

**Ministry for Environmental Protection and Nuclear Safety
State Committee of Ukraine for Energy Conservation
State Committee for Forestry
Agency for Rational Energy Use and Ecology**

CONTENT

1. PREFACE	1-3
2. OVERVIEW	2-4
3. EVALUATION AND DEVELOPMENT OF ENERGY SAVING MEASURES.....	3-9
3.1 Introduction	3-9
3.2 Analysis Of Energy Saving Indicators And Develop-Ment Of The National Economy Of Ukraine.....	3-9
3.3 Strategy Of Energy Saving And Improvement Of Fuel And Energy Resources Utilisation	3-10
3.4 Criteria And Priorities In Energy Saving.....	3-11
3.5 Barriers On The Way To Implement Energy Saving Measures	3-13
3.6 Energy Supply Sector	3-14
3.6.1 <i>Current Situation in the Sector</i>	3-14
3.6.2 <i>Energy Saving in Fuel and Energy Complex</i>	3-16
3.6.3 <i>Alternative and Renewable Energy Sources</i>	3-23
3.7 Energy Consumption Sector	3-27
3.7.1 <i>Current Situation in the Sector</i>	3-27
3.7.2 <i>Energy Saving Measures in Metallurgy</i>	3-28
3.7.3 <i>Energy Saving Measures in Machinery and Equipment</i>	3-33
3.7.4 <i>Energy Saving Measures in Residential Sector</i>	3-37
3.7.5 <i>Energy saving Measures in Chemistry</i>	3-41
3.7.6 <i>Energy saving Measures in Construction Materials Industry and in Construction</i> .	44
3.7.7 <i>Energy saving Measures in Agriculture</i>	3-48
3.7.8 <i>Energy Saving Measures in Transport</i>	3-53
3.8 Cross-Sectoral Energy Saving Measures	3-57
3.9 Conclusions	3-61
4. MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN FORESTRY	4-67
4.1 Introduction	4-67
4.2 Measures To Increase Forestland Area To Sequesterate Carbon	4-69
4.2.1 <i>Creation of Protective Forest Plantations</i>	4-69
4.2.2 <i>Creation of Forest Shelterbelts</i>	4-71
4.2.3 <i>Afforestation of Lands, Contaminated as a Result of Chornobyl' NPP Accident</i>	4-72
4.2.4 <i>Productivity Increase of Forest Plantations' Biomass</i>	4-75
4.2.5 <i>Forest Protection Improvement</i>	4-77
4.3 Mechanisms And Conditions To Implement The Measures	4-78
4.3.1 <i>Organisational Provisions</i>	4-78
4.3.2 <i>Financial Provisions</i>	4-79
4.3.3 <i>Legislative Provisions</i>	4-83
4.3.4 <i>Scientific Provisions</i>	4-84
4.4 Conclusions	4-85

1. PREFACE

In June 1992 world leaders and representatives from more than 200 countries came together at the UN Conference (Rio-de-Janeiro, Brazil) to confront the global ecological crisis. At the Earth Summit, Ukraine joined other countries in signing the Framework Convention on Climate Change (UNFCCC), an international agreement to address the danger of global climate change. 161 countries have signed the Convention. Ukraine ratified this Convention in 1996.

The objective of the Convention was stated as:

«...to achieve... stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.»

The international community rallied around the threat of climate change because scientists agree that the risk is real. There is no doubt that human activities are increasing the atmospheric concentrations of greenhouse gases, especially carbon dioxide, methane, and nitrous oxide. All theoretical models predict that these increases in greenhouse gas concentrations will cause changes in climate both regionally and globally - with adverse consequences likely for human health, as well as to ecological and socio-economic systems. The best current predictions suggest that the rate of climate change will far exceed any natural climate changes that have occurred during the last 10 000 years. Of course, there is uncertainties regarding the precise magnitude, timing and regional patterns of climate change. But any anthropogenic climate change that does occur will not be easily reversed for many decades or even centuries because of the long atmospheric lifetimes of the greenhouse gases and the inertia of the climate system.

Therefore, there was a obvious necessity to develop the Ukrainian National Action Plan to address climate change. This plan involves economic forces to meet the challenges posed by the threat of global warming. It calls for limited, and focused, government action and innovative public/private partnerships. It relies on the ingenuity, creativity, and sense of responsibility of the Ukrainian people.

2. OVERVIEW

In 1992 the USA Government adopted the U. S. Country Studies Program Support for Climate Change Studies in the developing countries and the countries with transitive economics. This Program is aimed to achieve the following objectives:

- enhance the capabilities of countries and/or regions to inventory their net emissions of greenhouse gases, assess their vulnerabilities to climate change, and evaluate the options available to them to mitigate and adapt to climate change;
- support countries' efforts to establish a process for developing and implementing national policies and measures to deal with climate change over time;
- develop data and information that can be used at the national, regional, and global levels; assess current and future trends in net anthropogenic emissions of greenhouse gases; and further national and international discussions of climate change issues.

Ukraine takes part in US CSP. Country Study on Climate Change in Ukraine is coordinated by the Agency for Rational Energy Use and Ecology (ARENA-ECO) under supervision of Ministry of Environmental Protection and Nuclear Safety of Ukraine.

The project consists of four elements:

- development of GHG emission inventory in Ukraine;
- assessment of ecosystems vulnerability due to climate change and adaptation options;
- analysis of mitigation measures;
- public education and outreach activities.

The first element of the Study resulted in developing the national inventory of GHG emissions. For the 1990 base year, total GHG emissions in Ukraine were 232,882 thousand tons of carbon equivalent (CE). CO₂ emissions were partly offset by an uptake of carbon in Ukrainian forests of 14,175 thousand t CE. Due largely to fossil fuel consumption, carbon dioxide emissions accounted for the largest share - approximately 76 percent. Methane accounted for 23 percent of total emissions, which included contributions from agricultural activities and landfills, among others. The nitrous oxide emissions are less important comprising 1 percent of total emissions.

