

**RENEWABLE SOURCES OF ENERGY IN UKRAINE**

**by**

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## PLAN

### **Introduction:**

#### **Chapter 1**

1.1 Energy profile of Ukraine

1.2 Energy strategy of Ukraine

#### **Chapter 2**

Renewable sources of energy in Ukraine

2.1 Potential

2.2 Legal basis

2.3 Local players (local overview)

2.4 Foreign investments in the sector of renewable (foreign overview)

#### **Chapter 3**

3.1 European Union ó Ukraine cooperation in renewable energy sector

#### **Conclusion**

## INTRODUCTION

The population of our planet today receives 90% of energy by using coal, oil, natural gas and nuclear fuel. The energy consumption of humanity is constantly growing, but according to current estimations conventional sources of energy will be enough for about 40 years what makes the advantages and increasing need for development of alternative sources of energy crucial and inevitable.

The increase of energy prices, the perception of seriousness of global climate change, unsolved problems of nuclear power is only part of the reason that force to seek alternative energy solutions for Ukraine as well.

Over the next years Ukraine has the urgent task to adapt its energy sufficiency based on created in 1970s and 1980s generating and transmitting capacities to the needs of the urgently developing modern industrial society. At the same time the energy policy of Ukraine must guarantee safety of delivery and/or diversification of international dependence, increase of effectiveness of production and usage of electric energy and thermal power, as well as to take into account climate and environmental protection.

The production of electric energy and thermal power in Ukraine has been traditionally based on such energy carriers as coal, gas and atomic energy. In the latest Energy Strategy of Ukraine up to 2030 the state gives high importance to continuation of production of coal and atomic energy.

In future Ukraine may safeguard the necessary volume of firsthand energy carriers for technologies of generation of such electric energy (coal and uranium) by its own means, what can help decrease the level of its dependence on Russian gas and guarantee price stability.

The part of coal in production of electric energy comes up to 44% and until 2030 has to stabilize on this level or to increase a little. Natural gas has no more basic role in production of electric energy while until 2030 its part in production of thermal power has to decrease approximately 1/3 of today's total volume. The part of nuclear energy in production of electric energy comes up to 48% and production of new 11 nuclear reactors will increase this number up to 52% in 2030.

Ukraine has a well developed technical potential for usage of renewable sources of energy and thanks to its vast agricultural sector there are good perspectives for usage of biomass energy. As comes to hydroenergy, its potential is almost totally exhausted, but at the same time it can be enlarged by the increase of effectiveness of hydroelectrostations. Wind energy potential is

concentrated mainly on the West and South of Ukraine ó in Carpathian mountains and in the Autonomous Republic of Crimea. Besides that, there is a rather satisfying technical potential for development of solar and geothermal energy but at the same time in the nearest future its utilization is not considered economically rentable.

Renewable source of energy in Ukraine play a secondary part in the energy policy of the country. The part of renewable that is planned in the Energy Strategy of Ukraine, that is approximately 6% up to 2030, is considerably lagged from the possibilities of economic potential. These possibilities today exist in such segments as biomass and hydroenergy and in future ó wind energy.

Focus on energy production based mainly on fossil sources hides the danger that combined with economic development and increase of demand for energy carriers there will be a larger emission of hotbed gas. As a result Ukraine will be not ready for possible future obligations regarding environmental and climate protection which are quite possible in case of the continuing European integration of energy markets.

The increase of prices in summer 2010 and further increase in 2011, creates microeconomic stimulus for more effective usage of energy and improvement of framework conditions for improvement of renewable sources of energy.

What makes Ukraine very peculiar is a very tight connection between the state and the private capital. On the one hand, it makes easier the implementation of large projects (including renewable sources of energy), organized on the basis of private economy, as they can be implemented õfrom the top to the bottomö. On the other hand, such approach decreases the level of trust of foreign investors to the political structures and slows down the activity of middle enterprises.

Over the recent years since the beginning of the process of democratization of Ukraine there have been formed certain powers of civil society who along with their active position as to ecology and climate protection also demand a vaster usage of renewable sources of energy. Partially it rose the volume of new instruments of influence on the development of renewable sources of energy as well, for instance the law on Green tariff which temporarily stimulates production of energy from renewable sources.

The development of the renewable energy sector in Ukraine will be tightly connected with a number of general political and economic factors which will influence the investment climate and economic welfare of the country in general.

In Chapter 1 the energy profile of Ukraine as well as Energy Strategy of Ukraine is presented, focusing on description of traditional energy sources that are most commonly used in Ukraine. The Energy Strategy of Ukraine is described mainly from the angle of importance of renewable sources of energy for Ukraine today and in future.

In Chapter 2 the potential for development of renewable sources of energy as well as the legal basis for its implementation is overviewed. Additionally, the outlook on the local players in the renewable energy market and the foreign investment situation is presented.

Chapter 3 deals with the cooperation between the European Union and Ukraine in the sector of energy efficiency and renewable sources of energy.

Next follows the conclusion and bibliography.

## CHAPTER 1

### 1.1 Energy profile of Ukraine

#### Ukrainian SSR

Over the years of the Soviet Union epoch Ukrainian SSR transformed into a highly developed industrial-agrarian republic with a diverse complex of light, hard, food industry as well as with multi-dimensional agrarian sector. Totally the industry of the Ukrainian SSR counted approximately 300 sectors, where one of the leading industries was the energy sector .

Electric energy is the basic sector of industrial complex, and the usage of electric energy is the moving power of scientific and technical progress. This sector influences the territorial organization of producing powers. All electric stations or electric plans can be divided into four types according to the energy recourses used:

- Heat electric power plants
- Hydro electric power plants
- Atomic electric power plants
- Electric power plants functioning by means of renewable sources of energy (wind, solar).

[15; 2010]

By 1984 over 17,2% of the over-soviet electrical energy production sector belonged to the Ukrainian SSR. In 1990 66,7% of production powers were concentrated in thermal power plants, 24,8%- Atomic power stations, 8,5% - hydro-electric power stations (in comparison to 1980 with the indexes 85,4%, 5,5% and 9,1% respectively). In the total volume of industrial production electric energy accumulated 3,2% in 1990, while today this number has changed reasonably ó at 12-15% ( 2008, . 24-26).

*Thermo power plants.* In 1984 there were 12 thermal power plants in the republic with the total power of 1 mln KW and more. These were: State District Power Plant Ugegorskaya, State District Power Plant Zaporozhkaya, State District Power Plant Krivorozhskaya, State District Power Plant Burtishanskaya, State District Power Plant Znievskaya, State District Power Plant Voroshilovgradskaya, State District Power Plant Starobeshevskaya, State District Power Plant Pridnestrovskaya, State District Power Plant, State District Power Plant Slavianskaya, State District Power Plant Ladijinskaya, State District Power Plant Tripolskaya, State District Power Plant Kurahovskaya and others ( . 2009, .213).

The combined production of thermal and electrical energy in Heat Electric Generation Plants recognized large development on the territory of the republic. Such huge heat electric generation plants as Kievskaya-5 (700 thousands KW), Harkovskaya-5, Kievskaya-6, Lvovskaya, Darnitskaya and Severodonetskaya functioned in the Ukrainian SSR ( . . . . . 2009, .218).

*Atomic power plants.* On the territory of Ukraine there were five largest atomic power plants that generated electricity:

- Chernobilskaya APP,
- Rovenskaya APP,
- South Ukrainian (Yuzhnoukraniskaya) APP,
- Zaporozhskaya APP,
- Khmelnitskaya APP.

Apart from that Krimsiaya APP, Odesskaya Atomic Electric Generation Plant, Harkovskaya Atomic Electric Generation Plant were being constructed ( . . . . . 2009, .220; . . . . . 2007, .17).

*Hydro electric power plants.* There were numerous hydro electric power plants in the republic, that stretched along the Danube river:

- Kievskaya
- Kanevskaya
- Kremenchugskaya
- Dnieprotzerjinskaya
- Dnieprovskaya named after Lenin
- Kahovskaya ( . . . . . 2007, .17)

The construction of hydroelectric pumped storage power plants also received very important development in the Ukrainian SSR: thus, the first such power plant erected in the USSR was the Kievkaya Hydroelectric pumped storage power plant. On the bank of the river Yuzhniy Boug the unique South-Ukrainian energy complex was being constructed, which was supposed to unify the South-Ukrainian (4 mln KW), Tashlikskaya (1,8 mln KW) and Konstantinovskaya (0,4 mln KW) hydro pumped storage power plants as well as Tereble-Rikskaya hydro pumped storage power plant in Zakarpattya region ( . . . . . 2009, .232).

*Energy systems.* The first lines of electric power transmission with the electric potential of 110 KW was constructed in 1926. It unified Shterovskaya hydro pumped storage power with Kadievka city. In 1984 the total electric power transmission lines of the Ministry of Energy of the Ukrainian SSR came up to 880 thousands km, including the electric power transmission lines over 35 KV ó 116,8 thousands km.

The main generating powers of the republic were concentrated on eight generating energy unions: Vinnitsaenergo, Dnieprenergo, Donbassenergo, Kievenergo, Krimenergo, Lvivenergo, Odessaenergo, Harkovenergo. On the territory of the Ukrainian SSR the United Energy System of South, that was included in the United Energy System of USSR was functioning. (4;2010)

As far as fuel industry is concerned, in the total volume of the industrial production of USSR the share of fuel industry comprised 6,1% in 1984, while approximately 1/3 of the capital was spent on its development. The production of coal, oil and natural was made. In the total volume of industrial production fuel production comprised 5,7% (while today this number comes up to 10-12%). In 1990 the structure of production was the following:

- coal ó 76,7 %,
- natural gas ó 18,7 %,
- oil ó 3,8 %,
- other ó 0,8 % (mainly lignum fossile) (4; 2010).

After the collapse of the Soviet Union and the independence of Ukraine in 1991, the leading role in electric energy production was passed to heat electric power plants, which generate over 60% of the total electric energy in the country. The majority of large heat electric power stations are located in Donbass region (Donetsk Oblast) (12; 2010): these are Uglegorskaya, Starobeshevskaya, Kurahovskaya, Slavianskaya heat electric power stations, etc. One of the largest heat electric power stations are Krivorozhskaya-2, Pridneprianskaya (Dniepropetrovs Oblast), Smievskaya (Karkov Oblast), Burshtinsk (Ivano-Frankovsk Oblast), Zaporozhie (Zaporozhie Oblast), Ladizhinskaya (Vinnitsa Oblast), Tripolskaya (Kiev Oblast), Dobrotvorskaya (Lvov Oblast), etc.

Heat electric generation plants begin to acquire large importance, the biggest from them are Kiev heat electric generation plant-5 and 6, Darnitskaya, Harkovskaya, Odesskaya, Kramatorskaya heat electric generation plant, etc.



Atomic energy sector in Ukraine is represented by such functioning powerful atomic electric power plants as Zaporozhskaya, Yuhnoukrainskaya, Rovenskaya, Hmel'nitskaya, Chernobilskaya. Owing to the social pressure, the construction of Krimskaya, Chigirinskaya, Karkovskaya and Desskaya atomic electric power plants was banned and terminated [12;2010].

Atomic electric power plants are oriented exceptionally on consumers, especially on regions with limited sources of energy and fuel and produce around 35% of the total volume of electric energy production in Ukraine.

Hydro electric power plants of Ukraine ó Kievkaya, Kanevskaya, Kremenchugskaya, Dnieprodzerzhinskaya, Dneproges, Kahovskaya, Dniestrovskaya, Tereble-Ritskaya ó are almost ineffective due to out-to-date equipment and morphological conditions of the territories where they are located. Hydro electric power plants produce around 4,5% of the total volume of electric energy production in Ukraine. The total number of hydro electric power plants located nearby the banks of small rivers are fifty five [ 2008, . 10-17]:

The largest consumer of electric energy is industry (65%), transportation (10%) and agriculture (10%), construction and other sectors of economy. Nowadays the energy sector of Ukraine is being in a deep crisis due to the out-to-date equipment, absence of sufficient state financial support and foreign investment [6, 2011].

One of the way outs from this tragic situation is to take into account the advantageous geopolitical and geographical position of Ukraine and related its role as a transit country in terms of globalized energy processes.

