (Ministry of Regional Development, Construction, Housing and Utilities, 2013).

3.1.6 Energy efficiency problem in households

Buildings have very high coefficient of thermal losses. This was caused by the inefficient construction projects for the buildings built in the USSR. This sector need to be reconstructed and improved in terms of improving thermal insulation, changing of heating systems and other important means. If we compare the standards and situation de-facto for the loss of heat in the EU and Ukraine, we can see where the problem lies. In the EU the current standard is about 15-49 kWh/m2/a, in Ukraine the standard is 79-90 kWh/m2/a. However the problem is that the majority of the building was built before the 1980s, where the problem of energy efficiency was very low. The average indicator of the heat loss varies from 226 to 270 (and higher) kWh/m2/a. For the buildings constructed after 1980 the number is around 166-180 kWh/m2/a. The standard for the buildings before 2008 was 121-135 KWh/m2/a. (Tucker 2013)

I would like to refer to the report of the World Bank and to cite the evaluation of the situation with the heating supply of the households: “Most buildings, Government-owned as well as municipal and mixed ownership, are very inefficient, as much as five times less efficient as the norm in Western Europe. The buildings lack control systems to regulate heat and the building envelopes are poorly insulated. Heat losses from inefficient design are exacerbated by the long heating season. Expensive to heat, many buildings also provide an uncomfortable environment. If adequate action is not taken soon, a significant part of this housing may deteriorate beyond repair and create unacceptable housing conditions. This is

a particular problem for vulnerable groups such as the elderly, sick or very young, all of which rely on public institutions to care for them. Unlike electricity, heating costs of the poor are appropriately higher than for the wealthy as they are not in a position to upgrade their building envelope" (World Bank 2011, 34).

Regarding the energy efficiency projects in household, the company made an audit and presented the following results: "Numerous energy audits of residential and municipal buildings conducted by our company in different regions of Ukraine (see map), have shown that the specific heat consumption of existing buildings is in the range of 180-240 kWh/m2 per year. Payback projects of a deep thermo modernization to the level of 35-45 kWh/m2 per year make up 11.8 years for public sector buildings and 35-45 years for residential buildings" (Stepanenko, 2013).

Recently a new type of building management has appeared in Ukraine, so called condominiums, where citizens refuse from being managed by the state institutions and create their own administration. This is the first step towards more effective use of resources, financing. It can be also used experience of other counties in cooperation with banks, financial institutions in order to receive funds for the EE projects.

"However, the current system of household tariff estimation by the NERC is not based on any logical methodology either, nor is there a calculation for a price-ceiling up to which households could be charged. In addition, low-income households are protected by income subsidies. The law stipulates that expenditures for communal services cannot exceed 20% of total household income. Should actual expenditures be higher, the government has to pay the difference directly to the communal services administration." (Dodonov, Opitz and Pfaffenberger 2004)

"At present there are tariffs for 7 different consumer groups: industrial and other consumers with a capacity of 750 kVA or higher, industrial and other consumers with a capacity lower than 750 kVA, agricultural producers, electrical railway transport, electrical city transport, non-industrial consumers and households. Household tariffs in turn are subdivided into one for rural households, and two for urban households, those with an electric stove and those with a gas stove" (Fankhauser, Rodionova and Falcetti 2008)

The question of raising prices for electricity for the households is not a question anymore. This measure was necessary and according to the research made by Fankhauser et al (2008), the current costs are not covered, even taking into consideration that it was used an increased tariff methodology. The authors of the research made an evaluation of the changes in the price and their influence on

the welfare of private households. It showed that the increase of the price by estimated by the NERC level would not lead to considerable losses of the welfare.

3.1.7 Energy efficiency problem in industry

An important energy sector, which deserves a high attention, is the coal industry of Ukraine. According to the energy strategy, the coal production should be increased in order to leverage the dependence from Russia and increase the energy security. However, as it was already discussed in the first chapter, it should be said that the industry itself suffers from inefficiency and dependence on import. If the situation is not improved it can become a threat to the energy security as well. In an article in the journal “Strategic priorities” it is said that there are several threats to the coal sector of industry in Ukraine:

- High wear of the assets of coal mining companies. The degree of wear is estimated at 65-70%. Near 90% of the coal mining have been working for 25 years without retrofitting or modernization. The condition of the equipment is terrifying: in the areas with steep layers, which are up to 60%, the drilling is provided with the jackhammers. This leads to an increase in loss of production of coal (Vorobyov and Sobkevych 2013).
- Low level on investments. Currently the companies are not ready to invest much in the modernization of the industry. The investments, which are received, usually are directed for the aims of developing of the perspective projects.
- Low level of management standards:
- Absence of the market for selling coal production
- Imbalance of economic interests of producers and consumers in the market due to the lack of the possibility of establishing market prices.
- Low ecological standards, absence of end of pipe technologies, which led to the fact that in Donetsk and the cities in its surrounding the level of carcinogenic substances in the air exceeds the level in other cities and villages in 12 times.