Baseline and climate scenarios were elaborated in the frames of the second element, the assessment of vulnerability of agriculture and forestry, water and coastal resources due to climate change was carried out, and possible adaptation measures were identified.

Mitigation measures analysis, development of baseline and mitigation scenarios was elaborated in the frames of the third element. Economic development and GHG emissions were forecasted. The main measures for mitigation of anthropogenic impact on climate change in Ukraine have been analyzed.

Since 1990 the Ukrainian economy is facing a very deep crisis (⌘) and therefore GHG emissions have been essentially decreased.

Table 2-1. Economics. GDP, Inflation and Unemployment Trends

	1990	1991	1992	1993	1994	1995
GDP, 109 \$	73.62	67.21	60.56	51.96	40.01	35.29
Unemployment, thousand person	-	9.8	128	180.9	216	126
Inflation, %	-	-	1310	4830	990	420

Ukrainian economy is in painful transition period now. But Ukrainian government pay much attention to the energy efficiency and environmental protection. Many legislative documents have been adopted in the last time.

The Law of the Supreme Council «On Environmental Protection» was among the first legislation acts of the independent Ukraine. Later the following legal provision was adopted by the Supreme Council of Ukraine: Law of Ukraine «On Protection of Atmosphere»(1992), Law of Ukraine «On

Wildlife» (1994), Law of Ukraine «On Changes and Amendments to the Code of Ukraine with concern to Administrative Infringements»(1993), which empowers the bodies of the Ministry for Environmental Protection of Ukraine to take legal steps in the case of administrative infringements in the field of environmental safety, Law of Ukraine «On Energy Conservation» (1994), Law of Ukraine «On Changes and Amendments to the Criminal Code and Criminal Procedure Code of Ukraine» (1994), which specify criminal and fiduciary responsibilities for infringement of conditions of import (or transit) of waste products and utility waste on the territory of Ukraine, Law of Ukraine «On Ecological Examination» (1995).

In the last time the whole number of programs for the economic development of Ukraine was elaborated and adopted, the most important of them were as follows:

1. National Energy Program [1];
2. Program of Restructuring of Ukrainian Economy [2];
3. Comprehensive State Energy Conservation Program of Ukraine [3];
4. National Development Programs of Industrial Sectors [4-9];
5. National Climate Program;
6. Program of the Development of Forestry and Forest Industry in Ukraine;
7. National Program of the Development of Agricultural Production in Ukraine.

These documents were assumed as a basis for forming the baseline scenario of the development of economy and its sectors, for assessing projected GHG emissions and mitigation measures.

In correspondence with the baseline scenario of the economic development it is planned to provide main indicators of the socio-economic development of the country (**Error! Number cannot be represented in specified format.**) in the period considered, up to 2015.

Table 2-2. The main indicators of socio-economic development of Ukraine till 2015

<i>Indicators</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>2005</i>	<i>2010</i>	<i>2015</i>
GDP, billion \$	73.62	35.26	41.30	58.82	84.07	97.17
GDP, %	100.0	47.9	56.1	79.9	114.2	132.0
Fuel combustion, PJ	9246.3	5531.5	6965.1	7557.7	8022.5	8551.9
Population, million	51.9	51.5	50.2	51.0	51.5	51.8
Housing fund, million m3	922.1	978.5	1018.5	1169.6	1255.0	1360.5

Alongside with the baseline scenario the indicators for the optimistic and pessimistic scenarios of the economic development were forecasted. These scenarios differ in terms of crisis peak, duration of economic recovery and further rate of development.

An active and consistent reformation and large-scale economic restructuring (firstly in high intensive industrial sectors) and the increase of its liquidity, considerable increase of Ukrainian goods competitiveness, promotion of energy saving problem in Ukraine are projected in the baseline scenario.

The performance of a balanced financial policy is envisaged. Reforms towards simplifying taxation system, expansion of its base and achieving GDP re-distribution through the state budget up to an ultimate level of 40% of GDP is forecasted.

The increase of budget expenses effectiveness, the reduction of dotations and capital transfers structure optimisation are envisaged in budget policy as well as the support of budget deficit at a minimal level (not more than 3.5% from GDP). Realization of money-credit policy should provide the achievement of money stabilization, support of credit system, stimulation of credits towards long-term investment as well as the support of productions, which provide a deep transformation of national mineral-raw resources and build-up the output of import replacing products and export potential of the country.

In correspondence with the forecast of the development of material production sectors in 2001-2005 according to optimistic assessment the accelerated development of metallurgy, chemical and petrochemical industry as well as machine building is envisaged.

Such character of structural shifts will be reflected to a certain extent on the increase of volumes and infrastructure of energy consumption. The change of economic conditions for sectors functioning is also projected, and first of all, the introduction of an active state regulation of energy resources consumption, realization of energy saving measures.

Acceleration of service sector development, in the first turn, due to the development of paid services of the financial economic sector, the increase of a specific weight of paid services in socio-oriented economic sectors, appearance of new types of services, connected with the expansion of informational exchange, etc., are envisaged.

According to optimistic projections of the national economy development positive changes will take place in the period forecasted due to a relative reduction of energy resources import and increase of the Ukrainian coal export. Under these conditions it is possible to achieve a positive net export (1% of GDP) till 2000 with its further growth up to 2% in 2005.