### **Structure of primary energy consumption in Ukraine, EU-15, the U.S. and the world at large**

	<i>World</i>	<i>Ukraine</i>	<i>EU</i>	<i>USA</i>
<b>Natural Gas</b>	21%	41%	22%	24%
<b>Oil</b>	35%	19%	41%	38%
<b>Coal</b>	23%	19%	16%	23%
<b>Uranium</b>	7%	17%	15%	8%
<b>Other renewable sources</b>	14%	4%	6%	7%
<b><u>TOTAL</u></b>	100%	100%	100%	100%

*Source:* 2009, . 4

The recently explored reserves of coal in Ukraine amount to 52.6 milliard tonns that can satisfy demands of Ukraine for hundreds years. The main reserves of black coal are concentrated

in the Donetsk and Lvov-Volyn` coalfields, brown coal - in Dnepropetrovsk Oblast. From 1990 to 2000 annual mining of coal dropped from 165 to 83 mill t. It was because of economic crisis, structural restructure of the branch and competitiveness with relatively cheap natural gas from Russia. Potential productivity of currently existing mines makes 109 mill t/year and there is intention to rise coal consumption for energy generation. According to existing plans coal mining must be reached 110 mil t in year 2010, 117 mill t in 2010 and 120 mill t behind 2030. [15: 2010]:

Explored reserves of oil and gas condensate in Ukraine amount to 222 mill t. For the most part they are small fields, which will not be able to cover demands of Ukraine. The maximal extraction of oil - 14.5 mill t - was achieved in 1972. From 1990 to 2000 oil extraction dropped from 5.2 to 3.8 mill t/year at the demand of about 35 mill t. It is planned in the future to stabilise oil extraction at a level of 5.2 mill t/yer [ . 2007, . 54-55]. In 1970s a number of large fields of natural gas were worked. In 1975 natural gas extraction was 68 milliard m3. Remaining now gas reserves are dispersed over small fields, which cannot cover Ukraine`s demands. In 2000 natural gas extraction was 18 milliard m3 at annual consumption of about 70 milliard m3. It is planned in the future to stabilize natural gas extraction at a level of about 31 milliard m3/year.

There are big deposits of uranium ore in Ukraine, which are considered the greatest ones in the world. Availability of uranium ore permanently generates intention to create complete cycle for the extraction of uranium and processing of nuclear fuel in Ukraine.

## 1.2 Energy strategy of Ukraine

Position of Ukraine on international energy markets shares certain advantages and disadvantages.

Advantages include [5; 2010]:

- É Sufficient supplies of coal and nuclear fuel components, uranium and zirconium;
- É excess capacity for transporting gas, oil and electricity exports;
- É advantageous geographical and geopolitical position;
- É developed energy infrastructure;
- É highly skilled human resources.

Disadvantages include [5; 2010]:

- É limitations of explored reserves of natural gas, oil and nuclear fuel produced;
- É lack of diversification of energy sources;

É use most of their water resources facilities;  
 É high technogenic load on the environment;  
 Époor technical condition of energy facilities, including energy transportation systems.

In March 2006, the Cabinet of Ministers approved the Energy Strategy for the period until 2030, which outlines strategic objectives for energy sub-sectors that aim to enhance the country's overall economic development and people's well-being [ 2008, . 87-88].

The main goals of the state strategy are the creation of conditions for a sustainable and high quality energy supply, to ensure reliable and sustainable functioning of the energy industry and its efficient development, to reduce energy dependency and intensity, to increase the environmental and civil safety as well as to integrate Ukrainian power industry into the European system while increasing power exports and strengthening the country's position as gas and oil transit country.

The Energy Strategy specifies that Ukraine will increase the use of renewable and non-traditional sources of energy from 10.9 mtce in 2005 to 40.4 mtce (18.3% from total energy consumption, including 9.2% from biomass) in 2030 what will require investments in this sector in the amount of approximately 60.4 billion UAH [13, 2009].

The largest increase is expected in the use of solar energy, methane gas from coal mines and heat. The strategy envisages that the electricity production from renewable energy will increase up to 1.6 billion kWh in 2020 and 2.1 billion kWh in 2030.

As this thesis is focusing on the renewable sources of energy in Ukraine, I am going to pay attention to the Energy Strategy of Ukraine that deals only with renewable sources of energy without mentioning traditional resources which are both produced and imported by the state. Legal, economic, environmental and organizational principles for the use and promotion of the use of all alternative sources of energy in the fuel-energy mix were underlined in the Law of 20.02.2003 No. 555-IV "On Alternative Sources of Energy" [6, 2011]. Article 1 of the Law contains the definitions of "alternative sources of energy", "alternative energy", "alternative energy facilities", and "sphere of alternative energy". Under this Law, alternative sources of energy include renewable energy sources such as solar energy, wind energy, energy from the seas (wave and tidal), rivers, biomass, geothermal energy and "secondary energy resources that exist constantly or are periodically generated in the environment". Energy equipment is

considered to be alternative if contribution of renewables is not less than 50% of installed capacity.

Despite the de jure existence of a Law for renewable sources of energy in Ukraine, its weak part is its declaratory nature and the absence of concrete supporting mechanisms and instruments for energy production from renewables.

The basic principles of the state policy in the sphere of alternative sources of energy are [ . 2009, 48-49]:

- increasing production and consumption of electricity generated from alternative sources to decrease Ukraine's dependence on the import of traditional energy sources;
- improving the local and global environment by reducing the negative impact on the environment by consuming electricity generated from alternative sources of energy rather than from fossil fuels;
- appropriately managing the environmental impact during the construction and operation of alternative energy facilities and in the transmission and supply of electricity generated from alternative sources of energy;
- attracting domestic and foreign investments and supporting entrepreneurship in the sphere of alternative sources of energy, in the development and implementation of the national and local programmes promoting of alternative energy.

Currently the following state programmes on the development of renewable sources of energy in Ukraine are being undertaken at the national level [ . 2009, 48-49]:

- The National Energy Programme of Ukraine to 2010 approved by the Resolution of the Verkhovna Rada of Ukraine of 15 May 1996 No. 191/96-VR "National Energy Program of Ukraine to 2010" envisages 10% covering of general energy consumption by renewable energy sources; the commissioning of 190 MW wind farms by 2010
- The State Support Programme for the Development of non-traditional and Renewable Energy Sources and Small Hydro and Thermal Power Plants approved by the Resolution of the Cabinet of Ministers of Ukraine of 31 December 1997 No. 1505. The target is 10% of renewables till 2010 year from general energy consumption
- The Comprehensive Wind-farm Construction Programme approved by the Resolution of the Cabinet of Ministers of Ukraine of 3 February 1997 No. 137

- The State Programme for Scientific and Technical Support "Ecologically Clean Geothermal Power Engineering in Ukraine" approved by the Resolution of the Cabinet of Ministers of Ukraine of 17 January 1996 No. 100. Although this resolution expired in 2001, the energy potential of geothermal resources is tapped under this programme.
- Program "Ethanol" was approved by the cabinet of Ministers in 2000 (Decree #1044 of 4.07.2000) and is directed at wider use of ethyl alcohol as energy carrier and raw material for industry. One of its tasks is to start production of environmentally friendly blend petrol. Main lines of the Program include the production of high-octane oxygen containing admixture to petrol (HOA - Ukrainian analogue of bio-ethanol), ethyl tertiary butyl ether (ETBE), ethylene, acetone, synthetic rubber, and biodiesel. It is planned to realize the Program in two stages: 1 stage (2000-2005) - to start production of high-octane oxygen containing admixture to petrol, ETBE, technical alcohol, ethylene, acetone, ethyl acetate, styrene; 2 stage (2005-2010) - production of ethylene and its derivatives including biodiesel. Financing of the Program is envisaged at the expense of own funds of enterprises (including involved credits) and the fund "Ethanol" which is planned to be created by common agreement of enterprises - executors of this Program [2, 2009].

The state Law on renewables envisages the creation of national, regional and local programmes in the area of alternative energy sources, especially the provision of financial support for scientific and technological research. It is intended that organizational support of the activity would include:

- granting licenses for production of electric, thermal and mechanical energy from alternatives sources and its transmission and supply;
- granting licenses for production of geothermal energy;
- granting construction permits for energy facilities that use solar irradiation, wind, and tides;
- granting construction or renewal permits for hydro power facilities on small rivers;
- granting licenses for construction and operation of networks to transmit energy generated from alternative sources to customers;
- defining the sources and purposes of financial support for alternative energy sources;
- granting approvals to the network operators for connection of facilities that generate electricity from alternative energy sources to the interconnected power system of Ukraine irrespective of the ownership of the facilities;

- creating records of the available resources of alternative energy sources;
- inspection and technical compliance approval of generating facilities [2, 2009].

While the Law envisages that permits for the location and construction of facilities generating electricity from alternative energy sources and for the construction of networks to transmit alternative source electricity to customers will be granted, it fails to determine the conditions and procedure of granting these permits what is a huge obstacle that legs the overall development of renewable in the country.

According to INTERFAX Ukraine, In September 2011 the Verhovna Rada of Ukraine (the main legislative power of the state) set new priorities for innovative activity for the next ten years. According to this law, the priority sectors for innovative activity in Ukraine are divided into strategic, which are to last for ten years, of medium-term priority, with the duration of up to five years and address the implementato of tasks of strategic priority. Therefore, it is important to mention that development and implementation of new technologies of energy transporting, introduction of effective energy conserving technologies, development of renewable sources of energy and development of high-technology transport system development are among the strategic priorities of Ukraine for the years 2011-2021 [ 2010 [online]].

Ukraine is a country experiencing power shortages, and therefore imports 75% of natural gas and 85% of oil and petroleum products. Such structure or energy and fuel balance is critical and unacceptable from the point of view of energy security of the country. Since the majority of energy is consumed by industrial production, especially by such sectors as metallurgy, chemical and oil-refining industry, the share of energy in the cost of a final product comes up to 30-50%. In several enterprises this index comes up to 60%. Thus in general, in Ukraine the energy ratio of GDP is three to five times bigger in comparison to developed countries of the West. This means that a product that is produced in Ukraine will have a much higher cost of price in comparison to the respective product abroad. According to the State Committee on Energy Efficiency, at the end of 1990s Ukraine bated not only the leading states of the world according to this index, but also to neighbouring states such as Poland and the Russian Federation. We can achieve a more clear image considering the level of retard as to energy efficiency of production through the following table.

GDP Energy Efficiency in Ukraine and in certain regions and countries of the world by reference

fuel in indexes of oil equivalent (o.e.) and volume of GDP production per citizen.

Region, country	GDP Energy efficiency (kg o. ./ \$US)	GDP per one citizen, thds. \$US
World	0,31	-
EU	0,27	-
Japan	0,20	29,96
France	0,24	27,74
Germany	0,25	26,18
USA	0,34	31,75
Poland	0,47	4,10
Russian Federation	0,90	1,94
Ukraine	0,98	0,83

Source: , . / . //  
 . - 2009. - 2

The reasons for such a dreadful situation in the sector of energy efficiency lie in the past as well as in the present. In the part energy expenditures in the economy of the Ukrainian SSR were 25% higher in comparison to the average index in the Soviet Union. Having overcome the energy crisis of 1970s, the leading countries of the world re-oriented their energy policies to the increase of energy efficiency. At the same time the decrease in GDP energy ratio came up to 46% in the USA, 35% in Japan, 32% in the EU. The Soviet Union during this period lagged even more as the decrease in energy ratio in its economy came up to 16%. ( . 2009, . 38-43)

After the collapse of the USSR destructive processes were taking place in the economy of the newly formed independent former Soviet republics: productive funds were not updated, a large share of economy was transformed into shady economy, the disorganization of enterprises increased with the aim of reaching the line of bankruptcy and sell out at ridiculously low prices. Part of the productive potential became property of foreign investors, whose goal was not the

update of production, but achievement of profit from the existing basis or even worse ó making them bankrupt which was a means of destroying the competitors [12, 2010].

The high energy requirements of Ukrainian production and inability to carry out power system reform and create a stable market diversified oil and gas, combined with errors in conducting foreign policy became a catalyst for gas blackmail of Russia, which rapidly raised the price of hydrocarbons.

A significant proportion of energy pricing has led to a decrease in competitiveness of Ukrainian products on the global and domestic market. The situation became particularly acute in the industry where the share of energy in the rental price was about 60%, whereas in developed countries, sectoral index did not exceed 25%. As a result, steel production has long been unprofitable that caused the crisis in its 90 years [12, 2010].

Part of an industrial complex has been reconstructed, allowing us to renew production. But on the whole situation with the fuel and energy resources passed through the increasingly complex times. The reason - the new prices, which by the late 90s increased by six times.

Thus, today energy efficiency of industrial production and reduction of energy expenditure in Ukraine is no question of economic feasibility, but the question of survival. If it is resolved, the economy of Ukraine in the context of its accession to the WTO will go bankrupt, not being able to achieve effective sustainable domestic consumption and imports. Gradual and consistent of the energy savings can give up to 1 / 3 of energy. Savings can be directed to upgrade outdated technology base, new technologies, raising the living standards of people [13; 2008].

Recently, the new State Target Economic Energy Program the period of 2010-2015 was introduced in Ukraine. The objectives of the programme are creation of conditions for convergence in energy intensity of gross domestic product of Ukraine to the level of developed countries and EU standards, reduction of energy intensity of gross domestic product during the term of the Program by 20 percent compared with 2008 (by 3.3 percent annually), increase f efficiency of energy resources and strengthening the national economic competitiveness, optimization of the structure of national energy balance by reducing the share of imported fossil energy, particularly natural gas, and substitution of other forms of energy, including derived from alternative energy sources and secondary energy resources [13; 2008].