Here you can see the structure of energy consumption in Ukraine in 2012-2013

Table 5. Structure of electricity consumption by major industries and consumer groups for 2012 and 2013

major industries and consumer groups	Consumption of electricity (million kW h)		%	Share%	
	2012	2013	difference	2012	2013
Energy consumption total (net):	150721	147264,4	-2,3	100	100
1. Industry(total)	70761,4	66339,4	-6,2	46,9	45
1.1 fuel	8935,5	8525,3	-4,6	5,9	5,8
1.2 metallurgical	36936	35092,7	-5	24,5	23,8
1.3 chemical and Petrochemical	5993	4892,5	-18,4	4	3,3
1.4 engineering(machine building)	5833,6	5291,5	-9,3	3,9	3,6
1.5 construction materials	2530,4	2507,1	-0,9	1,7	1,7
1.6 food and food processing	4713,8	4682,2	-0,7	3,1	3,2
1.7 other	5819,1	5348,1	-8,1	3,8	3,6
2. agricultural consumers	3830,9	3935,6	2,7	2,5	2,7
3. transportation	9279,1	8690	-6,3	6,2	5,9
4. construction	1013,4	1003	-1	0,7	0,7
5. municipal and household consumers	18508,1	18545,3	0,2	12,3	12,6
6. other non-industrial consumers	7061,4	7373,2	4,4	4,7	5
7. population	40266,7	41377,9	2,8	26,7	28,1

As we can see, industry is the biggest consumer – 45-46.9%, thn goes population with the 26.7-28.7%, municipal and household consumers is a separate

group – 12.3-12.6%. These are the most energy intensive groups, which needs the biggest amount of investments into efficient technologies.

In the chapter, where it was studied the situation of the energy production in Ukraine, the conclusion we came to was that modernisation of the power plants is not really efficient way to increase energy security. The assumption is that the best way to increase energy security is the following:

1. Implementing of energy efficiency technology in households sector
2. Construction of the new thermal power plants
3. Promoting energy saving philosophy both for the population and industry
4. Investing into the renewable energy in the long term perspective

The problem, which makes the efforts to improve the efficiency even more complicated, is the absence of information, numbers, quantity of energy consumed by an average household per year and other relevant and important information.

In the report on “Energy Efficiency in Buildings in the Contracting Parties of the Energy Community”, which was made by the Energy Community, it said the following: “Ukraine does not have centralized collection of information about the total building stock in the country. Some fragmental information about the building stock is presented by the State Statistics Service of Ukraine. The only category of buildings, which is described in the State Statistics Service, is “residential buildings”. Another way of categorization is used in the local Building Regulations (DBN B.2.6-31:2006) for energy consumption indicators. However this type of categorization is not used for collection of statistical information.” (Tchervilov, Grytsenko and Kaloyanov 2012).The following categorization is used and provided for 4 climatic zones of Ukraine and divided into the following types of buildings, as mentioned earlier:

- residential buildings and hotels (of different number of floors and heated area)
- public and administrative buildings (of different number of floors)
- medical and children educational buildings (of different number of floors)
- kindergartens
- shops, stores, supermarkets (of different number of floors)” (Tchervilov, Grytsenko and Kaloyanov 2012)

There is an article, which is illustrative of what the current situation in the technological development in Ukrainian industry is. The article was published in the

“Elektropanorama” magazine. The author, V.Stepanenko, describes the problematic case of the Kyivvodocanal, which is the major water supplier of Kyiv. This case very clearly demonstrates the overall condition of the key-objects of industry infrastructure and the inefficiency problem in it. The depreciation of technical equipment causes big losses of electricity and money. “"Kyivvodocanal" is one of the largest consumers of electricity in the city. With a load of about 60 MW, it takes a leading place in Kiev by consuming more than 450 million kWh per year”, - Stepanenko points out in his article. He also mentions that the technologies, used by colleagues from the West, require half of the amount of energy consumed by Kyiv water supply station. Thus it is even profitable business for its owners. It is said that almost no significant investments have been made into the renovation/modernization of the technical equipment during the last 30 years. The author raises a very substantial topic of where the investments for the modernization may come from. In order to increase the efficiency to the current standard of efficient energy use and water supply, it is required the replacement of 80% of pumps, new automated control systems as well as the new corporate management system of "Kievvodokanal." (Stepanenko, 2007)

The main problems which arise when the issue of technology modernization comes up are the following: who will pay for that? In the case of Kyivvodokanal, Stepanenko (2007) states that funding can be found only within the institution itself. The sum, necessary for modernization of technology is 5-10 million dollars per year. Some energy-saving projects related to the development of Kievvodokanal, for example the construction of new networks, pumping stations and hydro systems, will be financed from the municipal budgets of cities and oblasts. The total amount of the cost he estimates at around 170 million dollars. That sounds as a huge amount of money for the state institution of a low- to middle-income country. However, let us see how much this institution loses by inefficient energy consumption, absence of metering equipment, old and unproductive technology. Due to an outdated and unbalanced system of accounting "Kyivvodocanal" loses annually 60 million hryvnas from underpays for water and more than 50 million hryvnas from underpays for wastewater treatment. The company will lose $ 250-300 million for payments for electricity (and that's assuming that the tariffs will stand on the spot as they were in 2007). The author also gives a very good reason to implement the modernization: “In order not to lose 250 - 300 million dollars within the next 15 years, it is necessary to invest at least $170 million in energy efficiency - that's the main goal of modernization projects in "Kievvodokanal." Invest in order to reduce losses.” The

good thing about investments in energy efficient technologies is that they are returned pretty quickly. If the future savings from implementing such technology are guaranteed, it is possible to borrow money for energy modernization and pay back the money from the savings, achieved from reduced electricity consumption.

The problem of inefficient energy consumption is partially caused by the inefficient management. Lack of financial resources can be compensated by the effective administration. Investments and international cooperation in energy efficiency sphere.

3.1.8 Experience of other countries in fighting with energy inefficiency

It should be said that the government has been working towards solving the energy inefficiency program as well as have civil society organizations, institutions and experts. Some sound knowledge base already exists. The state cooperated with the international institutions in order to get the financial assistance and investments into the increasing and improving energy efficiency. The World Bank is working closely with Ukreximbank, the regulator NERC, the State Agency of Ukraine for Energy Efficiency and Energy Conservation and the Ministry of Regional Development, Construction and Municipal Economy to identify municipal energy efficiency pilot sub-projects that could be financed through the project." (World Bank 2011)There are programs, strategies, which analyse and suggest the ways of increasing the efficiency of energy consuming.