The performance of an active state policy regarding a stimulation of export production in Ukraine is forecasted. The analysis shows that in the years of crisis the less production recession was marked in those sectors, which have an access to external trade markets. Under the limited domestic demand of some sectors' products it was export-oriented production which allowed to avoid their degradation. To regulate export production the forecast envisages the revision of production structure, active search of new external markets and restitution of lost ones, structural and technological rehabilitation of production. Mutual coordination of scientific-technical policy with the policy of currency, external economic and taxation-budget regulation should be provided. Forecast show, that in 1998-2010 a real achievement of economic stabilization with a further development of the country economy is possible. This conclusion is based on economic potential for the development of a number of sectors (agriculture, metallurgy, machinery and equipment, light industry) as well as on the possibility of a gradual solution of energy supply problem in the country.

Activization of investment processes through the increase of a share of basic capital cumulation in a total volume of capital creation should be important for a forecasted period.

Country's withdrawal from crisis is possible only in conditions of the activization of a positive state influence on the production and social processes towards all-round stimulation of producers and strengthening a real social defence of population.

In order to assess GHG emissions and mitigation options the following sectors and subsectors of economy were considered:

- I. Fuel & Energy Complex (FEC) and subsectors:
 - A. Electric Power & Heat Supply
 - B. Coal Industry
 - C. Oil & Gas Industry
 - D. Oil Refining

Electric Power & Heat Supply subsector fuel consumption was forecasted only for utilities supervised by the Ministry of Energy of Ukraine. Heat and electric power generation by industrial and residential power units was taken into account in corresponding sectors, because of historical planning practice orientated not to functional but sectoral approach.

- II. Industry and main subsectors:
 - A. Metallurgy
 - B. Chemical Industry
 - C. Machinery and Equipment
 - D. Building Materials Industry
 - E. Food Industry

F. Other Industrial Sectors

- I. Construction Sector
- II. Agriculture
- III. Residential and Commercial Sector
- IV. Transport
- V. Other Sectors of Economy

These sectors are selected as a result of historical planning practice and economic development forecasting together with the fact that these sectors are the main sources of GHG emissions. A deep crisis of Ukrainian economy considerably complicates the assessment of future GHG emissions. It is extremely difficult to project the terms of economy stabilization, directions and rates of further economic development, state-of-the-art technologies implementation and energy efficiency improvement.

Also it is impossible to apply mathematical models and methodologies used in the developed countries and earlier used for planning development of Ukrainian economy including the regressive analysis, production functions and input - output models.

Accounting and iterative equilibrium models to forecast the development of economy and GHG emissions were used. Optimization models were applied to develop mitigation scenarios and to estimate mitigation options.

Coal, natural gas, coalbed methane, residual fuel oil, diesel oil, other oil products were considered as primary fuels. In metallurgy coke and coke gas, and in a residential sector coal briquettes and firewood, were taken into account.

In the future direct GHG emissions are projected to be lower than the emissions of 1990 in any scenario of the economic development, despite the essential growth of GDP in a baseline and especially in optimistic scenarios of the economic development of Ukraine. This is supposed to be achieved by the whole set of measures for GHG emissions decrease and the increase of CO₂ uptakes in the forestry.

In the baseline scenario it is projected to implement mitigation measures with overall potential of 100 000 Gg CE and therefore emissions at the level of 2015 will be 45,889 Gg CE less than in 1990.

GHG emissions and removals trends are given in **Error! Number cannot be represented in specified format.** for the baseline scenario.

Table 2-3. Total GHG emissions/removals in the baseline scenario

	1990	1995	2000	2005	2010	2015
<i>Direct GHG emissions</i>						
CO ₂ , Gg	711,447	425,299	530,042	569,149	598,016	634,352
CO ₂ , Gg CE	194,031	115,991	144,557	155,222	163,095	173,005
CH ₄ , Gg	10,115	7,150	8,383	7951	7,467	6,738
N ₂ O, Gg	38.2	15.7	34.7	39.3	40.8	42.3
Total, Gg CE	255,192	158,268	195,503	204082	209,310	215,172
Total, % compared to 1990	100	62.02	76.61	79.97	82.02	84.32
<i>CO₂ uptakes in forestry</i>						
CO ₂ uptakes, Gg	-51,976	-64,886	-66,643	-68,548	-70,702	-72,784
CO ₂ uptakes, Gg CE	-14,175	-17,696	-18,175	-18,695	-19,282	-19,850
<i>Net</i>						
CO ₂ , Gg	659,471	360,413	463,399	500,601	527,314	561,568
Total, Gg CE	241,017	140,572	177,328	185,387	190,028	195,322
CO ₂ , % compared to 1990	100	58.32	73.57	76.92	78.84	81.04

In optimistic scenario of the economic development, the net GHG emission levels in 2015 will total above 220 Tg CE, that is approximately 10.7% lower than in 1990.

In pessimistic scenario net GHG emissions on the level of 2015 will total above 180 Tg CE or about 73% from the level of 1990.

A very wide range of change of indicators, characterizing the future economic development and expected emission levels is connected with a very high grade of uncertainty of future development of Ukrainian economy (**Error! Number cannot be represented in specified format.**).

Table 2-4. Ranges of fuel consumption and GHG emissions in 2015

	<i>Pessimistic scenario</i>	<i>Optimistic scenario</i>	<i>Range</i>	<i>Average deviation, %</i>
Fuel, PJ	7,596.4	9,787.2	2,190.8	12.8
Direct GHG Emissions, Tg CE	195.2	245.4	50.2	11.5
Sinks in Forestry, Tg CE	-19.9	-23.9	-4.0	9.1
Net GHG Emissions, Tg CE	175.3	221.5	46.2	11.6

The results of Country Study evidence that energy saving and options in the Forestry have the main mitigation potential. Therefore National Action Plan deals with such areas.

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3. EVALUATION AND DEVELOPMENT OF ENERGY SAVING MEASURES

3.1 INTRODUCTION

The problem of energy efficiency and energy saving improvement is inevitably related to the general socio-economic situation in Ukraine, which remains rather complicated now. Due to a discursive implementation of economic reforms and a lag of structural transformations, transition of the economy to its stage of stable growth is not provided.