The problem is supposed to be solved by introduction of new technologies of production and consumption of energy resources, cogeneration technologies and technologies that involve the



use of heat pumps, electric heating and heat water supply; use of thermal solar energy and geothermal energy; extraction and use of gas (methane) coal fields as alternative energy; production and use of biofuels; development of wind power; upgrading the transmission system, heat and water supply, power plants and cogeneration plants; measures to reduce energy consumption by institutions functioning by the state budget; reduction of environmental pollution; legislative regulation of the reduction of energy intensity of gross domestic product and optimization of the structure of national energy balance, adaptation of national legislation on energy efficiency, energy conservation and alternative energy to the EU legislation; creating favorable conditions for attracting domestic and foreign investment in energy efficiency and energy conservation in order to optimize the structure of national energy balance, reducing emissions of polluting substances; formation of the state system of monitoring and control for efficient use of energy resources, the implementation of sectoral and regional programs for energy efficiency, increased reliability of statistical information on indicators of energy consumption [ « » 2010, .25-28].

## **CHAPTER 2**

### **Renewable sources of energy in Ukraine**

#### **1. Potential**

Ukraine has enormous potential for energy efficiency as its energy intensity is inordinately high. The largest efficiency gains can be achieved in the metallurgy, fuel, power and chemicals sectors. Improved efficiency and lower costs will reverberate through the economy as their output is used by other sectors, and will improve national energy security.

The energy saving potential for the country has been determined at almost 50% of the volumes of used fuel and energy resources.

**Wind.** Ukraine has favourable conditions for development of wind energy. The greatest wind energy potential is located in the vast areas adjacent to the Black Sea and the Azov Sea, as well as the Carpathian, Transcarpathian and Lower Carpathian areas. It is considered that installed capacity of wind power plant that can be achieved as a part of centralized energy system of Ukraine may come up to 16000 MW, and power generation may come up to 25-30 TWh/year. This figure is often accepted as a potential of wind power. The area necessary for the construction of such a WPP capacity is 2500- 3000 km<sup>2</sup> that is quite real taking into account shoal of the Azov Sea and the Black Sea. According to other estimations 7000 km<sup>2</sup> of Ukraine's territory can be

used for the construction of WPP of 35000 MW total capacity. Currently total capacity of WPP is 50 MWe. For the period till 2030 it is predicted the construction of WPP of 11290 MW total capacity with annual power generation of nearly 25 TWh/year [ . 2009, . 11].

According to State Energy Efficiency Agency, the annual potential of wind energy in Ukraine comes up to approximately 500 mln MW. Today, according to the Renewable Energy Resources Market Players Association, there are 11 large wind stations functioning in Ukraine with the total power of 98 MW. According to the President of this Association over the year 2012 the power of ewind energy production can double.

According to the research made by the agency RosBusinessConsulting, the market of wind energy in Ukraine demonstrated the largest dynamic in development among all the CIS countries and was bigger than in some European countries. Since the independence of Ukraine in 1991 approximately 1170 wind aggregates of 10 KW were installed in Ukraine, the largest share of which was installed over the last 1,5 years. The total power of functioning in Ukraine low power wind generators reaches 12 MW which is over 11% of the total power of all functioning energy generators in Ukraine.

According to the National Renewable Energy Institute of Ukraine, a wind energy station of 100 MW can annually supply budgets of all levels by 100 mln UAH from taxes, which is why the development of this kind of renewable source is highly profitable for the state [ . 2009, . 117-121].

The wind energy market continues to grow. It is characterized not only by production of competitive equipment, but also by enterprises dealing with trade, installation and further services. Ukrainian wind aggregates already function in Poland, Germany, Hungary, FYROM.

Another factor that characterizes the development of wind energy market is that the Ukrainian consumer increases its trust to alternative sources of energy as he sees profit in its usage.

According to New Energy Ukraine alliance, Ukraine can use 300-400 MW of wind energy powers up to 2013 which means that wind energy could replace around 4% of all generating powers of Ukraine which according to recent estimations come up to 52 GW.

Nevertheless, the development of this sectors faces obstacles due to the following reasons: problems with getting land for construction of wind parks, slow ornithological researches, partial readiness to renewable energy by energy grids.

Wind generators became most popular among owners of cottages and summer houses, countryside hotels and peasant houses. The reason for this is the absence of proximity to the basic energy sources and in the above mentioned case wind generators are used as supportive powers in case of problems with central energy supply systems. Such consumers became active since 2010.

**Solar energy.**Period of sun shining at the territory of Ukraine is 1900-2400 hr/ye and total average annual solar radiation varies from 1070 kWh/m<sup>2</sup> in northern part of Ukraine to 1400 kWh/m<sup>2</sup> in Southern part. Existing programmes for energy development envisages increasing use of solar energy mainly for local hot water supply in summer season. Potential of solar energy for heat production is estimated at about 32 TWh. Climatic conditions of Ukraine allow to use solar energy for the heating of buildings, creation of year-round centralized district heating systems with seasonal heat storage. Such technical solutions have been already realized in many countries located much more to the North than Ukraine. When using solar collectors and 400 kWh annual heat production by 1m<sup>2</sup> of solar collector potential of solar energy for heat production is almost 75 TWh/year [ 2007, . 17].

Solar energy has been developing all over the world, including Ukraine, where there is a large potential of the market for this kind of energy (the volume of solar radiation reaches from 800 to 1450 W/sq.m a year). At the end of 2010 in Crimea next to the village Rodnikovoe the first and largest in CIS countries solar station of 7,5 MW was constructed. In July 2011, the new station near to the village Ohotnikovo started to function, and it is expected to become one of the largest in the world. By the end of 2011 its total power volume is expected to increase up to 80 MW.

By 2013 the solar energy market players expect an increase of demand for solar panels and collectors. The main demand is expected from large industrial objects, supermarkets, agricultural enterprises, mountainous settlements, etc. according to estimations, by that time the cost for natural gas (which is the main energy source) in the inner market of the country will double ó the fact that will become a huge stimulus for the continuous increase of renewable energy production and the development of investment projects in the sector of renewable sources of energy [ 2007, . 17].

According to experts, the price on the produced solar electric energy decreased by two times over the last five years mainly owing to the improvement and development of photovoltaics. But even the relatively high prices are not an obstacle for many enterprises and organizations who install roof solar systems in their premises.

**Photovoltaic (PV).** In Ukraine technical potential of solar energy for power production is estimated at about 16 TWh/yr that makes up in average about 3.3 m<sup>2</sup> of PV batteries per capita with the production of about 100 kWh/m<sup>2</sup>/yr. provided that a dwelling is equipped with modern and promising energy saving household appliances, indicated volume of power production could satisfy necessary household needs. It is assumed for year 2030 the PV-power generation makes 2 TWh/year and that for 2050 makes 9 TWh/year [ 2007, . 10-12].

**Biomass.**The total potential for biomass was estimated at 86,300 GWh per year. Ukraine currently gets under one half of one percent of its energy from biomass resources and biofuels however, it is estimated that Ukraine could produce more than ten times its current level.

Production of energy from renewable sources is dynamically developing in most European countries. In 1995, the EU countries the share of renewable energy sources (RES) was 74.3 million tonnes of oil equivalent (o. e.), Representing about 6% of total primary energy consumption (TPES). Of these, the share of biomass accounted for more than 60%, equivalent to about 3% of TPES. In some countries the contribution of biomass in TPES is significantly higher than the European average in the USA, its share is 3.2%, in Denmark - 8%, Austria - 11%, Sweden - 19%, Finland - 21%. In accordance with the development of renewable energy (White Paper), biomass in the EU will cover about 74% of the total contribution of renewable energy in 2010, which would be equivalent to about 9% of TPES. It is clear that biomass is the most developed and steadily growing sector of RES in the EU [ 2007, . 10-12].

Table 3 shows the structure of the energy potential of biomass based on the likely and optimistic estimate. Both estimates were made by the Institute of Engineering Thermophysics of NASU. According to the optimistic forecast of the total potential of biomass available for energy use in Ukraine is 17.6 million tons of coal equivalent, probable forecast gives 6.10 million tce In both cases, the bulk potential is agricultural waste (straw, stalks, husks, etc.). One of the main differences between the forecasts is to assess the potential of straw. In the likely approach is that only 20% of the total amount of straw can be used for energy purposes. In addition, it is not considered the potential of fuel from municipal solid waste (MSW) and biogas produced from sewage sludge.

**Table 3. Energy potential of biomass in Ukraine (2001 )**

Biomass type	Energy potential, mln	Energy potential, mln
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	tones/year (probable estimation)	tones/year (optimistic estimation)
Grains / straw (excluding maize)		
- wheat	0.97	
- barley	0.79	
- oats	0.10	
- rye	0.15	
- other	0.77	
Total for crops	3.63	5.6
Corn for grain / stalk, cobs	1.19	2.4
Sunflower / stalk, husk	2.31	2.3
Manure / biogas	1.59	1.6
Waste water / biogas	-	0.2
Landfill	0.3	1.6
waste wood		
- Wood not removed at felling (felling residues), W 50-60% - moisture)	0.32	
- Waste timber industry for sawing logs, W 40-45%	0.11	
- Waste at the docks in the manufacture of finished goods, W 25-30%	0.18	
- Wood, exported from the cutting area, W 40-45%	0.97	
Total waste timber	1.58	2.0
<b>TOTAL</b>	<b>10.6</b>	<b>17.6</b>

Source:

2007

Biomass (excluding shares used in other sectors of the economy) could provide 5.3-8.8% of the total needs of Ukraine in the primary energy (taking into account the different estimates of the energy potential of biomass). Biomass utilization technologies are at the beginning of their development in Ukraine and have good prospects for commercialization in the near future.

Currently under consideration is the "Energy Strategy of Ukraine till 2030", developed by a group of Ukrainian scientists in the Presidential Decree. According to the working paper of the Strategy for the share of biomass in TPES of 3.4% (2.7 million tons of coal equivalent) in 2010, 7.8% (6.3 million tons of coal equivalent) in 2020 and 12.6% (9.2 million tonnes u.t .) in 2030 (Table 4).

During the development of the concept of bioenergy development in Ukraine the concept developed in Denmark was taken as a basis, and the probable estimate of the energy potential of biomass in Ukraine. Both countries have a relatively small area covered by forest (14%) and highly developed agricultural sector, which leads to a similar structure of biomass potential in them.

**Table 4. The use of RES in Ukraine according to the "Energy Strategy of Ukraine till 2030 and beyond"**

Indexes	RES technical potential		Production of thermal and electric energy from RES in 2001-2030							
			2001		2010		2020		2030	
	Mln t	%	Mln t	%	Mln t	%	Mln t	%	Mln t	%
Wind energy	15.0	23.8	0.012	0.2	0.59	0.3	4.29	18.9	8.9	25.4
PV energy	2.0	3.2	-	-	0.009	0.09	0.23	1.0	0.72	2.1
Small-scale hydropower	3.0	4.8	0.17	3.1	0.15	1.6	0.48	2.1	0.65	1.9
large hydropower	7.0	11.1	4.36	78.69	4.8	51.2	5.6	24.6	6.53	18.7
	4.0	6.4	0.002	0.04	0.12	1.2	0.7	3.1	1.96	5.6

Solar thermal collectors										
<b>Biomass energy</b>	<b>20.0</b>	<b>31.7</b>	<b>0.99</b>	<b>17.8</b>	<b>2.7</b>	<b>28.5</b>	<b>6.3</b>	<b>27.9</b>	<b>9.2</b>	<b>26.3</b>
Geothermal energy	12.0	19.0	0.004	0.07	0.99	11.1	5.07	22.4	7.00	20.0
TOTAL	63.0	100	5.54	100	9.34	100	22.66	100	34.98	100
share of own traditional energy resources	78		7		12		28		48	
Share of TPES	32		2.8		4.7		11.3		17.5	

Source:

2007

Involving potential of biomass, unused by other sectors of the economy to energy balance of Ukraine is a priority, the implementation of which is possible over the next 5-10 years. Among the factors that may increase the amount of biomass available for energy production in the near future, it should be noted increase in grain yields (and thus, the total harvest of straw) and a decrease in the proportion of straw used as roughage and bedding. According to preliminary estimates, these factors will lead to a twofold increase in the amount of biomass available for energy use. In addition to Ukraine, with its great potential agricultural land is very promising is the organization of special energy plantations rapid turnover (willow, poplar, miscanthus, etc.). Involvement of biomass specifically grown on land that is currently not used or used inefficiently in Ukraine will increase the share of biomass in the energy balance of 20-25%. In Ukraine, the most promising for commercial use in the next few years are the following technologies:

- É Industrial wood-boilers 0.1-5 MW for installation in the state forestries and woodworking mills;
- É wood-station of district heating (DH) capacity of 1-10 MW;
- É Straw farm boilers and boilers for small district heating power of 0.1-1 MW;
- É Straw Station CT capacity 1-10 MW;
- É Biogas plants for large cattle farms, pig farms, poultry farms and food processors;
- É installation of extraction and use of landfill in the mini-power plants with capacity of 0.5-5 MW.