In my thesis I would like to attract attention to the tools, which were used in other countries with similar difficulties. There is a case of Hungary, which has a positive result in coping with the similar problems in energy inefficiency of buildings. Near 35% of the building stock of Hungary was built in 1960s, 21% - before the World War I. It is usually not allowed to change the facades of the building, so the modernization efforts were focused on improving the energy efficiency performance of windows and roofs, as well as the efforts were focused on isolating the upper and lower floors (including the basement and basement ceilings) rather than walls insulation. This analysis was made by the International Finance Corporation. Residential buildings are built with industrialized technology, which is known as 'panel buildings'. They are built by the means of the following technology: "pre-fabricated panels, blocks, locally prepared concrete structures, cast wall, reinforced concrete frame or other pre-fabricated technology" (IFC Advisory Services in Europe and Central Asia, 2011). Panel buildings account for approximately 1.5 million flats and were very popular during the Socialist-era, in the period from 1960 to 1980. I

took this case, as this peculiarity can be also seen in the majority of post-soviet countries. The biggest problem with this type of buildings is the low efficiency, which has led to the problem that an average space heating demand of the buildings is 70% above that of the EU average. A program “Energy efficient renovation of MFBs built with industrialized technology” was introduced in 2000 aiming to solve the mentioned problems. It is operated by the Energy Centre Hungary and the Ministry of Local Government. The aims of the program were “the renewal of residential buildings built with industrialized technology. “A subsidy can be claimed for the works performed during the renovation of buildings for the following:

1) subsequent heat insulation;

2) renovation of building, engineering systems (resulting in energy savings);

3) modernization and renovation of building surroundings;

4) development of individual adjustment of heating energy consumption together with the conditions of metering district heating use of each apartment (replacement of radiators and connecting valves for individual meters or cost sharing and all required modifications of the heating network)” (IFC Advisory Services in Europe and Central Asia, 2011: 83)

3.2 The role of TPP

Thermal supply system in Ukraine consists of the following elements:

- the objects, which generate heat (CHP, thermal power plants, nuclear power plants, cogeneration installation, central heating boiler, industrial heating boiler individual enterprises, flat generators heat, waste energy, renewable and energy sources (ARES);
- Objects, which transmit and distribute the heat energy among the consumers (trunk heat networks, heating units, local distribution network , including distribution networks houses);
- System of administration and regulation of heat supply

The main consumers of thermal energy are the housing sector, which amounts in 44%, industry -35%, other sectors make up about 21%.The main fuel for power plants is natural gas, which is 76-80% , the oil fuel constitute 15-18% and coal – 5-6%. The fuel distribution for the boilers is the following: gas - 67 %, solid fuel (coal) - 31%, oil fuel - 1.5%. The cost of natural gas constitutes about 55% in the cost value structure of thermal energy. The rest of the cost value constitutes electricity with 11-15% and water, which is 8% (Shevtsov, 2010).

District heating systems are a significant source of greenhouse gases. In Ukraine, they account for 20% of total CO2 emissions and 81% of methane emissions, which hare released as a result of burning fossil fuels.

The report, made by the World Bank, states that the district heating in Ukraine plays an important role in satisfying the basic needs in the heat supply. At the same time, the industry faces significant challenges that must be overcome in order to avoid its collapse. For the heat communal (teplokomunenergo – Ukrainian) the main concern is their financial stability. They do not have enough income to carry out necessary investments in the network of district heating. This situation reduces the quality of services and increases operating costs. For consumers, the main concern is the quality of service and availability of this service. Artificially lowered prices lead to permanent deterioration of assets, which provide heat supply (and gas), which in its turn results in deterioration of the quality of heating. Low prices on district heating do not promote energy conservation and energy efficiency improvements. In this respect, Ukraine is one of the most energy-intensive countries in the world. (Semikolenova et al., 2012).

In the analytical note, made by the National Institute for strategic Studies, it is said that “most of thermal power stations were put in operation in the period 1950-1980 of the last century. During this time, not only the technology of production has changed, but also the demand for heat in the regions of their placement has increased. Traditionally in Ukraine the percentage of consumers whose thermal heat demand is covered by district heating is quite high. Unlike in Western Europe in Ukraine a significant part of the domestic consumers of thermal energy is concentrated in compact areas in multi-apartment buildings. A large amount of heat energy is also consumed by industry” (Shevtsov, 2010). The author of the note also points out that the share of the thermal power stations in a heat supply constitutes 25%. At the same time in such countries as Finland, Germany and Denmark the share is near 75-85%.

The general condition of boilers is dramatically low. However the necessity of modernization is recognized and the government declares the intention to work in this direction. According to the data of the State Emergency Service of Ukraine, 1 billion hrynia (approximately 0.06 billion Euro) were spent on modernization of boilers and heating networks of Ukraine from the state budget (State Emergency Service of Ukraine, 2013).

According to the State Statistics Committee, as of 01.04.2010, heating is supplied by 8,250 providers of all forms of ownership, which operate 32,725 boilers

with total capacity of 130,618.7Gcal/h. The total number of installed boilers is 75,831 units, including boilers with a lifetime of more than 20 years. The last ones amount to 16,254 and constitute 21.4% of the total number of operating boilers. The length of the two-pipe heating systems is 34,625.5km; the length of dilapidated ones, which are in the condition of emergency, is 5,491.4 kilometers.

The share of district heating in the total heat in Ukraine is about 42%; 60% of the territory of Ukraine is provided with thermal energy by district heating system.