There are a number of reasons that do not allow creating a favourable economic environment to cause afflux of any investments to implementation of energy efficient projects. Main reasons, having adverse impact over the investment process in energy saving, are the following ones:

- incompleteness of tax system reforming and in coordination of laws in the country;
- considerable deficit of the State budget;
- non-arrival of planned budget incomes due to untimely and incomplete effectuation of payments to the various level budgets;
- «shadow» economy and a number of other factors.

This chapter describes results of energy saving indicators analysis in major sectors of the national economy of Ukraine, principal energy saving measures, criteria and priorities of energy saving; it also depicts the barriers to improve efficiency of fuel and energy utilisation, which, in turn, would reduce the greenhouse gas emissions.

The chapter includes primary energy saving measures in regulatory-legal, organizational, financial-economic, informative and technological directions.

3.2 ANALYSIS OF ENERGY SAVING INDICATORS AND DEVELOPMENT OF THE NATIONAL ECONOMY OF UKRAINE

One among principal energy saving indicators, characterizing the extent of the national economy of a country, is energy intensity of the Gross Domestic Product.

As of Ukraine, this index is two times of the energy intensity in European Union countries, 2.5 times of that in Germany, and 4.5 times of that in Japan. Output of the most part of products in Ukraine is made on account of an increase of specific energy resources consumption. Specific consumption of heat and electric power for output of more than 50% of types of products were increased in 1995, while consumption of fossil fuel – for 44%. If the specific weight of fuel-energy resources (FER) in the prime cost of machinery and equipment in Ukraine was 5-6% quite recently, than this index has grown to 30-50% now, what is several times of similar indicators in foreign companies [4]. This results in a rise of the final price of a product, diminishes its competitiveness on a foreign market, reduces commodity turnover scopes and, in the end, curtails any deductions to the budget.

Thus, for example, analysis of FER specific consumption in 1996 shows that these were increased practically in the most part of productions; in particular, in 78 technological processes these were increased for 1% - 20%, and several processes demonstrated the increase for 21% - 50% and even more.

Major factors of such low efficiency of fuel and energy utilization are the overall production recession, outmoded processes and equipment, as well as irrational utilization of energy resources. Significant indicators of FER losses in Ukraine dictate the necessity to find ways to reduce fuel and energy consumption. An experience of foreign countries had proven the necessity for the policy aimed at improving efficiency of FER utilization and energy saving.

Restructuring of Ukrainian economy is one among the principal goals, oriented towards:

- the reduction of the share of fuel-intensive industries in the industrial production;
- the accelerated determination of optimal share of energy-intensive industries in the national economy;
- restoration of the production with improvement of its technical-economic indicators and with provisions of products' competitiveness on the world market;
- development of scientific-intensive and high-technology economic sectors;
- balancing the national economy on account of re-orientation of production of producer's goods, first of all in machinery and equipment, metallurgy, chemistry with intention of more full meeting the needs of domestic inter-sector co-operation;
- re-orientation of the production towards the environmental safety technologies.

Thus, energy efficiency improvement and, respectively, reduction of energy intensity of the products manufactured in Ukraine is the strategic course of the national economy and social sphere for the nearest and more distant future.

3.3 STRATEGY OF ENERGY SAVING AND IMPROVEMENT OF FUEL AND ENERGY RESOURCES UTILISATION

In accordance with the Comprehensive State Energy Conservation Programme of Ukraine [5], energy saving potential compared to FER utilization in 1990 made 145 - 170 million tons of coal equivalent (tce). Relevant potential in reduction of greenhouse gas emissions approaches to 103,840 thousand tons of carbon equivalent (CE).

Basic principles of energy saving strategy in Ukraine are:

creation of economic and legal conditions on the part of the state for the enterprises, institutions and individuals to become interested in the energy saving;

effectuation of governmental regulation of activities in the field of energy saving on the grounds of utilization of economic and standard-technical methods of control;

giving the top priority to energy saving needs in performing economic, productive, managerial and other activities, related to production, processing, transportation and utilization of FER;

creation of energy saving structure of material production on the grounds of comprehensive resolution of economy and energy saving matters with consideration of ecological requirements;

application of incentive bonus and financial responsibility methods with the purpose of rational utilizing and efficient consumption of fuel and energy.

An essential role in the energy saving strategy is also played by the matters such as standardization and rating, energy expertise and audit, popularization of energy saving advantages and improvement of educational level of the people, international co-operation and others.

With the purpose of implementing the energy saving strategy, a system of governmental control and support of energy saving has been completed and is functioning now.

In particular:

- the Law «On Energy Conservation» was adopted by the Verkhovna Rada of Ukraine on 1 July 1994;
- the State Committee of Ukraine for Energy Conservation was created on 26.07.95 by the Decree of President of Ukraine;
- Units, dealing with matters of energy saving management, were formed by the of Resolution of the Cabinet of Ministers of Ukraine and these are functioning now at ministries, departments and regional state administrations;
- Regional (Oblast) Inspections on energy conservation were formed and are functioning now;

- Over 20 regulatory acts were elaborated and adopted by the Verkhovna Rada and Government of Ukraine; these include the Resolution of the Cabinet of Ministers of Ukraine on creation of all-national out-of-budget Fund for Energy Conservation, implementation of FER consumption rates and penalties for irrational utilization of fuel and energy.

Nevertheless, the problem of efficiency improvement in the course of production, transportation, distribution and consumption of fuel and energy remains rather urgent task of Ukraine nowadays.