Priority development in Ukraine require technologies for direct combustion of wood, primarily for heat and process steam. This is due to a low enough price for electricity that exists in Ukraine (\$ 0.021 / KW/h) and at the same time - quite a high price for fuel and heat. The introduction of mini-power plants and CHP, burning solid biomass (wood, straw, husk), will be profitable in case of significant increase in electricity prices or in the case of subsidies. Getting heat from biomass is economically viable now, even in the case of imported equipment. Ukraine also has the technical capacity to start its own production of wood and straw fired boilers [ 2008, . 33-39].

Combustion technologies of straw are also very promising for Ukraine. But the wide spread of these technologies requires the solution of issues of collection, pressing bales, transportation and storage of straw. First of all, the best prospects for implementation on farms have farm boilers and boilers for small district heating power of 0.1-1 MW. After demonstrating the benefits of these boilers, large stations DH also have good potential for commercialization.

As for the small Heat electric power plants for biomass, we limit them to the concept of bioenergy development in Ukraine, two demo stations (one in a timber and a straw) to a significant increase in electricity tariffs. Larger biogas plants also play an important role in the concept. Their widespread adoption is possible in factory farms with livestock for more than 5 thousand farms, cattle (cattle) with more than 600 heads of livestock, poultry and food industry. According to estimates in Ukraine there can be constructed in 2903 biogas installations with digesters of average volume of 1,000 m<sup>3</sup>, including 295 units in the pig, 130 - at poultry farms and 2478 - on-farm cattle and food industry.

Production of liquid fuels from biomass in Ukraine is unlikely in the near future, since their cost is considerably higher than that of conventional liquid fuels. The main effort in this area should focus on research and demonstration projects. The same can be said about the technology fast pyrolysis and gasification of biomass.

If we take into account the experience of EU countries (where the share of biomass is 60% of all renewable energy), biomass can cover about 6% of the needs of the economy of Ukraine in energy. This figure is well fit in with the data presented regarding the concept of bioenergy development in Ukraine. For a wide range of issues related to bioenergy development in Ukraine, we believe it is necessary to design the State Scientific-Technical Program for bioenergy development in Ukraine [ 2008, . 39-41].



**Geothermal.** Ukraine has considerable geothermal resources that can be used mainly for heat supply. There are also prospects for binary geothermal power plant creation based on existing wells at abandoned oil and gas fields. At present thermal water is used for municipal heat supply and in agriculture in the western and central part of Crimea [ 2007, . 27].

**Hydropower.** The estimated total potential of the Ukrainian hydropower generation is close to 20 billion kWh of electricity per year. For small hydro alone, the estimated potential is about 2,500 million kWh of which only 170 million kWh is currently being utilized (Winkler, 2009).

The total installed capacity from renewables is amounted to 4.8 GW. The total installed capacity of Ukrainian wind farms is approximately 89 MW (UDI, 2009). There are a few modern wood-fired boilers in operation in Ukraine, one has 980 KW installed capacity. The total thermal installed capacity of Ukraine is 10.9 MWt, which generates 119 TJ of energy per year. Ukraine has a current operating capacity of approximately 4,880 MW. ( . 2009, . 7)

In Ukraine there are more than 63 thousand small rivers and streams with a total length of 135.8 kilometers, of which about 60 thousand (95%) are very small (less than 10 km). Their total length is 112 kilometers, i.e, the average length of the watercourse is 1.9 km. Most of the small rivers with the length of less than 10 km have an area of water intake from 20.1 to 500 km<sup>2</sup> (87% of the total and 72% of the entire length of the small rivers flowing into Ukraine). Small rivers with catchment area of 50.1 km<sup>2</sup> and 100, there are 890 (28% of the total), and 797 rivers (25%) have an area of water intake 20.1 - 50 km<sup>2</sup> [ 2007, . 37].

The technical hydropower potential of small rivers is 0.7 million kW (6.4 billion kWh) or 30% of the total technical potential of all the rivers of Ukraine (21.5 billion kWh). Economic hydro potential of small rivers in Ukraine can be estimated to be 1.3 - 1.6 billion kWh. In the early 20s in Ukraine there were 84 hydropower plants with total capacity of 4000 kW, and at the end of 1929 - already 150 stations with a total capacity of 8400 kW, including the Ascension (840 kW), Bug (570 kW), Sutisskaya (1000 kW) other. In 1934 the Korsun-Shevchenko HPP (2,650 kW) was installed and put into function, which in terms of technical performance was one of the best stations of the time.

In the postwar period, the electrification of agriculture has also been based on increasing capacity and improving the technical and economic performance of small power plants. In the early 50's, the number of small hydropower stations built was 956 units with a total capacity of

30,000 kW. However, in connection with the development of centralized power in the republic and persistent trend towards concentration of production of electricity on high heat and hydro, small hydro construction was halted [ 2007, . 3].

During the 1984-1988-ies, a survey of the technical condition of equipment and facilities of existing small hydro electric power plants was conducted. Analysis of these data shows that at the time of the survey 150 small hydropower plants survived in Ukraine, what formed two groups: active and inactive (49 units and 101 units respectively).

More than 75% of the total hydroelectric capacity are available on existing stations. Almost 80% of these stations are owned by the Energy Ministry of Ukraine. These include a relatively powerful station as Tereblya-Rikskaya, Gaivoronskaya, Korsun-Shevchenko, Steblevskaya, Ladyzhyn, etc. The technical condition of the existing HPP is characterized by: considerably or completely worn out main hydropower, hydraulic and electrical equipment, the presence of faults in waterfront facilities, that may cause emergency situations, siltation of reservoirs; increasing water withdrawals for non-energy needs, fixtures spillway erosion and coastal areas downstream, etc.

Small-scale power in Ukraine due to its low specific gravity (0.2%) in the total energy can not significantly affect the conditions of power supply of the country. However, the exploitation of small hydropower plants makes it possible to produce about 250 million kWh, equivalent to annual savings of up to 75,000 tons of scarce fossil fuels [14, 2011].

***The use of firewood and wood residues.*** In Ukraine forests cover only 15,6% of the territory, at that nearly half of them have environmental value. The country lacks for merchantable wood that is why timber is importer. The main forest areas are located in Carpathians and Polissia where more than 90% of wood is harvested. According to estimations wood potentially available for energy production makes up 1,6 mill m<sup>3</sup>/yr of felling residues, 2.1 mill m<sup>3</sup>/yr of wood processing waste, 3.8 mill m<sup>3</sup>/yr of firewood that in sum is equivalent to 16 TWh/yr. in 2000 consumption of wood and wood waste for energy production amounted to about 5.8 TWh. According to prognosis consumption of wood and wood waste for energy production will be about 13 TWh in 2030 and may achieve 16.3 TWh/year in 2040.

Further development of energy utilization of wood can be also expected under reorganization of forestry and intensive development of forestry. At present there are workable propositions aimed to raise productivity of Ukraine's forests to the level of neighbouring countries and achieve

wood logging of 30 mill m<sup>3</sup>/yr and then 60 mill m<sup>3</sup>/yr without any harm to nature. So, prognosis on energy utilization of wood in 2050 may be 25 TWh/yr [2007, . 42].

***The use of agriculture residues.*** Ukraine has good prospects to revive highly efficient agriculture, which is able to satisfy domestic needs in foodstuff and feedstock and also produce products for export. The big part of the territory is steppe, that is characterized by low atmospheric precipitation, frequent draughts and other unfavourable phenomena. Due to that yields of the main crops are not stable. In Ukraine some people have doubts as to possibility to use straw and stems for energy purposes. At the same time projects realized in Ukraine under support of European countries demonstrated technical possibility and economic expediency of straw application for energy production. At present amount of straw used for energy production in Ukraine is equivalent only to 2 GWh/yr [2011, . 13-14].

In accordance with the prognosis for the development of bioenergy in Ukraine the use of straw and stems for energy purposes will be equivalent to 23 TWh in 2030.

***The use of biogas.*** According to estimations technical potential of biogas available for energy production consists of the biogas from manure (animal husbandry and poultry farming) of 2308 mill m<sup>3</sup>, the biogas from sewage sludge of 334 mill m<sup>3</sup>, and landfill gas 2300 mill m<sup>3</sup>. Formerly in Ukraine biogas was widely produced while now in many cases it has stopped due to bad technical condition of digesters and due to the unwillingness of the state to stimulate this activity. A number of biogas plants for dung and manure processing are out of operation. Now in Dnipropetrovsk Oblast a modern biogas plant is under construction that is supported by Dutch government. According to estimations the use of landfill gas and biogas from sewage sludge will develop dynamically in the nearest years. After 2010 it is expected the increase in biogas production from animal husbandry waste. In 2030 total utilization of biogas will amount to 10.2 TWh, and by 2050 it will achieve 17.4 TWh/yr [2011, . 19].

According to UNO data, recently the interest in the world for investment in alternative energy recourses and energy efficiency has increased and there are some positive changes in this direction in Ukraine as well.

Basically the development of renewable sources of energy has started in Ukraine in 2009 upon introduction of the law on Green tariff. Although before that moment there were many active industrial producers of solar batteries and wind energy generators, their production virtually was not exported. According to State Agency for Energy Efficiency and Energy Preservation, today the part of renewable sources of energy on the energy balance of Ukraine comes up to approximately 2%. While the potential for development of this sector is quite promising. According to the research by State Agency for Energy Efficiency and Energy Preservation, Ukraine is able to produce enough alternative energy in order to cover 50% of the total needs for energy in the country.

According to the Renewable Sources of Energy Market Participants Association of Ukraine, during January-June 2011 industrial units dealing with renewable sources of energy produced 16% more electric energy in comparison to the same period of 2010, where the largest part of electric energy was produced by units of hydroenergy (191 961,4 KW), wind energy (29 839, 22 KW), bioenergy (3 483,9 KW), solar energy (3 334, 79 KW).

Although, in the nearest future the balance of power in the sector can change due to the implementation of the solar electric station in Crimea by Activ Solar company. It has been already announced that by the end of the year the power of Crimean solar electric stations will reach 87,5 MW. Apart from that, in the second half of 2011 the implementation of new wind energy production powers is awaited, the fact that will also make its contribution to the increase of the share of renewable energy in the whole of the energy balance of Ukraine.

This tendency is a crucial topic for Ukraine not only due to the energy efficiency of the country, but also due to the obligations that are connected with the European integration of Ukraine: one of the requirements of the European Union is to increase the share of alternative sources of energy in the national energy production at the level of 6% and no less than 12% including the sector of large hydroenergy [ 2008, . 17-19].

Ukraine has a long way to go in order to reach these indexes. Meanwhile, according to UNO report, world investment in renewable sources of energy last year increased by 32% (that is \$211 bln). In particular, such a result was based on huge scale projects for development of wind parks

in China and solar panels on the roofs of European houses. Solar, wind, biomass and other forms of green energy live through a boost. Nowadays the leader for implementation of green energy is China which spent \$48,9 bln on projects mainly dealing with wind energy production, thus having increased its expenses on renewable sources of energy by 28% in comparison to 2009. The second ranks the USA whose expenditures came up to \$23,8 bln. But still, according to the UNO report, the share of alternative sources of energy in the world in 2010 came up to 20% of the total world energy production and 16% of the total of the world energy consumption.

In 2011 renewable energy continues to attract new investments. According to the estimations of London research company New Energy Finance, in the second half of 2011 the world investment in this sector increased by 22%, or \$41,7 bln, in comparison to the same period of 2010. The largest investments are directed to solar energy.

As to state expenditure for the development of renewable energy, the tendencies are various: although China remains the largest sponsor of projects in this sector, in the second half of 2011 it shrunk their financing by 11% (or up to \$12 bln). At the same time the USA tripled the volume of investment in this sector by \$10,5 bln. In Europe state expenditures for renewable energy increased by 14% (\$89 bln) while in India by 46% (\$2,5 bln.)

Despite the problems of increase of state debts and budget deficits, politicians of leading countries of the world continue to give active support for the development of green energy. The US President Barak Obama set a goal to generate 80% of green energy by 2035. At the same time the USA place big importance for construction of solar electric stations in its deserts, and Europe concentrates its attention on wind energy. The government of Great Britain recently announced its intentions to increase its wind energy production by 5 times until 2020. According to them, in recent future eight renewable energy technologies will let them produce 90% of all energy in the country: by means of wind generators, offshore wind generators, the energy of the sea, biomass, introduction of ecologic means of transport that function by means of biodiesel and electric energy as well as compressed air [ 2006, . 40-58].

Coming back to Ukraine, according to recent changes in the State Energy Efficiency Programme, the share of renewable sources of energy in the energy balance of the country must comprise not less than 10% by 2015. The government counts on the development of wind, solar and small hydroenergy. The volume of financing of related projects by the state budget in 2012-2015 will come up to 13,81 bln UAH, which is certainly not enough to cover all the expenditures to reach this aim. In 2011 the state budget covers 910 mln UAH, and expects 2 bln UAH from regional

budget as well as 27,97 bln UAH from other sources. In the State Energy Efficiency Agency it is expected that thanks to such investments, in 2011 the use of natural gas and oil will decrease by 3 bln Km. According to the National Committee for Energy Resources, in August of 2011 electric energy from renewable sources in Ukraine is produced by 83 electric stations (by 48 companies). During the second half of 2011 the number of objects, using green tariff, increased by 1,5 times and their total power comes up to 143 MW while by the end of the year this index can grow by over 25%. This forecast is connected with expectations that this year there will be at least 20 new objects, generating electric energy according to green tariff, mainly in the sector of solar, biomass and hydroenergy [13, 2009].