The total heat output of CHP, boilers of various purposes, individual heat generators and other sources is 230-240 million Gcal per year. The tendency of heat production was decreasing lately due to the economic crisis, the deterioration of heating and hot water supply, which, especially in the summer season, were practically absent in most cities of the country. The supply of thermal energy to the consumers is provided by the heat-generating systems, thermal-transporting and district heating organizations as well as by organizations, which are currently the subject to different agencies (Ministry of Energy, Ministry of Housing and communal services, local authorities and others). In Ukraine there are 21 regional and 17 municipal associations and heating utilities. (Shevtsov, 2010)

As it became clear the necessity of total modernization of the thermal power industry is very urgent and vital. The question is what is more rational to start building the new power stations or to invest into the modernization of the old ones. In order to understand it we can compare the two main parameters, which are the capital investments and the price for the fuel. The old power station, since they were built long time ago, have low capital investments, however high operation costs and high fuel consumption. At the same time the efficiency is considerably lower than on the new thermal power stations. The new ones have high capital investments costs (for the construction), but due to the reasons that Ukraine owns large coal reserves and due to the high efficiency of the new stations, can be more reasonable to choose the last option as the pathway towards an efficient energy system.

The coal price is quite complicated issue, because the state doesn't announce the current prices, which it paid for the coal and the private corporate also do not open this information. However it is known that the prices are lower than the market price and sometimes do not even cover the net costs. In the report it is said: "In 2004, net cost amounted to UAH 214.18 (13 Euro data as of 2004) while the price was only UAH 171.71(10.50 Euro), and UAH 605.84 (37 Euro data as of 2008) and UAH 453.88 (27.7 Euro) in 2008, respectively. There is a tendency towards the increase of this gap. In 2004, price constituted 80% of net cost, in 2008 the price

was equal only to 75% of the average production cost, and in 2009 to only 64%. However, net cost may vary depending on the producer and could reach UAH 10 thousand per ton of coal in some cases. (Ogarenko, 2010)".

Basically the need for the new stations was already described by the deputy minister of Fuel and Energy of Ukraine in 2005: "Accumulation of obsolete equipment leads to an increase of modernization costs. As a result, the costs of multiple life extension are comparable with the cost of the new equipment. Thus, in 2002 the cost of repair of TPP equipment was 348 million Uah (in frames of the planned 567 million Uah), or 12% of the cost of electricity generated by them. In case of continuing of using obsolete equipment, these costs will increase by 1.8 to 2005, and by 2.4 times in 2010 – and will amount to not less than 785 million Uah (150 million USD) per year" (Sheberstov, 2005). Olexiy Shebertsov (2005) said that there were no other ways for the modernisation of the thermal power industry as only to invest into building the new power stations. He also made some calculations, which support his idea: full technical re-equipment of the units working on gas, by the introduction of the combined-cycle technology and a fuel consumption of 240 g / (kWh) of gas will make annual savings of 1.8 billion m3, and the cost of gas savings will amount to 144 million dollars per year. Technical re-equipment of coal-fired units can improve the efficiency of coal combustion by 15% and more. The released costs from the annual coal consumption of 19 million tons of fuel will be about 171 million dollars USA.

There are working and effective schemes of attracting investments into the building the new power stations. Ukraine can use some of them to build the new efficient and ecologically cleaner power stations. Some of them are such schemes as PPP, which is private-public partnership. The idea is to shift the source of the investments burdens from the state budget to other alternatives. Usually it is a private entity, which takes the burdens and according to the contract operates during some period of time (15-30 years) in exchange for the fees. After the contract expires, government receives the control over the plant. The PPP can have different types (Murtha Cullina LLP, 2010):

- Design-Build
- Operation and Maintenance
- Design-Build-Operate-Maintain
- Design-Build-Finance-Operate-Maintain
- Design-Build-Finance-Operate-Maintain-Transfer

This type of investments has been successfully used in Europe and can be one of the most effective tools for Ukraine.

The renovation of the majority of the thermal power plants needs to be done in the near future. This is the question of the high priority and has to be included into the short term perspective.

Moreover the very necessary thing is to change all the lines of energy transmitting as they are source of high energy losses.

3.3 Shale gas production

The role of shale gas can be really important for Ukraine. However, this issue can have concerns such as environmental issues over hydraulic fracturing, the costs and whether it really can be an alternative to the conventional gas.

According to the research made by both Ukrainian and foreign experts, Ukraine owns considerable reserves of shale gas. Olexandr Lukin, a corresponding member of NAS of Ukraine, states in his paper that the natural gas resources of the following type have the high recovering rate: for example methane dissolved in groundwater; Methane hydrates in the Black Sea, the bottom of which is unprecedentedly intense with gas recovery capability. Lukin also states that he agrees with the academician Shnyukov and professor at the University of Texas, Makogon that “Ukraine has the potential to completely provide itself with gas of the only Black Sea gas hydrates” (Lukin, 2011). This potential could be really crucial for Ukrainian energy security, however this is not clear due to the crisis of 2014, where Crimea and the black sea region is not controlled by Ukraine.

According to the analysis in the territory of Ukraine two promising areas of shale gas are considered: Dnieper-Donetsk and Lublin with 1.36 trillion m3 and 4.22 trillion m3 respectively. Nearly 1.19 trillion cubic metres (20%) can be technically extracted out of the 5.58 trillion m3 mentioned above. In the case of only technically accessible shale gas, and saving the 2012 level of consumption, proved reserves of these sites will last for 27 years (Kuhar and Belyavskiy, 2013).

Of course shale gas can become a magic stick for Ukrainian industry, but it is very difficult to make some specific prognosis on the amounts of it. Moreover in a difficult political situation this issue becomes a mid-term perspective.