3.4 CRITERIA AND PRIORITIES IN ENERGY SAVING

World practice of projects' analysis uses Net Present Value index (NPV) of a project as one of the principal criteria in evaluation of the elaboration and implementation of energy-efficient projects; this index is also called the Present Worth of the Net Benefit.

NPV is calculated by the formula:

$$NPV = \sum_{t=1}^n \frac{B_t - C_t}{(1+i)^t}$$

where B_t - total benefits for « t » year;

C_t - total expenses for « t » year;

t - relevant year of the project;

n - validity term of the project, time horizon depth in years;

i - discount rate (percent).

However, since NPV can not be used in all cases, other criteria are used as well.

Thus, a general criterion, which is used more seldom as compared with NPV, is Benefit -Cost (B/C) Ratio, which is calculated by the formula:

$$B/C = \frac{\sum_{t=1}^n B_t / (1+i)^t}{\sum_{t=1}^n C_t / (1+i)^t}$$

When applying this criterion, they select all independent projects with B/C Ratio equal to or over «1».

Drawbacks of such approach are in that it can produce incorrect results for relative majority of independent projects even. In this case, one would remember that relative (not absolute) benefits are compared.

One more criterion of energy saving projects' evaluation is Internal Rate of Return, which represents discounted money flow with the time owing to implementation of an energy saving project.

It is necessary to note that because of high risk level, caused by incomplete transition to market forms of control over the economy, by imperfection of legislative base and late high inflation rate and fluctuation of foreign currency exchange rates, the above criteria are applied very seldom in Ukraine.

Financial analysis widely uses a Payback Period criterion, which shows the period during which the expenses on the project can be reimbursed. Economic efficiency of energy saving measures in this case is determined by standard SSTU 2155-93 «Energy Saving. Methods to Determine Economic Efficiency of Energy Saving Measures».

To compare current economic indicators of enterprises' activities before and after the implementation of any energy saving measures, the above Standard uses the method of separation of that share of the total profit value, retained by an enterprise, which is directly gained by implementation of energy saving measures.

Profit indicators are calculated with consideration of any reduction in needs of the enterprises for fuel, electric and thermal power, as well as any reduction of enterprise's payments for pollution of the environment, achieved due to implementation of any energy saving measures.

Drawbacks of such modality are in that it is oriented only towards savings of fuel and energy and does not take into account any improvement of FER utilization efficiency, even if saving of these is absent, but production scope is increased.

Criteria for evaluation of energy-efficient project can also be:

- saving of fuel and energy resources;
- costs of development, implementation and operation of a project;
- positive ecological and social effects.

An important factor of implementation of energy saving programs and efficient control over the energy saving is also a reduction of energy intensity of products.

As far as it concerns the priorities of energy saving, selection of these is dictated by improvement of ecological safety in Ukraine and includes:

- abatement of energy dependence of the country;
- increase in concernment and loading level of domestic producer;
- improvement of energy resources consumption efficiency at the consumers';
- enhancement of reliability and extension of utilization scopes of pollution-free and technologically safe power engineering and energy saving processes and equipment, of alternative renewable energy sources, large-scale utilization of energy production wastes in the economy;
- attraction of investments from international financial structures to create and retrofit power engineering facilities;
- elaboration and implementation of a set of measures to prevent mass stealing of energy products;
- promotion to creation and incentive bonus for activities of transnational fuel and energy companies, joint power engineering constructing and other enterprises, as well as for these of financial-industrial groups;
- contingency and harmonization of national legislation in the field of power engineering;
- social purposefulness of energy policy and necessity of energy supply diversification.

Selection of the mentioned above criteria and priority fields of energy saving is stipulated by any particular conditions and abilities to implement this or that energy efficient project.

The energy saving measures below are classified into three groups by the specific value of capital investments for 1 tce of saved FER, in conformity with the classification of the Comprehensive State Energy Conservation Programme of Ukraine. Thus, low-cost energy efficient projects include these where the specific capital investments for 1 tce of saved FER are less than UAH200/tce, medium-expensive ones include those where the costs are UAH200-250/tce, and high-expensive ones – UAH250/tce and more.

3.5 BARRIERS ON THE WAY TO IMPLEMENT ENERGY SAVING MEASURES

The Law of Ukraine «On Energy Conservation» prescribes that the task of economic mechanism of energy saving in the market economy conditions is an incentive bonus for rational utilization and saving of FER. Article 11 of the Law describes the constituent of the mechanism, including:

- comprehensive use of economic remedies and stimuli,
- introduction of payment for factually used fuel and energy;
- introduction of economic sanctions for wasting energy;
- issuance of subsidies, allowances, tax credit and other privileges to promote the activities on energy efficiency improvement.

However, the most part of economic measures, aimed at the energy saving and declared by the law of Ukraine «On Energy Conservation», were not reflected in such primary economic Laws of Ukraine as «On the Taxation System», «On Taxation of Enterprises' Incomes» and others.

Taking into account an incoherence of these laws, one may conclude that the priority of the energy saving, declared on the all-national level, has no economical grounds practically.

Thus, existing legislative and regulatory bases do not allow to introduce preferential taxes for producers and customers of energy saving equipment and contemporary energy efficient technologies.

One of the major barriers on the way to implement any energy saving measures is the deficiency of means in the state and local energy saving funds.

Among other reasons, hindering from implementation of energy saving measures, we may indicate the following:

- incompleteness of economic reforms concerning transition to the market and privatization;
- total economic crisis, including absence of means and low solvency of the consumers;
- absence of material incentives for implementation of contemporary energy efficient technologies;
- imperfection of price-forming mechanism;
- insufficient economic mechanisms to attract foreign investors to any energy saving projects;
- imperfection of energy consumption standards;
- imperfect market of domestic capitals;
- risk of high inflation rates;
- risk of fluctuations in currency exchange rate;
- domination of state-owned sector;
- insufficient influence and deficit of stock capital;
- imperfection of capital's structure;
- absence of banks for development in the country;
- prevalence of short-term liabilities over long-term ones which is conducive to the trade but not to investments into production and energy saving;
- high taxation percentage;
- restricted access of small enterprises to official financing sources.