National ideology is one of the key factors for the development of renewable energy in the European Union. Ukrainian politicians are becoming more and more ideologically tolerant regarding this question, there are progressive ideas regarding green energy to be heard from the representatives of the present government. Still, there is a very long to go until green economy will be introduced not in the whole country, but at least in some regions.

At the same time for a typical house or apartment in Europe and Northern America water preheating is the second domestic process regarding energy output ratio. The usage of solar energy is able to decrease the cost of domestic water preheating by 70%. Such a system can be easily installed and almost does not demand servicing. Abroad solar heating systems are used in houses, apartments, schools, car washes, restaurants, agriculture and industry. In Ukraine by far little is known about it. That is why it is vitally important for the state to mastermind and integrate the plan for increase of popularity of renewable sources of energy in the country. A programme of state preferences could play a positive role for the development of green energy in the country: e.g. the state grants technical equipment for leasing for five to seven years and releases from taxes during 10 years, while the regional powers must grant territories that are not suitable for productive agriculture to objects of renewable energy.

The forecast of the National Committee for Electric Energy Regulation states that in less than seven years renewable energy prices will be lower than those of the traditional sources of energy. According to WMF research, Ukraine ranks the last position regarding price on electric energy in Europe. The cost of one KW for citizens is only \$0,03. Although, a relatively low level of income of the population makes the price for electricity an exceptionally important social parameter. The most expensive electric energy is that in Denmark where a citizen pays on average \$0,39 for one KW. High electric energy price is a push factor for the development of renewable energy for the country which ranks second in the ranking: in Germany the price for one

KW for the population comes up to \$0,35. Cyprus ranks third, whose energy system, unlike the majority of European countries, is isolated and there is no alternative to oil fuel in production of electric energy. As a result the country reasonably suffers from high prices for oil. Belgium and Sweden are also included in this top-5, as the respective price in these countries comes up to \$0,28 [2010, p. 73].

## 2.1 Legal basis

In the sphere of energy efficiency and renewable energy act more than 200 documents, among them more than 10 laws of Ukraine, about 15 decrees of the President of Ukraine, more than 120 decrees of the Government of Ukraine and other by-laws.

The "Energy Strategy of Ukraine till 2030" that was issued in March 2006 discusses the importance of pursuing renewable energy resources to help decrease their dependence on imported fuels. Also, in September 2008, the Verkhovna Rada of Ukraine adopted a law on green tariffs, which was granted the title "On Amendments to Certain Laws of Ukraine Concerning the Introduction of a Green Tariff." The green tariff includes wind power, hydropower, biomass, biogas, and several methane capturing power producing activities [4; 2010].

Current legislation of Ukraine on renewable sources of energy provides the following mechanisms of energy efficiency stimulation and alternative energy development:

- 1) Immunity from import custom duties and VAT: equipment, fed by alternative and renewable sources of energy, materials, equipment, components and parts used for production of equipment, fed by alternative and renewable sources of energy, energy conservation equipment and materials, measuring and control equipment, equipment and materials for alternative types of fuel production; materials, equipment and constituent parts which are used for production of equipment, which works on renewable energy sources, which produce alternative type of fuels, energy saving equipment and materials, machinery, exploitation of which ensures the saving and rational usage of fuel energy resources, measuring systems, control and cost management of fuel energy resources [4; 2010].
- 2) Immunity from profit tax: obtained from selling on the territory of Ukraine of such self-produced goods, as equipment, which functions on the basis of renewable sources of fuel, energy conservation equipment and materials,

machinery, the functioning of which helps optimize the expenses and allows rational use of fuel and energy resources, measuring and control and cost management of fuel energy resources, equipment for alternative types of fuel production [4; 2010].

Producers of machinery, equipment, hardware for production and reconstruction of technical and transport facilities, including agricultural machinery, and energy installations, which consume biological types of fuel, obtained from sell of mentioned machinery, equipment and hardware, which were produced on the territory of Ukraine for 10 years as well as producers of biofuels, obtained from sell of biofuels for 10 years also enjoy the mentioned state support.

Institutions and organizations that are included in the state register of enterprises and deal with design, implementation and use of energy efficient measures and energy efficient projects enjoy not more than 50% of total taxable profit.

As to immunity from import custom duties, in the period from the 1<sup>st</sup> of January 2010 until the 1<sup>st</sup> of January 2019 mechanisms, equipment and hardware, which are to be used for reconstruction of the already existing and construction of new enterprises that are involved in the production of bio-fuels and for production and reconstruction of technical and transport facilities with the aim of use of bio-fuels also enjoy the mentioned state support. The law also involves technical and transport facilities, including agricultural machinery, that functions on the basis of bio-fuels.

In order to understand better the goals and the reason for introduction of Green tariff, it is important to have a quick overview of its implementation process. The Green tariff is installed on the level of retail tariff in the January 2009, multiplied by the Green tariff coefficient in USD equivalent. Namely:

1,2 for electric power, produced from wind power by objects of electric power, under 600 kWt of total installed power;

1,4 for electric power, produced from wind power stations, 600-2000kWt of total installed power;

2,1 for electric power, produced from wind power stations, more than 2 000kWt of total installed power;



2,3 for electric power, produced from biomass;

4,8 for electric power, produced from solar radiation energy by the ground electric objects;

4,6 for electric power, produced from solar radiation energy by the ground electric objects, which are mounted on the roofs of buildings, structures and facilities, more than 100kWt of installed power;

4,4 for electric power, produced from solar radiation energy by the ground electric objects, which are mounted on the roofs of buildings, structures and facilities, under 100kWt of installed power, and also for objects, installed on elevations of buildings, structures and facilities, in spite of installed power;

0,8 ó for electric power, produced by small hydropower stations [4; 2010].

### **2.3 Local players**

Before we go on with the description of local players on green energy market of Ukraine, it is important to refer to in the introduction to this thesis where it was mentioned that one of the disadvantages and obstacles for the sector of renewable sources of energy in Ukraine is this tight connection between the state and private business. Eventually in Ukraine only those close to the state government are granted the necessary privileges for development of renewable energy in the country. For instance, the renewable energy enterprises belonging to the First Vice-Prime Minister of Ukraine Mr. Andrey Kluev and his brother, deputy of the Party of the Regions (*the governing party*) Mr. Sergey Kluev received large state support for development, the fact that other companies which are trying to enter this market can not boast of which can be described by the phrase "everyone is equal, but some are more equal than the others". The above mentioned Vice-Prime Minister of Ukraine Mr. Kluev owns five companies which are united under the title Crimea Solar and belong to a group of companies owned by Kluev brothers named Activ Solar. On September 2010 the National Electric Energy Regulation Committee of Ukraine issued a green tariff for the Crimea Solar-1 and Crimea Solar-2 companies which will be dealing with producing of electricity from solar energy in the Autonomous Republic of Crimea. In February 2011 other three clone-companies were added to this list for granting of highly profitable green tariff ó Crimea Solar-3, Crimea Solar-4 and Crimea Solar-5 which all the give companies will be using up to 2030. According to green tariff the state is obliged to purchase electric energy from private companies, that was produced from renewable sources of energy by price from 0,87 to

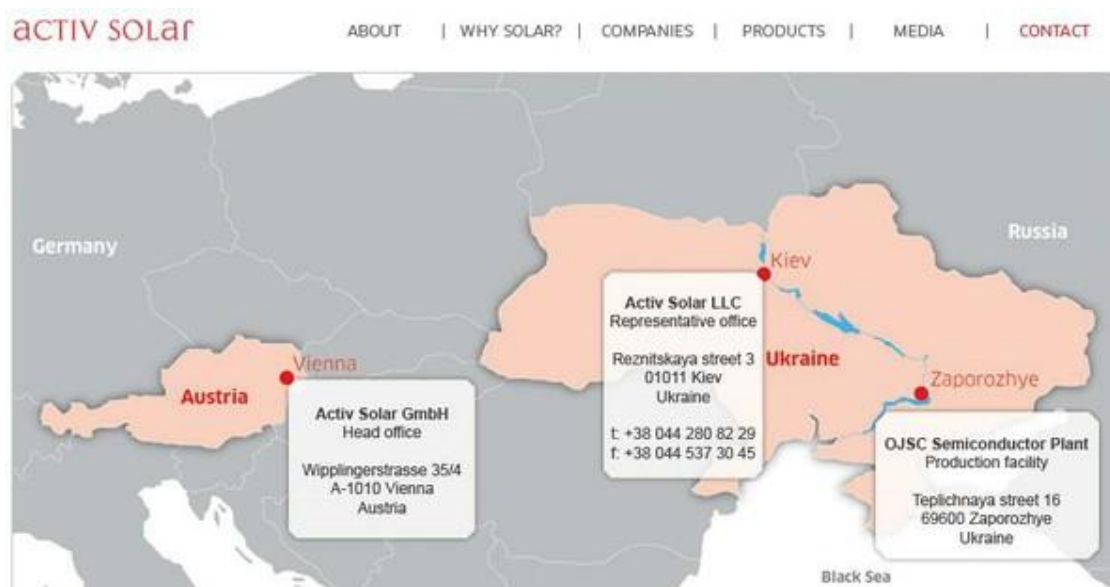
5,23 UAH/KW a year. According to this, the gross price for electric energy from renewable in Ukraine is 0,54 UAH/KW a year [ , 2007, . 14-15].

The volume of the green tariff for various categories of electric energy producers and according to the type of renewable energy sources is decided by the National Energy Regulation Committee. The idea is that high price for electric energy from renewable sources of energy has to stimulate investors to make investments in the development of alternative renewable sources of energy and eventually to decrease the dependence of Ukraine upon traditional energy sources such as oil, natural gas, coal, etc.

On the whole 42 companies were granted green tariff in 2011 but the maximum tariff was granted to the group of companies Crimea Solar. In July 2010 the government released Crimea Solar-1 and Crimea Solar-2 from payment of customs tax and VAT on import to Ukraine of two solar electric stations and respective components, of the total cost of 700 mln. Euro. It is important to remember that part of Kluev`s companies started to function when he granted 200 mln. UAH to the development of renewable sources of energy business from the state budget [ , 2007, . 17-18].

In order to understand the present situation on the internal renewable energy market of Ukraine and therefore the obstacles in the investment climate in this sector, it is important to look back to the history of the mentioned group of companies.

The Austrian company Active Solar registered sub-companies Crimea Solar 1-5 in order to construct solar electric stations in the village Rodnikove which is 3 km away from Simferopol (Autonomous Republic of Crimea). The Ukrainian office of the Austrian Active Solar is situated in Kiev and has the address of the rest of the Kluev`s companies of the group.



*Placement of offices of the company Activ Solar in Austria and Ukraine (Source: Activ Solar website)*

In its term, Activ Solar GmbH is a sub-structure of the Activ Solar Holding GmbH whose main owner is the Austrian asset of Kluev brothers Slav Beteiligung GmbH. According to National Energy Regulation Committee [10; 2010], green tariff was granted to 46 companies, out of which 6 are dealing with solar energy production and 5 of them are sub-companies of Activ Solar. Other 6 companies received green tariff for production of electricity from wind energy, the largest of which are Vitroenergoprom, Wind Park Novoazovskiy and the state Wind Electric Station Donuzlavska. The remaining 34 companies produce electro energy by small hydroelectric stations and 2 produce energy from biomass.

As to wind energy in Ukraine, its production is mostly controlled by the Donetsk company Wind Parks of Ukraine. In July 2011 its sub-company Wind Park Novoazovskiy introduced the firstline of wind energy stations of 25 MW, received the green tariff and a license for electricity production. This station that was constructed on the land of the state owned company (!) Wind Electric Stations Novoazovska is expected to be put to function by 2013. In 2004 the Regional Administration on Donetsk Oblast granted Wind Electric Stations Novoazovska in concession for 50 years to the union Vitroenergoprom which belongs to the company Slav AG, controlled by the First Vice-Minister Mr. Andriy Kluev and his brother Sergey. In 2008 the state ceased to finance Wind Electric Stations Novoazovska, Vitroenergoprom refused to invest in it as well and as a result the enterprise was leased to the Wind Park Novoazovskiy. At the same time Wind Parks of Ukraine is a sub-company of Trade

House of Ukrainian Machinery Plants ("

"), which is connected with the former Governor of Donetsk Oblast who is currently the Minister of Construction Mr. Anatoliy Blizniuk. His son Mr. Sergiy Blizniuk was a stockholder of Trade House of Ukrainian Machinery Plants [17; 2011].

The well-known Ukrainian oligarch Mr. Rinat Ahmetov, who also owns the Ukrainian company DTEK is planning on investing 24 bln UAH in wind energy stations DTEK Priazovskiy and DTEK Mangush until 2018. The total power of Mr. Ahmetov, who is the potential competitor of Blizniuk`s family, is 500 MW [17; 2011].