4. The long term perspective of the energy system of Ukraine

The end goal of the energy strategy of Ukraine is to create sustainable, efficient and secure energy system. This is the logical and natural desire of a regular civilized state. It is difficult to predict the scenarios for the future, however it is necessary to set the goals and analyse the possibilities of achieving them. The long term period in this case is framed till 2050. By this time it is necessary to:

- Build new efficient power stations
- To decrease gas dependence from imported resources,
- Increase significantly the efficiency in households and industry.
- Increase the share of the renewable energy

4.1 Thermal Power plants in the long-term perspective

The necessity in new and efficient power plants was described in the earlier chapters. However, the strategy regarding this issue has to be a little bit more sophisticated than just to build new ones or retrofitting the old ones. The long term perspective to my mind has several steps, which include construction of new efficient power plants, construction of flexible power plants, connecting the UES to the ENTSO-E. The least two ones are the issues of the long term perspective.

The role of flexible PP can be very important for Ukraine as it can adapt to the different situations with the load and current situation in energy supply. The peculiarity of modern TPP is that they cannot react quickly to the changes in the load and start or stop with minimum time period and resource. Especially this issue will be raised in the future, when the renewables will play the major role in the energy supply, as they will have constant variations in electricity production. Operating the old soviet power plants is very inefficient in term of fuel consumption as well. In the long run, it is absolutely obvious that the future energy mix of a country will have higher share of renewables. The weak point is the lack of storages and unpredictability of the amount of renewable energy generation. The regular power plants will have to leverage excess or shortage of energy. But they need to start up or shut down very quickly and with less fuel consumption. Moreover, if the Ukrainian grid is connected to the ENTSO-E, where the European countries are constantly increasing their renewable share in energy production, Ukraine can just buy the surplus of such energy when needed. Especially taking into account that the

renewable electricity will become cheaper and cheaper the more countries produce green energy. In this case so called flexible power plants are a good solution.

4.2 The role of renewable energy by 2050

According to the Energy Strategy of Ukraine till 2030, Ukraine is going to invest in the building of power hydro power plants (HPP, HAPP) and electricity grids. With regard to the main network, by 2030 two transit lines of 750 kW in total must be constructed: the South KNPP-ZNPP and the northern RNPP-AC Donbass). Construction cost is going to be split between the government and private sector.

The share of renewable energy in the general balance of installed capacity should be increased to the level of 12.6 % meeting the obligations of Ukraine to the Energy Community and being in line with developed SAEE National Action Plan for Renewable Energy by 2020.

According to the Strategy, the planned (possible) amount of installed power capacity of different RES power plants in 2030 should be as follows:

- Wind energy: 3-4 Gigawatt;
- Solar energy: 4 Gigawatt;
- Small hydro: 1-1,5 Gigawatt of electricity and 10-15 Gigawatt of heat (Energy Strategy of Ukraine till 2030, 2013).

The question, which is sometimes raised, is the interconnection between the role of renewable and economy of a country. In the case of Ukraine, with the weak economy and difficult political situation, this interrelation should be studied more careful. To my opinion there is a considerable dependence on the investments into renewable and the growth of GDP. I assume that Ukraine has a good possibility to attract foreign investments in this sphere which will positively reflect on the overall economic situation.

It is distinguished two groups of factors of economic growth (extensive and intensive): the first type, extensive economic growth has the following factors: increase employment; increasing the volume of capital. The characteristics of intensive growth are: technological progress; education and professional training; savings through economies of scale; better resource allocation; legislative, institutional and other factors. Sources of economic growth, i.e. the growth in output (DY) can be obtained from three separate sources: the growth of labor; capital gains; technical innovations. The main idea of an intensive economic growth is the more efficient use of the resources, technology. That is why the alternative sources of energy may become a factor of economic growth. Moreover, the market of

alternative energy is developing more and more. Investments made in this field are growing as well. Here you can see some figures of the investments in renewable energy 2004-2011. We can see that, for example, in Europe investments increased from 11 to 40.8 billion dollars.

	2004	2005	2006	2007	2008	2009	2010	2011
Europe	11.0	17.5	23.6	35.6	45.0	42.9	42.1	40.8
China	1.5	4.5	8.4	12.3	22.8	30.9	41.6	49.7
United States	3.7	7.6	22.2	21.8	23.3	12.6	20.9	40.9
Brazil	0.4	1.4	4.3	7.3	12.4	6.7	6.4	7.3
India	1.9	2.6	4.5	4.1	4.3	3.7	6.7	11.6
ASOC (excl. China & India)	2.9	3.9	4.3	5.9	6.5	4.5	5.4	4.6
AMER (excl. US & Brazil)	1.2	2.9	3.0	3.7	4.8	5.3	10.3	5.9
Middle East & Africa	0.3	0.2	1.5	1.2	2.5	2.1	5.4	3.5
Disclosed deal count	218	507	696	915	976	821	804	625
Total deal count	572	984	1321	1621	1764	1631	2031	1784
Footnote:	Total values include estimates for undisclosed deals.							
Source:	Bloomberg New Energy Finance, UNEP							

Figure 10. Asset financing new investment in renewable energy by region, 2004-2011

Investments are usually associated with the second type of economic growth, intensive one. It can provide the economy with the new technology, inflow of capital.