The following factors are also responsible for hindering from implementation of energy efficient projects:

- insufficient methodical base;
- lack of experience in development and implementation of energy saving projects;
- shortage of high-qualified staff for projects' analysis, energy audit and management;
- disintegration of productive connections and co-operation;
- low level of energy saving advocacy in the country.

The above listed factors are characteristic for all energy efficient projects practically.

3.6 ENERGY SUPPLY SECTOR

3.6.1 Current Situation in the Sector

The fuel and energy complex (FEC) includes coal industry, oil and gas industry, oil refining industry, and electric power industry and heat supply.

Production of major kinds of primary energy carriers was reduced by 11% in 1996 as compared with 1995, and coal mining was reduced by 16%. At the same time, production of gas and oil with gas condensate was increased in Ukraine for 1.4% and 0.2%, respectively.

A recession in electric power generation was observed in 1996; the generation was 6% less than in 1995.

Characterizing the sector of fuel and energy supply of Ukraine, the following should be noted.

Coal Industry

Operating mine facilities in Ukraine in 1995 comprised 285 mines and 7 open-cast mines with strip mining of brown coal. Annual production capacity makes up to 190 million tons [4].

261 mines are functioning in Donets'k coal basin; 119 of these are mining the coking coal (yearly productivity – 79.5 million tons). 42 mines will be closed by the year of 2000, and 97 mines are planned to be closed by 2010.

L'viv-Volun' coal basin comprises 17 operating mines; 13 of those will be closed by 2005.

6 mines and 7 open-cast mines with 7 million tons of coal productivity are operated in Dniprovs'ky brown coal basin.

Coal mining in 1975-1990 was reduced by 51 million tons and by 70.5 million tons by 1995. Task of *the coal industry* is a stabilization of coal production scopes and an increase of it to the level where needs of the national economy will be provided. To achieve this, it is planned:

- new mines and coal-preparation plants shall be constructed and the working enterprises shall be restructured and technically updated;
- the mines shall be restructured and the industry management shall be improved;
- creation of non-budgetary funds for the capital construction and reorganization of the coal-mining enterprises;
- handling the social problems of the mining regions by the conveyance of the social facilities of the mining industry to the local administrative bodies.

Oil and Gas Industry.

Radical changes in the oil and gas extracting industry shall be achieved by large-scale geological exploration on both land and defined areas of Black and Azov water.

The development of the production capacity of new deposits to commercial levels is expected to speed up, and comprehensive methods on both improving the situation with waterflooding in the mines and increasing the productivity of the promising oil and gas fields shall be introduced.

The *Oil Processing Industry* of Ukraine was oriented at satisfying the needs of power-generating stations and industrial production in boiler and stove fuel, and that is why oil was processed to a low extent.

A great deal of attention shall be paid to such methods as hydrofining for the production of diesel fuel with minor contents of sulphur, catalytic reforming of gasoline, catalytic cracking and hydro-cracking of crude oil. The oil imports shall increase to keep oil-refining facilities running at greater capacity and produce products for both domestic needs and export.

The National Program «Oil and Gas of Ukraine» up to the year of 2010 foresees the increase of an annual production of oil and gas condensate from 4.1 million tons in 1995 to 7.5 million tons in 2010, 2.5 million tons of which will be extracted from shelves of the Black Sea and Sea of Azov. It is planned to increase annual gas production up to 35.3 million m³ by 2010. Prospected stock of hydrocarbon raw materials in Ukraine are in 297 deposits, 80 of which are gas fields, 94 – gas condensate ones, 49 oil and gas condensate, 9 – condensate and 65 – oil fields. Major basins of oil and gas are Prycrapattya, Dnipro-Donets'k and Prychormonorsky regions.

Electric Power and Heat Supply

Installed capacity of electric power plants of Ukraine is 55,200 MW, including 32,400 MW and 4,700 MW of thermal power plants (TPP) and hydropower plants of Minenergo respectively (58.6 and 8.5%); capacity of nuclear power plants – 13,800 MW (25%); that of block-plants of other ministries and departments – 4,300 MW (7.7%). Over 1 million km of transportation pipelines and some 3 thousand kilometers of heat-supply networks are in operation.

It is worthy to note that the specific weight of coal equivalent for production of electric power was increased during 1993 - 1995 from 355.4 g/kWh to 364.7 g/kWh, while this index for heat production was increased from 170.6 kg/GCal to 172.9 kg/GCal. Technological losses of electric power due to its transportation in electric lines were also increased from 10.78% to 12.4%.

Potential resources of alternative and renewable energy sources (ARES) are:

- water resources (4.32 million tce);
- wind energy (0.8 – 1.0 GW by 2010, annual production up to 2 bln kWh);
- solar, geothermal energy (up to 11 million tce by 2010);
- biogas, wastes utilization (annual production up to 10 million tce) [4].

As of the nuclear fuel, expected stock of uranium ore in Dnipropetrovsk region amounts 40 thousand tons [4].