Therefore, the development of business projects in solar and wind energy is conducted within extremely favorable investment climate and soft tax basis for Mr. Kluev and Mr. Blizniuk, who do not come across obstacles in their business activity from raiders, Ministry of Security of Ukraine, tax institutions and procurators due to their status of ministers of Ukraine and due to a warm friendship with the current President of Ukraine Mr. Viktor Yanukovich. Apart from that, both Kluev and Blizniuk are former colleagues and friends, as in 1998-2002 they both worked as Deputy Governors of Donetsk Oblast.

Apart from already completed wind and solar power stations, there are numerous projects for future that are to be conducted by local players in the Ukrainian market of renewables. As to wind power, there are two large objects under construction namely "DTEK Azov", "DTEK Mangush" [16; 2011].

DTEK, part of the holding company "SCM", makes the traditional sources of energy. The company produces and enriches the coal, which produces electricity by burning at the enterprises LLC "Vostokenergo" and JSC "Dniproenergo." In 2008, Rinat Akhmetov, has created a division of DTEK alternative energy "Wind Power" and is ready to build up the coast of the Azov Sea wind farms with total capacity of 1,200 MW worth 23 billion USD. All the power generated will be sold on the wholesale electricity market of Ukraine by the use of Green tariff. The first pilot project of "DTEK Azov" in Zaporozhye region \$ 9 billion UAH opens in 2015. By the end of this year, the company will complete the procedure for land allocation object. The pilot project "DTEK Azov" will Botievskaya 200 MW wind farm that will be revealed at the end of 2012. The service life of the wind farm - 20 years. By 2015, it would annually generate 683 GW / h of electricity. The project is a more distant prospect - "DTEK Mangush" in the Donetsk region. Compared with the Azov VESami it is a powerful and expensive. Its cost is 14 billion USD, and have installed capacity - 700 MW.

Also, in July 2011 the second stage of a wind farm "Novoazovsk" in the village unnamed Donetsk region on the Sea of Azov was set to function. At the moment, out of 43 planned wind power plants there are ten that are ready to go with a total capacity of 25 MW. On stage construction of another 13 turbines of 32.5 MW. According to the project sponsor, it penny of public funds. Construction of "Novoazovskiy" conducted in the state Novoazovsk WEC, passed in 2004 on a concession PEO "Vetroenergoprom." It is known that the technology of construction of modern wind plants brought German Furlander AG, received from the Cabinet's permission to import 23 installation at EUR77, 7 million without paying duty and VAT. But the second donor "Novoazovskiy" is not officially disclosed. LLC "Wind parks of Ukraine", which includes Novoazovsk, Ochakovsky and Berezanskii wind farms have been associated with Sergey Bliznyuk, the son of the Minister of Construction and Housing Anatoly Bliznyuk. Soon the wind turbines will be assembled at the factory "EMSS" in Kramatorsk in cooperation with Furlander AG. "Novoazovsk" may be the largest wind farms in Ukraine. Project sponsor has obtained a license for electricity production by NERC. Annually "Novoazovsk" can sell on the wholesale market to 75 million kW / h of power at a favorable "green" tariff - 123 kopecks / kW / hr which is enough energy to cover partial domestic needs of Mariupol city. The second project of "Wind Farms in Ukraine" company is being implemented at a surprisingly fast speed. In late 2010, Mykolayiv regional administration provided the wind farm Ochakovsky with 1.69 hectares for the construction and operation of a 300 MW wind farm in the village Dmitrievka. By the end of this year there will be implemented the first phase of 25 MW wind farm (10 wind turbines rated at 2.5 MW each) of the total cost of 360-380 million USD and according to estimations the investment is to be paid off in seven years [15, 2011].

Solar energy in Ukraine is mainly represented by such solar plants as "Okhotnikov", "Perovo", "Rodnikovoye". Expansion into the Ukrainian market of solar energy company Austrian Activ Solar began in December 2008 with the acquisition of "Plant of Semiconductors," in Kiev. After upgrading and reconstruction the company started to produce polycrystalline silicon which is a raw material for production of solar cells thus that is a unique object since only eight (8) countries in the world including Ukraine deal with production of polysilicon. In 2010, Activ Solar constructed a solar plant with the peak capacity of 7.5 MW in the village Rodnikovoye (Simferopol district, the Autonomous Republic of Crimea).

The most significant project of the company is the Okhotnikov solar plant with the total capacity of 80 MW which has already hit the top 5 largest solar plants in the world. Three stages

with a total capacity of 60 MW are ready while the last the fourth one will be introduced by the end of 2011. In general, the solar park will supply electricity to about 20 thousand households from nearby villages and the town of Saki in the Autonomous Republic of Crimea. In the meantime, the company Activ Solar is striving to increase the power of its stations from the current 100 MW to 300 MW [9, 2011]. The plant is being developed as part of the country's national Natural Energy project. Launched by the State Agency of Ukraine for Energy Efficiency and Energy Conservation in 2010, the Natural Energy project aims to build 2,000 MW of clean energy capacity in Ukraine and produce 30 percent of the country's energy from renewable resources by 2015. The Okhotnykovo plant, which will cover the equivalent of 207 football fields, is being built by Activ Solar, an Austrian Company. Although it relies on Russia for three-quarters of its oil and natural gas requirements, according to the CIA World Factbook, Ukraine is an energy exporter, supplying electricity to Hungary, Moldova, Poland, Romania, Russia and Slovakia. Ukraine's renewable energy projects are reportedly funded with profits the country earns from selling carbon emissions credits under the Kyoto Protocol. In 2009, Ukraine sold some its carbon emissions credits to Japan for \$400 million. The Okhotnykovo solar farm is expected to further offset Ukraine's carbon emissions by 80,000 tons. The Austrian company Activ Solar announces completion of the building of the third line of the "Okhotnykovo" solar park. The third line of the station with the capacity of 20 megawatt (MW) will produce more than 25000 MW/h of clean electric energy within a year. The installation consists of about 90000 land crystallized solar modules set on the area of 40 ga. It is expected that the solar installation will meet the requirements in electric energy of 5000 households and will allow shortening more than 20000 tons of emissions into the atmosphere a year.

The "Okhotnykovo" project has general capacity of 80 megawatt (MW), occupies more than 160 hectares and is the largest solar photovoltaic (PV) setting among all ever built installations in Central and Eastern Europe. The project is divided into four lines with the capacity of 20 MW. Kave Ertefay, Director general, Activ Solar, comments: "We are glad, that the first three lines of the project are completed earlier than it was expected and looking forward to the completions of building of the last line in the near future". The project will be connected to the national network, and will work according to the «green tariff» [6; 2010].

Ukrainian solar energy company Rentechno has recently announced about the successful completion and putting into operation the first turn of solar power plant in the southern part of Vinnitsa region. The installed equipment rated peak power amounts 250 kW. The PV panels used in the project were produced by the company which is among top 5 best manufacturers in

the world. The inverters, combiner boxes and cables for the solar power plant were produced in Europe.

The owner of the power plant is Ukrainian investor. Rentechno in turn developed engineering solution for the solar power plant with the total capacity of 1.8 MW, implemented the selection and organized delivery of the equipment. Furthermore the technical inspection of the installation process and commissioning works of the project were carried out by Rentechno LLC. The equipment supply was realized jointly with Israeli company Sunelectra as a strategic partner of Rentechno on the Ukrainian solar energy market.

The implementation of solar power plant in the southern part of Vinnica region is divided into several stages. The next 321,5 kW are planned to be installed during October, 2011 [5; 2011].

Another solar power plant will soon appear in Mykolaiv region (South-Eastern Ukraine) when the Chairman of Regional State Administration Mykola Kruglov granted permission to "East Solar Ltd." to develop a draft land management and technical documentation for regulatory pecuniary valuation of land covering about 108 hectares for construction and maintenance of solar power. The land is located in the area and Berezanskii will be given on lease for 49 years [14, 2020]

In the former USSR the only manufacturer of wind turbines was the NGO "Vetroen" (Istra town, Moscow region), which produced limited-edition release of wind turbines (windmills) low power (2-4 kW). Purposeful development of wind energy started in the 80s. In 1981, the USSR State Committee on Science and Technology of the USSR was adopted by the All-Union Scientific-Technical Program for the development of renewable alternative energy sources (VNIE), and in 1987 adopted a resolution of the Council of Ministers dedicated to wind energy.

In the former USSR there was only one manufacturer of wind turbines NGO "Vetroen" (Istra, Moscow region), which produced limited-edition release of wind turbines (windmills) of low power (2-4 kW). Purposeful development of wind energy started in the 1980s when in 1981 the USSR State Committee on Science and Technology adopted by the All-Union Scientific and Technical Program for the development of renewable alternative energy sources (VNIE), and in 1987 adopted a resolution of the Council of Ministers dedicated to wind energy. These documents called for the creation by 1990 of a wind energy plant of the total capacity of 30, 100, 300, 1000 kWt, but this project was never implemented actually. However, the development

plans were carried out for plants of various capacities, including wind power plant of 250 kW, 1000 kW (Design Bureau "Raduga", Dubna, Moscow region), wind power plant of 200 kW (joint development of the NGO "Vetroen" and CB "Southern"). USSR Ministry of Energy decided to construct in Ukraine the East-Crimean wind farm of the total capacity capacity of 12,5 MW, but unfortunately due to technological and, afterwards, to political reasons this object has not been constructed.

In Ukraine in 1980s wind power development was given little attention. This was primarily due to the fact that in the USSR, the entire initiative in this regard was coming from the USSR Ministry of Energy, which had at its disposal the political and economic leverage. Low activity of public opinion in those years also could not influence the course of events. However, by the end of the 1970s several prototypes of wind turbines ranging from 0.2 to 20 kW at the Kiev Polytechnic Institute and the Institute of Electrodynamics NASU were created. Since 1992, construction began on Aktashskoe, Black Sea, Adzhigolskoy windmills (windmills). In addition, in 1993 there was launched a project for construction of wind farms on the basis of Donuzlav licensed capacity of 107 wind turbines USW-56/100 kW [ 2007, . 113-130].

At the same time private companies started to engage themselves in developing and manufacturing of wind turbines. Thus, in 1994-1995 by efforts of financial-industrial group "Atika" based in Kiev have been developed and prepared for production wind power plants of 5, 30, 45 kWt. At the present time the company "Vetromash" based Dnepropetrovsk is the successor company. Also in Dnepropetrovsk the company "EDF" has developed a wind power plant of 20 and 420 kW vertical-axis rotation. Currently, these facilities are based in Evpatoria (the Autonomous Republic of Crimea) and function in an experimental mode.

Aiming at the organization of production of wind energy in Ukraine windmills USW-56/100 were set up by a Ukrainian-American venture (JV) "Windenergo Ltd." registered December 11, 1992. From the American side of the joint venture there was the company "US Windpower" (Wind Energy Department of the corporation "Kenetech") and "Putman, Hayes and Bartlett". Initially Ukrainian participants suggested the inclusion of NGOs "Ukrenergoresursy" and "Krymenergo" in the joint venture, but due to changes in law the re-registration joint ventures with the State Property Fund of Ukraine was implemented. The JV "Windenergo Ltd." is the only company created with the participation of foreign investors.

During this period, attempts were made by foreign companies to participate in wind energy projects that have not ended the long-term cooperation. They are:



- 1) The Ukrainian-Danish project "Ai-Petri." Under the contract, the Ministry of Energy of Ukraine and the Danish company "Genvind" in 1993 began construction of wind turbines GV-270 kW, 270 kW. During the installation there was a breakage of blades, which led to the failure of the project. Currently, the Danish wind turbine intends to restore in the framework of Ukrainian-Danish project "The completion of the windmill on the Ai-Petri", funded by grants from the Danish Energy Agency.
- 2) Implementation of thematic seminars and conferences, information exchange with Danish wind energy sector organizations. The most active company in this area "Genvind Engineering ApS" and "Folkecenter for Renewable Energy".
- 3) Negotiation of the company "Atika" with the American company "Sea West" (1993, 1995. D) for establishing a joint venture in order to construct wind farms in the Autonomous Republic of Crimea. The project is not implemented for reasons of adverse legislative and economic conditions in Ukraine.
- 4) Negotiations of NGOs "Rotor" based in Cherkassy city (Central Ukraine) with the German firm "Genesis" (1996 to 1997) for a joint venture for the production of direct-drive wind turbine with variable speed propeller. The issue is not resolved because of the lack of guarantees return on investment from the Ukrainian side. Currently, the process is a new beginning with the Ukrainian side in the face "Windenergo Ltd", which intends to engage a firm "Genesis" in a joint project under the "Comprehensive program of building wind farms in Ukraine until 2010."

Thus, we can state that unfortunately in general, international cooperation is inactive in nature. Low rates for wind power and inability to establish international cooperation in the period before 1996 can be attributed to the lack of these years of clear government policy to support this trend. Activation processes became possible only after the adoption of some legislative acts and policy documents at state level.