Some of the research says that there is no direct causality between energy and economic growth. For example, Chontanawat et al(2006) made a research on the issue whether there is cause effect between energy and GDP and GDP and energy. As the result in their work the make the following conclusion:

“Nevertheless, this is, as far as it is known, the first systematic study of such a large number of countries and has produced results that are contrary to prior expectations; that is causality between energy to GDP is more prevalent in the developed/OECD world than the developing/non-OECD world. In particular causality from energy to GDP is more prevalent in the developed/OECD world than the developing/non-OECD world which has significant consequences in a global world trying to reduce energy consumption in order to reduce pollutant emissions since it suggests that this will have a greater impact on the GDP of the developed world than the developing world. ” (Chontanawat et al., 2006)

The Ukrainian economy may be characterized as inefficient. As it is known, Ukraine used to be a country with heavy industry. There are steel plants, mines, atomic stations and other industrial factories. However, these industries are the source of economic problems and energy ones. The technology, which is used there is quite old and inefficient. This is the characteristics of extensive economic type of

development. The new technology requires new capital investments. The industries require more effective management. In general the problem of inefficiency of Ukrainian economy one can find, first of all, in inefficient energy consumption. It is absolutely necessary for Ukrainian economy to decrease the energy consumption in one of the most energy intensive industry, metallurgy. This industry employs 323 thousand people (11.7% of total number of employees in all types of industry). Volume of sales in metallurgy and manufacture of finished metal products is 18.1% of the total for the industry. At the same time the branch consumes 32% of general energy level, 25% of natural gas, 10% of oil and petroleum products. The energy intensity of the industry is 30% higher than the world's counterparts. Such examples can be met in almost every heavy industry in Ukraine. In the World Bank report there is the following statement:

"Ukraine is one of the most energy inefficient countries in the region and restructuring and upgrading its energy sector continues to be one of the key development challenges for the Government. The sector faces problems maintaining security, reliability and quality of supply due to delays in energy sector reform, poor financial condition of energy sector enterprises, lack of investments, and deferred maintenance in aging infrastructure. These factors threaten the sustainability of economic growth, degrade the environment and increase the cost of social services. Improving them is among Ukraine's top strategic priorities" (The World Bank, 2012).

The other factor, which is closely combined with inefficient energy consumption, is dependence on the imported energy goods. The significant level of energy dependence from the imported resources is the threat to the economic development of the country. The low level of the investments to the exploration and production of the hydrocarbons make the industry not competitive. The factor that influences the energy dependence is also the low share of the renewable energy; its share is approximately 1%, while the average European rate is about 10-15%. The other characteristic of Ukrainian economy as an extensive and not intensive is the fact that it is oriented on import, i.e. it imports more than exports. In addition to it, as it was already said above, one of the problems that decrease the competitive ability of Ukraine is the high intensity of the industry and the consumption of energy resources, major part of which is imported from abroad.

I tried to analyse whether renewable energy can become a factor of economic growth. I assume that the growing interest in renewable energy resources may be the source of an increase of investments both from abroad as well as from

domestic companies, which want to increase energy efficiency. All over the world, countries actively develop the use of the renewable energy resources. There is a clear economic issue for this tendency: the scarcity of the traditional sources of energy and the constant increase of the prices for the energy. The analytics of the UNEP program, which is the program of the UN in the environmental sphere, have published a report about the level of investments in the renewable energy field. According to this report, in 2012 the level of investments in this field reached 257 billionUS $, which is an increase by 17% by the end of the year (Turner, 2013).

The global trends have not bypassed Ukraine. The market of alternative sources of energy in Ukraine is still being formed. However, there is a big interest in it among the investors. The main reason is the high rates of the “green” tariffs. "Green" tariffs are determined by the formula in which each object is defined by a factor, the size of which depends on the type of alternative energy sources and the characteristics of power generating equipment (I-Energy, 2011). Ukraine is trying to keep up with the developed European countries to rapidly develop green energy, maximize the use of Ukrainlan natural potential. Only in 2009 from the state budget for the development of alternative energy in Ukraine, there was allocated 500 million hryvna (64 million dollars) for the facilities of the Ministry of Housing and 1.5 billion hryvna (approximately 192.4 billion dollars) for projects of the Ministry of Regional Development and Construction. But the effectiveness of public policy in alternative energy depends primarily on the effectiveness of regulatory and legislative framework, which aims to create favorable conditions for the Ukrainian market of renewable energy. (Dudchenko, n.d.). The question is whether the alternative energy may become one of the spheres, which can help the development of Ukrainian economy. According to the Bloomberg report, New Energy Finance, by the year 2030 the share of the renewable energy resources will reach the point of 50% of installed power generation capacity (Turner, 2013). They continue in the report:

“Wind and solar continue to dominate. Wind (on and offshore) rises from 5% in 2012 to 17% of installed capacity by 2030, overtaking large-hydro. Starting from a lower base, solar PV capacity grows from 2% in 2012 16% by 2030. Less variable renewables such as marine, geothermal and solar thermal make a lesser contribution due to their higher costs. Fossil-fuel generation capacity grows slightly in absolute terms in all scenarios, but its relative contribution falls from 67% in 2012 to 40-45% by 2030. The nuclear share remains steady at around 6%.” (Turner, 2013)

The high interest of investors all over the world in the alternative energy market may be favourable for Ukraine, since it has all the necessary preconditions in order to develop the industry and attract these investments. Experts forecast a 5 billion US$ investment in Ukrainian alternative energy by 2015. Spheres of investment resources are traditional for Ukraine: solar and wind power, biofuels, energy generation from biomass. Indeed, in 2011 alternative power in Ukraine has grown faster than the traditional one. In general, the total amount of alternative power plants of renewable energy sources has increased, while the total capacity of power plants on traditional fuels declined. The total capacity of the alternative energy has increased by 4% and amounted to 5.8 GW. In 2011, the power of alternative energy sources has increased significantly due to the solar energy facilities. It was expected that in 2012 the total capacity of solar power plants would increase to 300 MW, and in 2015 to 1 GW (AlterEnergy Info, 2012)