Steady energy supply of the national economy and a significant reduction of the harmful environmental effects shall be achieved by means of:

- technical updating and reconstruction of the active heat, hydro- and atomic power stations in order to prolong their life and also to increase safety and lessen the environmental hazards;
- the technical refitting and reconstruction of power and heat networks;
- adopting new high-tech coal-burning equipment and combined cycle plants including those with the HI-GAS process;
- putting into operation nuclear power-generating units of high and medium degree of readiness;
- further development of hydropower engineering by the development of Western Ukraine hydroresources, rebuilding and updating small hydro-power plants and building pump-storage power-generating plants;
- further introduction of heating systems and centralized heating supply;
- creation of the domestic fuel-nuclear cycle;
- provision of the domestic machinery and equipment and electrotechnical industries with power and electronic equipment;

- establishment of favourable conditions for the complete and timely provision of thermal electric power plants with domestically-mined coal;
- wide application of alternative and renewable energy sources;
- saving and development of the construction base of the industry;
- creation of the data-management systems for the Ukrainian power industry;
- restructuring of the sector and creation of the electric power market;
- providing for financial conditions and incentives for the simple and extended reproduction of the fixed assets of the sector;
- creation of proper social conditions for the workers of the industry.

3.6.2 Energy Saving in Fuel and Energy Complex

In accordance with the Comprehensive State Energy Conservation Programme of Ukraine, the energy saving potential of the fuel and energy complex of Ukraine makes 28.0 – 38.0 million tce. Relevant potential to reduce greenhouse gas emissions approaches to 9,820 thousand t CE. It is necessary to note that high and medium-cost projects can not be implemented to the full extent at present due to absence of financing and because of other barriers, mentioned in Chapter 2.5.

Full-scale implementation of low-cost measures will allow to achieve fuel and energy resources saving to the amount of 2-3% of the current consumption level.

As of the barriers to the implementation of energy saving measures in the fuel and energy complex, it is necessary to note that almost all factors, listed in Chapter 2.5, have this or that adverse impact over implementation of any energy efficient measures. Especial urgency is caused by the non-payment factors as inside the energy supply sector, so between the sector and consumers of fuel and energy.

Coal Industry: energy saving measures**High and medium-cost measures**

- ◇ restructuring the sector, including the closure of unprofitable mines, privatization of non-specialized enterprises, creation of stock companies;
- ◇ reconstruction and technical re-equipment of mines and concentrating mills;
- ◇ construction of new mines for account of state capital investments with involvement of foreign investors;
- ◇ support of productive capacities of existing mines for account of the equities of the sector;
- ◇ conducting organizational and technical measures on the creation of power complexes of «mine- concentrating mills-TPP» type;
- ◇ wide implementation of coal gasification;
- ◇ reconstructure and technical re-equipment of capacities of coal machine building;
- ◇ development of production and transport infrastructure for coal mining;
- ◇ introduction of adjustable electric drive;
- ◇ creation of small-sized movable up-to-date concentrating mills;
- ◇ reduction of the extension of mining networks and simplification of their structure by tunneling new vertical shafts;
- ◇ elimination of gradation in underground transportation by construction of new capital horizons (levels) at mines (associations);
- ◇ concentration of mining works on smaller number of coal beds and layers developed at the same time for account of the load of breakage face and reduction of average number of working lavas (not more then 6-7 lavas per one mine);
- ◇ development of mechanized complexes, that will allow to combine works on coal mining and filling goafs, equipped with automated control systems and units;
- ◇ mechanization of subsidiary activities, including construction of the timbering of arched and anchor types when sink working is made by

- combine and blasting works with the help of robot manipulators;
- ◇ equipping shaft-sinking set with efficient remote control facilities;
- ◇ development and implementation of automated monitoring systems and others information and control systems;
- ◇ use of technologies providing separation of coal layers and beds, starting from the site of mining;
- ◇ separation of flows in production lines with a la carte and starting devices (separators), using the principle of natural radioactivity of the layers;
- ◇ mining, dressing and drying coal in the framework of one enterprise (association);
- ◇ processing coal into synthetic fuel;
- ◇ reduction of the number of coal mining sites;
- ◇ coalbed methane recovering;
- ◇ implementation of technologies and technical methods of utilization of wastes from coal dressing and their use as a fuel;
- ◇ development and implementation of local power and technological equipment for electric and thermal power at mines.

Low-cost measures

- ◇ solving problems of price formation, grants, providing conditions to ensure payments for coal supply;
- ◇ acceleration of scientific and technical progress, cutting down terms for development and implementation of energy efficient technologies and equipment;
- ◇ canceling development of seams of less then 0.3 m thickness. Such complexes are based on the use of combined mining and traditional implementation of timbering;
- ◇ implementation of modern devices for audit and energy management;
- ◇ development and implementation of a package of technical organizational measures;
- ◇ development and implementation of progressive standards for energy efficient equipment and energy consumption rates;
- ◇ popularization of energy saving and personnel training;
- ◇ increase of the production efficiency for account of more rational use of its technical and labor potential;
- ◇ solving social issues and improvement of the social services structure;
- ◇ transfer of objects of social purposes from the balance of enterprises;
- ◇ considerable improvement of the mining works safety and labor conditions.

National Program

«Program of Development of Coal Industry in Ukraine and its Social Sphere up to 2005»[8]

Energy Saving Potential, PJ**190****GHG Emissions Reduction Potential, thousands t CE****3954**

Oil and Gas Industry: energy saving measures**High and medium-cost measures****Low-cost measures**

- ◇ implementation of methods to increase oil productivity of oil pools;
- ◇ implementation of pumps equipped with gas separators and modern technologies to pump high viscosity oil out of the great depth;
- ◇ utilization of excessive gas pressure in gas mains to produce electric power;
- ◇ increase of efficiency of gas condensate production through cycling process and its treatment;
- ◇ utilization of exhaust gases heat at compressor stations;
- ◇ concentration of materials and funds to increase volumes of service drilling;
- ◇ increase of production efficiency of existing oil fields and putting into operation open gas and oil fields;
- ◇ increase in the level of oil refining up to 70-75%;
- ◇ development of oil and gas production in the Black Sea's area of water;
- ◇ rising the efficiency of technologies for industrial gas preparation through the use of thermal catalytic cleaning;
- ◇ rising the efficiency of industrial equipment for low-temperature separation, in which gas ejectors are used;
- ◇ optimization of technological regimes of gas and oil supply;
- ◇ raising efficiency of sorption gas drying technology;
- ◇ implementation of technologies of gas condensate treatment at the field and motor fuels production;
- ◇ implementation of heat recovery system for vaporous products obtained in the result of distillation during oil refining process;
- ◇ introduction of the equipment for extracting hydrogen from exhaust gas mixtures at oil refineries.