In accordance with the "Comprehensive program for wind farms construction in Ukraine until 2010" the following scenarios of wind power capacity growth are expected, depending on the completeness of funding:

- É Full commissioning of the planned capacity of 1950 MW. Possible 100% financing, the Integrated Programme of building wind farms in Ukraine to 2010 (scenario 1).
- É Partial commissioning of the planned capacity of 32.2%. It is possible if the use of funds won by the only form of deductions at the rate of 0.75% (Section 2.5) of the value of commodity production of electricity production in Ukraine (scenario 2).

In accordance with the Comprehensive Program for the achievement of the planned facilities will require additional investment income in the amount of 1640 million UAH. or 965 million U.S. dollars.

In environmental terms, the development of wind energy in Ukraine provides a real reduction in the level of the prospects of fossil fuels, thereby decreasing levels of harmful emissions and pollution, it will facilitate the effective implementation of a number of ratified international treaties like the Convention on the Transboundary air pollution over long distances, the Protocol of reductions in sulfur emissions by 30%, the Protocol on limiting emissions of nitrogen and its cross-border flow.

Today, thermal power plants in Ukraine emit 76% of sulfur oxides, nitrogen oxides, 53% and 26% solids in relation to the total emissions from stationary installations. One million kilowatts. electrical capacity of nuclear power plants (NPP) released into the environment for at least 2 million kilowatts of thermal power unused. Irreversible loss of water at NPP unit is 30 million cubic meters. m per year. Only by doing "program of building wind farms in Ukraine to 2010" the size of substitution of fossil fuel will cost: in 2000, 160, 1 thousand tons at. tons in 2005-872 tys.t.u.t, in 2010, 2306, 0 tons at. m. For the full implementation of the program, these values increase by more than 2 times.

In accordance with the Kyoto agreement Ukraine has the opportunity to sell at the right amount of greenhouse gas emissions to other states, and the proceeds to invest in the future conversion of hazardous industries. According to "Windenergo Ltd", in the case of wind energy development programs in Ukraine, the value of sold rights to the CO<sub>2</sub> emissions for the period from 1999 to 2010 could reach 10433.4 mln. or 2641 million U.S. dollars. This aspect is particularly important for the resort and tourist areas of Ukraine, located in the south and the Carpathians, which are most favorable for the construction of wind farms.

Currently working document through which the implementation of the provisions of legislation is carried out is the "Comprehensive Program of Construction of Wind Farms in Ukraine until 2010." The program is designed for practical use for design and research organizations, enterprises, regions and areas in order to use its guarantee directly through the regional and sectoral programs. It covers the entire spectrum of wind-power industry, from research, production and wind power, ending the escort operation constructed wind farm. Planned three phases of the program.

The total installed capacity of Ukrainian wind farms was about 89 MW as of beginning of 2008. Currently operational Ukrainian wind farms mainly consist of the old model wind turbines with a capacity of 107, 5 kW. Since June 2003, the Belgian-built Turbowinds 600 kW turbines have also been assembled in Ukraine, with towers and blades manufactured locally. All the Ukrainian wind farms so far have been constructed under the "Complex Programme for Wind Farms Construction" adopted by the Ukrainian Government in 1997. Ukraine belongs to the country where manufacturing production of wind turbines (licensed USW 56-100 turbines, a US originated model with a capacity of 107, 5 kW) has been set up. Twenty three former military-industrial plants are now involved in component manufacturing while assembly is carried out at the Yuzhnyi Machinery plant in Dnipropetrovsk, the former rocket-building plant.

According to the Complex Wind Programme 1990 MW of wind capacity is to be installed by 2010. By 2030, 20-30% of the country's electricity production is to be covered by wind power generation. The main problem that has restricted the development of wind power in Ukraine is the lack of financing. Presidential Decree #159 on Construction of Wind Farms of 02.03.1996 specified the Complex Wind Programme financing through 0,75% extra charge on all electricity sales that is equivalent to totally estimated amount of about 20 mln euro per year. However, due to non-payments and debts in Ukraine's energy sector, in reality the Programme got only about 20% of its planned financing. Therefore, the Programme development was delayed.

In February 2006, the Government cancelled the 0,75% tariff imposed on electricity rates and instead approved a fixed annual budget of about 13, mln euro. Since April 2007 the National Space Agency of Ukraine has coordinated the Complex Wind Farms Construction Programme in the country. Unfortunately national wind industry so far has not been so much positively influenced with all these changes. Some attempts have been made by Ukrainian scientists in designing their own models of wind machines. Thus, specialists of Ukrainian Construction Bureau "Yuzhnoye" proposed their own "alternatives" to the licensed projects but Ukrainian-designed turbine AVE -250 and 420 kW vertical axis turbine failed [13; 2011].

Crimea has a fairly high potential for wind energy resources is a significant background in the development of alternative energy sources in the Crimea. The natural resources of the peninsula allow greater use of wind energy, transforming it into wind energy. Many countries have long used this practice, forcing even the wind to work for their states, thus preserving much of the budget. Wind turbines do not pollute the environment by harmful emissions, and most importantly, that the source of wind energy - Nature - inexhaustible.

Problems of development of renewable energy in the Autonomous Republic of Crimea is given much attention by the Crimean government in connection with the special requirements for energy complex of the region. First of all, the Crimea is scarce in terms of availability of its own generating capacity, and so needs to create a new generation to meet the needs of the population and industry. Second, the recreational nature of our region raises quite high environmental requirements for the establishment of new power plants.

The main goal of the project of construction of West-Crimean Weight capacity of 900 MW in the Black Sea region of the Autonomous Republic of Crimea is the reduction in natural gas consumption by using renewable energy. The total project investment is around EUR 1.2 billion .

The company "UkrVindInvestments Ltd." and its Ukrainian subsidiary "EvroUkrVind" construction project of West-Crimean wind farms with a total capacity of 900 MW installed at the site, located in the Medvedevo, Novoivanovskogo Okunevskaya and rural councils. The first phase of the project "West-Crimean wind power of 250 MW," the beginning of the preparation of construction scheduled for the fourth quarter of this year, has already received permission to develop land management, technical conditions and obtained a contract to join the West-Crimean wind farms to power grids. Developed design documentation and received a positive opinion of the state comprehensive examination and evaluation of a draft environmental impact on how the World Bank.

Start preparing the second phase of construction of West-Crimean wind farm 650 MW is planned for the second quarter of 2012. To finance the construction of the "West-Crimean wind power capacity of 900 MW," for each of the stages of a consortium of investors, the first of which represented Europe's leading investment companies (Guris, Greenworx and Suffelberg), and on the second international investment companies in Japan and South Korea (Toshiba , UNISON, KEPKO and KESEP). Data on the orders of consortia projects conducted audits for the two phases of construction, "West-Crimean wind power capacity of 900 MW)."

To place the site "West-Crimean wind power capacity of 900 MW," a need to develop urban planning documents - a detailed site plan, which is located within the boundaries of the West-Crimean wind farm. Placing the site, "West-Crimean wind station" meets the Scheme planning area of the ARC. In addition, the basis for the placement of the specified object is a

program of energy conservation in the ARC in 2010-2014, which envisages the construction of West-Crimean wind farm in the Black Sea region.

Currently, the Republican Committee of the Autonomous Republic of Crimea for Construction and Architecture introduced proposals in the Plan the first phase of the Strategy of economic and social development of the Crimea, which provides for funding from the ARC to develop schemes of territory planning the Black Sea region. Part of the work on the development schemes in these village councils undertake to pay the investors [8; 2011]

#### **2.4 Foreign investment and international cooperation**

If you do not take into account the small hydroelectric power stations, working mainly on the basis of Soviet small hydropower stations, other stations that produce energy from alternative sources, were constructed from zero. To date there are five solar stations in service, including - the largest in the CIS. Actively work has been made on the preparation and construction of wind farms by DTEK "Vetroenergoprom", "Concord." For example, a wind farm "Novoazovsk" in the Donetsk region of 10 units is expected to be put in function in summer of 2011, the other 13 - in 2012. Greek company ENECO Wind Energy expressed its interest in building wind plants in the Crimea and the same objective was announced by the Germans company Fuhrlander AG. Investors from German Managess Energy intend to rent land for the construction of the solar plant in Zaporozhye oblast.

Today the basic lucrative factor for investors in Ukrainian renewable sources of energy is the profitable Green tariff owing to which the duration of return on investment shortens largely. Additionally, important factors for world players to enter the Ukrainian renewable energy market are presence and volume of state aid grants and tax preferences, level of abundance of internal market, investment attractiveness of the state as well as presence of mechanisms of crediting of this sector.

Owing to the mechanism of Green tariff and investment conditions investors are not that frightened by the peculiarities of Ukrainian investment climate. But still there is a number of problems that the state must solve in order to fasten the development of this sector.

Out of the main problems, challenges and obstacles for investors in the renewable sources of energy market of Ukraine are [33; 2011]:

- Unstable political and legal situation in Ukraine remain the main risks for foreign investors.
- Time-consuming administrative procedures for construction of a solar or wind electric station of 1MW which need on average one year, while in EU the same procedures require around 6 months.
- In order to implement certain projects, there are 122 (!) permissive and licensing documents to be collected.
- Only purchase of land for construction of renewable energy electric station takes up to two years.
- The rule on local share: from January 2012 on the green tariff can be granted only to those objects that use modules, which were produced using no less than 30% of Ukrainian raw materials. The problem here is not only that imported materials are more profitable, but also that by now there is no understanding and mechanism of calculation of the Ukrainian materials share.
- Absence of legal norms on connection to electricity grids and the mechanism of compensation of investor`s expenditures on (re)construction of its damaged parts.
- High price for solar modules in Ukraine, the average price of which is 1,5 times higher in comparison to China and almost 20% higher in comparison to European countries.
- Old branch circuits constitute a high risk for investors. According to the Wind Energy Association of Ukraine, in case in Crimea 3,7 thousand MW wind generators are built, only 2 thousands MW will possible to connect to energy grids.
- In Carpathian region the problem can be constituted by land allotments: land in the regions of many rivers where hydroelectrostations are planned to be constructed, can be privatized.
- The majority of regions which are favorable for construction of renewable energy powers (such as Carpathian region, Nikolaev and Kherson region, the steppe of Crimea) are not highly populated. Which means that constructed electric stations will either need the construction of energy grids, through which the produced energy will be transported to other regions, either in infrastructure projects that will consume the produced energy.
- The absence of practical experience in preparation of technical documents regarding introduction of electric energy, produced by solar panels, in energy grids. Another crucial theme for the development of solar energy market in Ukraine is the situation in bank crediting of this sphere.

As a result, the market is quite closed for foreign investors. The absence of necessary budgetary support what respectively means that the state is unable to give enough financial aid for development of the renewable energy sector. If Ukrainian market was open for foreign investors, this problem could be largely solved. If Ukraine created favorable conditions for foreign investors, during five years it could increase its share of renewable sources of energy up to 8-10% as the potential for solar energy usage in Ukraine is higher than in the majority of European countries which are leading states in this sector. Although, in order to enter the top of European leaders-producers of renewable energy Ukraine`s total volume of powers has to reach 9 GW.

Despite numerous obstacles, companies from Great Britain, Germany, France, Portugal and United States of America started construction of several wind electric stations of the total power of 5 thousands MW in Crimea. The expected volument of investment is estimated as 8 bln Euro. Apart from that, in 2011 a new project in the sector of renewable sources of energy with participation of Greek investment of 795 mln. Euro is planned to start in Crimea.

Nordic Environment Finance Corporation is an international non-profitable specialized financial institution established by five Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. The main goal of Corporation establishment is improvement of environmental situation in Eastern Europe. NEFCO is financed by irreversible contributions of its founders; clean generated income is reused for project funding in countries of Corporation operations. Intergovernmental financial institution NEFCO is established specially for environmentally friendly projects funding in neighbor countries, including Ukraine. Nordic Environment Finance Corporation proposes variety of financial services in Ukraine, aimed at Ukrainian economy development, including crediting of energy efficient and energy saving projects on social objects in hryvnia for 3% per annum. On the 11th of August, 2010, order of the Cabinet of Ministers of Ukraine #1634 About application on ratification of Framework agreement between Government of Ukraine and Nordic environment finance corporation by Verkhovna Rada of Ukraine (which was signed on the 17th of September, 2009, in Donetsk). On the 12th of August, 2010, Draft Law On ratification of Framework agreement between Government of Ukraine and Nordic environment finance corporation #0178 is registered in the Parliament. NEFCO already financed 20 projects of private companies in Ukraine, while

municipal programs are postponed. Also, NEFCO financed environment components in 6 projects in Ukraine. They are two plants on furniture production, where wastes are used for energy production and best practices in building sector are implemented; two agricultural projects on use of ecologically clean methods and wastes for energy production; one project on production of wood for export, where chips are used for wood drying and pellets production. Also, NEFCO opened credit line for bank, which finances measures on energy efficiency and conservation in private houses and small enterprises.