As we see from the chart below, there are the figures of the investments into the alternative energy. Here we can see a group of countries that saw billion-dollar investment flows. An interesting surprise was Ukraine, as it said in the Bloomberg report, which enjoyed an increase from $919 million to 2.8 billion US $ in 2012. The move on was driven by the financing of a series of small hydro projects totalling 980MW and worth 2.1 billion US$ on the Dnieper River. The largest deal in another sector was that for the 90MW, 126 million US$ Botievo Wind Farm Phase 1. The largest deals included Activ Solar'(which is a company with Ukrainian routes and has a head office in Vienna), $362 million refinancing of its 100MW Perovo PV plant in Ukraine (Frankfurt School - UNEP Collaborating Centre, 2013)

	2012	% growth on 2011
Ukraine	2.8	205%
Japan	3.0	230%
Canada	3.7	-17%
Germany	4.8	-58%
Brazil	5.1	-39%
United Kingdom	5.3	-10%
South Africa	5.7	23410%
India	6.4	-49%
United States	23.4	-49%
China	57.7	23%

Top 10 countries. Total values include estimates for undisclosed deals
Source: UNEP, Bloomberg New Energy Finance

Figure 11. Asset finance of reneawable energy assets by country, 2012 and growth on 2011, $bn

The share of "green" energy in the world will continue to grow. For example, the largest oil company BP predicts that by 2030 the production of energy from renewable sources (excluding hydro and biofuels) will increase fourfold. According

to the Bloomberg New Energy Finance, the growth will be more than eight times, and the power of "clean" energy will reach 2.5 TWh by 2030. After 2020, the 50% of the alternative facilities which are being established will be based on the solar energy. Estimated by the Suntech Power Holdings figure is that by 2015 the half of the world's solar power will become compared to the cost of traditional energy (Scachko, n.d.). According to the information from the national Ukrainian institute of strategic studies, the irreversible depletion of the world's hydrocarbon reserves, the increasing price of energy, problems of environmental pollution are forcing most countries to shape its energy strategy to develop alternative energy. According to the International Energy Agency, by 2030 the share of electricity produced by alternative energy sources will double compared to today's figures, which account for about 16% of the total production. In most developed countries, including the U.S., Germany, Spain, Sweden, Denmark and Japan, there are plans to increase the share of renewable energy up to 20-50%. The European Commission believes that in 2020, one fifth of the Europe's energy will be produced from environmentally friendly sources (Dudchenko, n.d.).

While preparing the general overview of Ukrainian alternative energy market, it became clear that the spheres, which attract the majority of investments, are solar and wind fields. In Ukraine, technically, the total annual energy potential from alternative energy sources can reach the amount about 63 million tons in terms of standard fuel. The share of energy extracted by alternative sources is currently about 3%. According to the Ukrainian energy strategy to 2030, the share of renewable energy in the overall energy balance of the country will be brought to 20%. The main and most effective spheres of renewable energy in Ukraine are: wind power, solar energy, bioenergy, hydropower, geothermal energy. (Dudchenko, n.d.). I would like to stop a little bit more detailed on the issue of the solar energy. The role of solar energy has a lot of opportunities for development in Ukraine. The European Photovoltaic Industry Association notes that in 2012 the total capacity of solar power plants in the world increased by 32 GW and 100 GW exceeded. And, at that time more than 70 GW of solar power capacity were installed in the European Union. In 2012, the European Union has built solar power plants with total capacity of 17 GW. This is approximately half the total power of photovoltaic plants built worldwide. It is noteworthy that the share of European solar power is gradually reduced by increasing the role of solar energy in China, India, Japan and USA. In 2012, China and the United States have established 2 times more photovoltaic plants than in 2011, Japan - 1.5 times , India - 5 times. It is expected that these

countries will develop solar energy at a slower rate in the future. Despite the crisis in the European industry of solar silicon, thanks to the efforts of the Chinese producers prices for photovoltaic cells are reduced and, therefore, reduce the cost of solar electricity. Currently receiving a solar kWh is approaching to around 0.1 euros. It is predicted that the total capacity of solar power plants by 2015 will double and by 2020 it will be increased by 6 times (AlterEnergy Info, 2012). Ukraine annually receives the amount of solar radiation at the same level with countries, which are now actively using solar panels (Sweden, Germany, USA and other countries.). The entire territory of Ukraine is suitable for the development of heating systems, which use solar energy. The introduction of "green" tariff has been a powerful incentive for the development of the industrial generation of photovoltaic products in Ukraine.

There are the following major domestic solar power producers: JSC "Pillar", Prolog Semikor LLC and LLC "Silicone". PJSC "Semiconductor Plant" Ukraine was the main producer of polycrystalline silicon that meets up to 5% of global demand. After the collapse of the Soviet Union, only the "Semiconductor Factory" remained afloat. In 2008 the plant was purchased by Activ Solar (Austria) and started a comprehensive program of modernization. Since then, it has invested more than 300 million Euros in the modernization of the plant. It allowed in October 2010 to receive the first batch of polysilicon. The plant's capacity is 2,500 tons per year, and Activ Solar has plans to increase the production capacity. Total investment in the project until 2017 is estimated at $ 11.2 billion hryvna ($ 1.4 billion US$).

According to the EBRD, Ukraine in the near future is ready to become a leader in environmentally friendly economies in Europe, especially with regard to solar energy market, which is one of the most promising markets for renewable energy. At the moment, in Ukraine there is the largest solar power plant in Europe. It is estimated that that the market for solar energy in Ukraine will grow annually by 90% until 2015. In Ukraine there are all prerequisites for the successful development of the market of solar energy: highest DNI (direct normal radiation), high grace "green" tariff, the ability to use the principles of JI (Joint implementation) in accordance with the Kyoto Protocol in respect of projects using solar energy and the favorable provisions for the release of taxes. In addition, the Energy Strategy of Ukraine means achieving 20% of energy from renewable sources by 2020, and the Ukrainian reduced rate in respect of alternative energy is almost twice the rate of some members of the G8 (European-Ukrainian Energy agency, 2011).

As we can see the market of renewable energy has a big potential to be developed and to attract investments into Ukrainian economy. Moreover speaking

about investments, it should be mentioned that it is going on not only about foreign direct investments, but also domestic investments. For example, Ukrainian DTEK Wind Power plans to create in Ukraine a few wind farms with total capacity of 1.9 GW. DTEK Wind Power manages energy industrial and financial assets of SCM. Thus, in the Pershamaiski and Volodarskaya areas of Donetsk will be built two wind farms, total capacity of 0.7 MW. Also, DTEK Wind Power is interested in the construction of a number of wind farms with total capacity of 1.2 GW, which will be built on the coast of the Azov Sea. Total investment from the company DTEK Wind Power in the Ukrainian wind energy projects will amount to 2 billion Euros. It also has significant environmental benefits such as a working wind farm will reduce greenhouse gas emissions from the territory of Ukraine by 1 million tons (AlterEnergy Info, 2012). The increase of use of alternative energy resources may play a positive role as for Ukrainian commitments in frames of the Kyoto protocol.

Finally, I would like to mention that the alternative energy projects in Ukraine are actively supported by the international organizations. The European Bank for Reconstruction and Development is implementing an investment program in Ukraine that is called USELF. Under this program the Bank is going to fund directly the projects in alternative energy. Without involving the process of Ukrainian banks, USELF program provides an opportunity to get a loan from the EBRD if the investor is already invested in the project 40% of the cost. The lending rate will be determined individually for each project, but will not exceed 9%. Bank received applications to participate in the credit program from 80 Ukrainian companies and estimates to receive the same amount more. In most cases, the credit is available for projects in the field of solar and wind energy, that is, those which are subsidized by the end of 2013 by the state. By the end of 2013 the total cost of investment resources provided under the program USELF will be increased in three times. It was declared an intention to bring the overall level of lending to Ukrainian alternative energy up to 1 billion euros (AlterEnergy Info, 2012).

5. Summary

Ukraine is a country with high energy potential as well as good economic prospective. On its way to the prosperous future the country faces some ground problems, among them: corruption, political instability, old and inefficient energy

system. Due to these factors Ukraine is lagging in its developing comparing to some other more successful countries from the former soviet bloc.

In this paper it is proposed some initial, however very important steps in terms of changing the energy system, which should help Ukraine to become a strong and economically more successful state.

In general the steps are divided into two main groups according to the time frames into: short term and long-term perspective.

In a short run it is vital to start changing the current system in legislation and approaches. It is necessary to change the angle of views on the energy system. It is necessary to understand that we have to change a lot in our minds, especially the understanding that energy will be not cheap. This factor might seem not relevant for the western people; however, this is a big issue for such countries as Ukraine. Because of the soviet past, people got used to the fact that energy is cheap. We don't have the "culture" of saving energy. Moreover, low level of income in Ukraine makes this problem even more complicated. Nevertheless, the most essential steps in the short run are the following:

- Improve the legislation and fight with corruption
- To increase the energy efficiency in households
- Study carefully the price regulation and adapt its implementation to the social situation in Ukrainian society
- Creation of special programs, negotiation with banks in order to develop social programs for funding energy efficient projects for households and business;
- Improvement of thermal power plants condition

Each of these steps is quite complex because it usually involves all the spheres, layers of society and considerable investments. However, it is not impossible. There are already existing projects, which deal with increasing energy efficiency. They need to have the support from government. The role of thermal power plants is also of great importance to Ukraine. This type of energy should be renovated. New power plants have to be constructed and the old ones have to be shut down. Due to old technology it is even more economically feasible to construct brand new plant than to spend huge costs for operating the old ones.

Especially important is to start working with the society. The understanding the purpose of energy saving can really help reduce the energy consumption in households. Renovation of heating systems in households can decrease costs for energy money for people and thus increase energy efficiency. There can be several

possibilities of finding the financial source for renovation: creation of social programs for heating systems renovation by banks, government. There is also a possibility to borrow the foreign experience such as appearance of companies, who fully take costs for renovating the systems with signing a contract with the flat-owners for some 10-20 years, while the last ones keep paying the current energy prices to this company according to the contract. There is also a necessity to copy the existing model of financing the construction of the power plants such as different kinds of PPP (Public–private partnership).

However all the changes need to go parallel with the changes in legislation as well as prices regulation. Such poor condition of the energy legislation regulation does not allow making real changes.

In the long run there are following necessary steps on the way to a sustainable energy system:

- Build new efficient power stations (flexible power plants)
- To decrease gas dependence from imported resources,
- Increase significantly the efficiency in households and industry.
- Increase the share of the renewable energy

In a big way it is a continuing of the short-term steps, because the purpose of the last ones was to prepare the ground for the real big transformation of the energy system. The idea of construction the new flexible power plants is supported by the argument that in future the share of renewables will grow, but in order to have a stable energy supply there is a necessity to have the power plants, which will cover the fluctuations in the load. It will allow starting or shutting down a plant very quickly with the minimum losses. Ukraine needs to integrate its electricity system to the system of EU. This will create a very stable and reliable system, when the excess of energy in one country can be easily transferred to another, who suffers electricity shortages. Such king of cooperation will decrease the problem of energy storages for the energy receives from renewable sources.

As a final aim, Ukraine will also need to increase the renewable energy sources. It may become the factor of economy improvement in case of attracting investments, but what is more important make Ukraine energy secure country.

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