National Agency for Energy Regulation together with Delegation of European Union to Ukraine implement program of Budget Support in the framework of European Neighborhood Policy Instrument (ENPI AAP 2008). Main goal of this sectoral program is establishing of cooperation between Ukraine and EU in the sphere of energy efficiency according to Action plan EU-Ukraine and MoU on energy, signed between Ukraine and EU and annexes. Concrete goals of this sectoral program are:

- É Implementation of measures, adopted by Action plan EU-Ukraine in the sphere of Energy efficiency and renewable sources of energy.
- É Support of priority measures implementation, adopted by MoU on energy, in the sphere of Energy efficiency and renewable sources of energy.
- É Organizational structure development aiming at support of measures in long-term perspective.

European Commission allocates 63 mln. Euro of grant on energy conservation and 7 mln. Euro as Technical Assistance.

In the framework of cooperation between Government of Ukraine and the World Bank it has agreed to open a credit line for energy efficiency (energy efficiency project in Ukraine) of \$250 million. The program can also attract grant from Clean Technologies Fund (CTF) of \$100 million. In order to properly prepare of energy efficiency projects in Ukraine, and on execution of the ordering of the Cabinet of Ministers of Ukraine from 10.10.2009 54010/1/1-09, NAER is working on developing a National Action Plan on energy efficiency (NAP EE) involving all ministries and departments as well as the participation of the World Bank. The aim of Plan of Action on Energy Efficiency in Ukraine is:

- É identifying the necessary and sufficient list of measures to eliminate existing obstacles;
- É finishing developing of system mechanisms, incentives in energy efficiency sphere;
- É prioritization of specific projects and their investment capacity;



É determining the timing of implementation and responsibilities for achieving results.  
 Action Plan Structure. The Plan has the following units:  
 É normative ó legal support;  
 É increasing the institutional capacity of government and manageability, energy efficiency of traditional energy sector;  
 É mobilization of the renewable energy potential;  
 É energy efficiency of transportation (transmission) and energy audit;  
 É energy efficiency of industries.

In second part of 2009, during its presidency of the EU, the Kingdom of Sweden founded the initiative in establishing a specialized fund for energy efficiency in the communal utilities sector ó Eastern European Energy Efficiency and Environment Partnership (E5P) (Swedish initiative). Among Eastern European countries Ukraine was elected for implementation this key initiative. The main attention is focused on implementing initiatives in energy efficiency projects. Currently, donors of Eastern European Partnership for Energy Efficiency and Environment Protection are ready to invest to the economy of Ukraine about 1.5 billion U.S. dollars on energy efficiency.

Ministry of Economy of Ukraine is preparing Order of the President of Ukraine about subscription the Treaty of Accession to the Swedish Initiative. All projects under the Initiative are divided into four group areas:  
 É communal heating systems in Ukraine;  
 É other energy saving projects in Ukraine;  
 É environmental protecting projects in Ukraine;  
 É projects for energy efficiency in other countries of the Eastern Partnership [11; 2011]

## **CHAPTER 3**

### **3.1 European Union ó Ukraine cooperation**

Ukraine has tremendous potential for energy efficiency. It is one of the most energy intensive countries in the world, even more so than energy-rich Russia. Ukraine first passed a law on energy conservation in 1994. However, funding for energy efficiency and a willingness to dedicate high-level attention to the issue have not always matched the scope of the problem.

Reflecting the renewed emphasis on energy efficiency, the previous government established a National Agency on Efficient Energy Use and developed a number of draft laws and sectoral programmes on energy efficiency. The new The State Agency for Energy Efficiency and Energy Conservation of Ukraine seems to have broader powers and greater support than the previous State Committee for Energy Conservation, which should bode well for the future of energy-efficiency policy.

Integration of the Ukrainian energy system is the European component of the strategic goal of Ukraine joining the EU. Unlike the new wave of EU enlargement, Ukraine has enough powerful and advanced gas, oil transportation and electric networks, combined with the transport networks of the EU and CIS countries, allowing it to participate in shaping the European energy policy and common energy market, play an important role in energy cooperation between CIS and EU.

The State Agency for Energy Efficiency and Energy Conservation of Ukraine along with the Representation of the European Commission in Ukraine are implementing the programme of budget support in the framework of ENPI.

The general aims of this sectoral programme are based on improvement of cooperation between Ukraine and European Union in the sector of energy efficiency according to the EU-Ukraine Action Plan and Memorandum of Understanding on Energy Issues that was signed between Ukraine and EU as well as related annexes. The tasks of the programme are:

- Stimulation of implementation of tasks, stated in the EU-Ukraine Action Plan in the sector of Energy Efficiency and Renewable Sources of Energy;
- Support of implementation of priority tasks, agreed in the framework of Memorandum of Understanding on Energy Issues, in the field of energy efficiency and renewable sources of energy.
- Development of related organizational structure aiming at support of implementation of these tasks in long-term perspective.

The European Commission will grant to Ukraine 63 mln. Euro in the framework of the mentioned programme as well as technical aid of the total volume of 7 mln. Euro.

In the framework of cooperation between Ukraine and World Bank there was an agreement reached regarding the Crediting line and Energy Efficiency (Energy Efficiency Project in Ukraine) of the total cost of \$250 mln. There is also a possibility to receive a grant of \$100 mln from the Clean Technologies Fund.

Also, it is important to mention that European Union is interested in complex development of the Autonomous Republic of Crimea (which ranks first region regarding renewable energy production potential in Ukraine) and expresses readiness to cooperation with the region in the framework of various programs. The latest agreement on bilateral cooperation was signed in May 2011 in Brussels regarding sponsorship by the EU of the programme "Support of joint initiative on cooperation in Crimea" totaling 12 mln. Euro. Additionally, it was announced that in the nearest future Verhovna Rada of Ukraine will pass a law, which will define a special economic regime for investors on the territory of Crimea which will also contribute to the improvement of cooperation between EU and Ukraine as well as open ground for European investors in the renewable energy market of Ukraine.

Also, in order to enhance EU-Ukrainian energy relations, the European and Ukrainian Energy Agency was established. To establish a solid platform for joint EU-Ukrainian actions in order to promote sustainable development, efficient use of energy and environmentally friendly technology transfer. Its goals are:

- To unite politicians, economists, scientists and businessmen from Europe and Ukraine.
- To promote EU energy saving solutions and boost technology and know-how transfer.
- To promote EU energy policy standards to be adapted in Ukraine.
- To stimulate efficient cooperation with financial institutions and foreign donors.
- To bring attention of the European community to the energy sector in Ukraine, both challenges and opportunities, as well as tools for problem solving.

European Ukrainian Energy Agency is a non-profit Association established in Kyiv, Ukraine on November 2, 2009. EUEA is meant to become a platform for representatives from politics, economy and science as well as financial service providers and consulting companies in Ukraine and Europe. The Agency also aspires to make a contribution to ecological and consistent energy policy in Ukraine.

The Agency started with concentrating its efforts in such important areas as:

- Energy efficiency in buildings - Green / Passive house technology, energy passport for buildings;
- Energy saving contracting and system that will allow management of public and private facilities and heat supplying companies by the third party, with the goal to make usage or

production of energy more efficient, where the remuneration of the operator is based on savings only;

- Amendments to the Land Codex for stimulation of wind energy projects;
- Energy Strategy for Ukraine;
- (European) network integration ó joint actions of network operators and energy producers;
- Fair competition of energy producers (energy exchange market);
- Network Access for "green electric energyö;
- Network access and tariff regulation for biogas;
- Adaptation of Ukrainian energy strategy and energy policy to European standards;
- Stimulation of joint projects in terms of the šRenewable Energies Directiveö;
- Stimulation of and support for projects under Kyoto Protocol (šJoint Implementationö).
- The European-Ukrainian Energy Agency and Euroconvention Conferences are glad to inform you about 'EU-Ukraine Energy Finance & Investment Summit 2011', which will take place on November 17th in Vienna.
- We invite you to consider presence and represent yourself and your company among the expected 200 guests.

The importance of the Ukrainian energy market for the European Union can be confirmed by the establishment of the European-Ukrainian Energy Day since 2010 and also in November 17, 2011 in Vienna (Austria) the 'EU-Ukraine Energy Finance & Investment Summit 2011' will be held [15, 2011].

Also, recently the European Union has allocated to Ukraine technical aid for the sum of EUR 70 million for the implementation of measures under the program to support implementation of the energy strategy of Ukraine in energy efficiency by 2015 [15; 2011].

In order to implement the Action Plan Ukraine - EU in the framework of the Memorandum of Cooperation between the EU and Ukraine on cooperation in the energy sector, a Working Group on Energy Efficiency was established, whose task lies in the establishment and further development of cooperation between Ukraine and the EU in energy efficiency and renewable energy sources sector, according to the central document which is the Road map on the issue.

As a result of the Working Group, 17 April 2008 between NAER and the European Commission signed a roadmap of cooperation between Ukraine and the EU in energy efficiency, alternative energy sources and combat of climate change. National Agency for Energy Regulation together with the European Commission to Ukraine, made implementation of the program budget support under the European Neighbourhood and Partnership Instrument (ENPI AAP 2008). With the participation of experts of the European Commission a draft list of indicators for budget support was developed.

Today the European Commission is ready to grant Ukraine in energy saving program grant of \$ 63 million and technical assistance capacity 7 million euros (Beneficiary - NAER). Also the European Commission Delegation in Ukraine agreed to involve European experts in the development of Ukrainian standards of energy marking households and industrial equipment that must comply with EU directives and implementing pan-practice levels of energy efficiency equipment. In September 17, 2009 during the International Investment Summit "Energy 2009" (Donetsk), according to the Cabinet of Ministers of Ukraine 26.08.2009r. Number 1005, on behalf of the Government of Ukraine Chairman NAER Yermilov SF signed a framework agreement between Ukraine and the Nordic Environment Finance Corporation (NEFSO). After ratification, the agreement will allow Ukraine to attract 20-25 million annually for projects of energy efficiency and clean production. The peculiarity of this Agreement, it is possible to attract credit resources in the social sector by 3% per annum in hryvnias [11;2011].

The main documents regulating the new EU energy policy have become Energy Charter and the Energy Charter Treaty. These documents pursue such a strategically important goal of strengthening EU energy security, improve the competitiveness of the economies of the alliance, to prevent monopolistic pressure on importers exporters of energy, improvement of environment, lower energy prices. In 2006 the so-called "Green Book" was published in which the basic approaches to the essence of a new energy policy, its main objectives and the means of solving these problems. The book highlighted the need for stable energy supplies to EU countries from energy-exporting countries, the importance of market liberalization, the need for energy savings and the development of new technologies in energy, strengthening of environmental requirements on energy consumption. Specific goals of the EU in the energy sector are of lower energy by 13% by 2020, bringing the share of renewing energy sources to 20% reduction in carbon emissions by 20%.

According to the Ministry of Economy of the Autonomous Republic of Crimea [8; 2011] the European Union is interested and is ready to multi-sided cooperation with the region of the

Autonomous Republic of Crimea in the framework of various programmes. During his meeting with the Minister of Economic Development and Trade Ms. Ekaterina Yurchenko the member of the European Commission for Enlargement and European Neighbourhood Policy Issues Mr. Stefan Fule underlined the high interest of the EU in the social and economic development of the Autonomous Republic of Crimea as well as in further development of cooperation with the Crimea`s authorities. He also mentioned that the EU is interested not only in the further development of cooperation in the framework of the joint initiative of the EU for cooperation with the Autonomous Republic of Crimea, but also in more wide frame of cooperation. He also evaluated positively the upcoming law of the Verhovna Rada of Ukraine which regulates the special economic regime for investors on the territory of Crimea and promised consultancy to Crimea upon the issues of cluster development and inter-regional cooperation. In May 2011 in Brussels Mr. Stefan Fule and the Head of the Council of Ministers of the Autonomous Republic of Crimea Mr. Vasiliy Dzarty signed an agreement about financial aid to Crimea in the framework of the programme "Support of the joint initiative about cooperation in Crimea" of the total amount of 12 mln. Euro.

## CONCLUSION

Since the moment when Ukraine gained independence, the newly developed state started to establish new policies and perspectives of development of the country. This procedure included the sector of energy and the development of strategies in order to increase the volume of the renewable sources of energy production and consumption, which would help to diversify the energy sources in the country. Ukraine is not only a large coal producer and natural gas importer, but a country with a strong potential for the development of wind, solar and biomass energy what makes it a favourable market for foreign investment and international cooperation. The development of renewable sources of energy could help Ukraine gain a stronger role in the eyes of the European Union and make it a stronger player in the geopolitical map of Eurasia. Unfortunately, this is mainly the instability and insecurity of foreign investment which turn out to be an obstacle for foreign businesses. Nevertheless, the Green tariff that was introduced in order to boost alternative energy in Ukraine became a huge stimulus for both foreign and local players. There is much to be done yet in terms of the social consciousness in regard to the usage of renewable resources of energy as the average energy consumer in Ukraine regards first of all the financial point of the issue when it deals with expenditures on energy resources. The programmes of cooperation between Ukraine and EBRD, the European Union, the World Bank and local European state and private organizations perform a vitally important mechanism for the development of the alternative energy sector in Ukraine.

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