- ◇ determining oil and gas losses in supply systems and their removal;
- ◇ development and implementation of methods of regulation of FER consumption for production, technological, economic, private and other purposes;
- ◇ implementation of modern energy management systems;
- ◇ development and implementation of progressive standards for energy efficient equipment and energy consumption rates;
- ◇ increase of production efficiency due to more rational use of its technical and labor potential;
- ◇ implementation of modern devices for audit and energy control;
- ◇ development and implementation of a package of technical organizational measures to save energy resources;
- ◇ development and introduction of normative and methodical documents on the methods of equipment diagnostics and energy control;
- ◇ popularization of energy saving and personnel training;
- ◇ conducting certification and inventory of energy consuming equipment;
- ◇ raising load factor for energy and production equipment;
- ◇ elimination of idle work of the equipment;
- ◇ rise of operating rhythm of the equipment;
- ◇ implementation of means and systems for optimizing processing methods;
- ◇ optimizing repair and preventive maintenance works;
- ◇ improving control and eliminating cases of stealing energy.

National Program «Oil and Gas of Ukraine up to 2010»	
Energy Saving Potential, PJ	88
GHG Emissions Reduction Potential, thousands t CE	1827

<i>Energy: energy saving measures</i>	
<i>High and medium-cost measures</i>	<i>Low-cost measures</i>
<u>Electric Power Industry and Heat Supply</u>	
<ul style="list-style-type: none"> ◇ technical re-equipment of TTP; ◇ implementation of new environmentally clean technologies of coal burning with the use of high efficient gas-steam units; ◇ equipping PP with state-of-the-art gas cleaning equipment; ◇ implementing measures on extension of service life of existing power-generating units with capacities 200, 300, 800 MW by 20-25 years through their replacement with modern turbine units providing environmental requirements to boiler equipment; ◇ paramount implementation of modern gas-steam technologies of power production; ◇ accelerated introduction of the equipment, based on new technologies of coal burning at reconstructed units; ◇ mastering domestic production and implementation of turbines for GTCC of high capacity (110, 115, 150 MW); ◇ withdrawal of the equipment, maintenance of which is inexpedient from the point of view of the environmental safety; ◇ transfer the main equipment at HPCP from 9 MPa to 13 MPa pressure; ◇ transfer HPCP into boiler houses after having the old equipment dismantled; ◇ introduction of GT with HRB; ◇ implementation of measures on HPCP mobility increase; ◇ implementation of steam gas HPCP with HRB, based on domestic and imported equipment, including the following scheme: at intra-cycle coal gasification on steam and air blow-through, and also with steam generators with CBB; ◇ improvement of traditional gas turbine cycle by the way of heat recovery through its cooling below the dew point; ◇ arranging the process of natural gas burning with heat recovering, that allows to reduce gas consumption by 10-12% and pollutants emissions - by 50-60%; ◇ acceleration of building works and input of new capacities at HPP under construction; ◇ reconstructure of HPP of the Dnieper cascade; ◇ reconstructure and technical re-equipment of small-sized HPP. 	<ul style="list-style-type: none"> ◇ conducting certification and inventory of energy consuming equipment; ◇ raising load factor for energy and production equipment; ◇ elimination of idle work of the equipment; ◇ rise of operating rhythm of the equipment; ◇ implementation of the means and systems to optimize the processing methods; ◇ rising mobility of energy systems and power generating equipment; ◇ selection of optimum composition of operating equipment; ◇ smoothing load curves of an energy system; ◇ production of optimum operating switching; ◇ optimizing repair and preventive maintenance works; ◇ improving control and eliminating cases of stealing energy; ◇ increase in level of air-tightness in buildings, constructions, production and processing chambers; ◇ timely cleaning windows, lamps, equipment and lighting armature; ◇ improving control and elimination of leakages of pressed air in networks, locking armature and processing equipment; ◇ efficient use of ventilation systems; ◇ elimination of looseness of sewage header hatches and penetration of storm water there; ◇ liquidation of losses of gas, steam and other energy carriers from flange junctions, locking armature, joints; ◇ liquidation of losses with exhaust steam due to the drawbacks of hot-wells construction; ◇ improvement of heat insulation; ◇ doors warmth-keeping and liquidation of spontaneous air flows through openings; ◇ replacement of incandescent lamp with more efficient ones; ◇ switching-off additional equipment, shops and plant's sites during power system pick loads;
<u>Nuclear power engineering</u>	
<ul style="list-style-type: none"> ◇ the completion of construction of NPP units, including unit #2 at Khmel'nitskaya NPP, unit #4 at Rivnenskaya NPP; ◇ putting into operation the units ##3,4 at Khmel'nitskaya NPP; ◇ the creation of domestic fuel nuclear cycle. 	
<u>Technical and organizational measures:</u>	
<ul style="list-style-type: none"> ◇ the completion of restructuring process in management of the sector; ◇ implementation of modern energy management devices and methods; ◇ development and introduction of guidelines on conducting energy audit; 	<p><u>Heat networks and heat equipment:</u></p> <ul style="list-style-type: none"> ◇ setting up production of the fail-safe locking and regulative armature and its implementation; ◇ design and implementation of heat pipelines on the base of expanded polymer composition;

- ◇ improvement of methods of temperature changes compensation;
- ◇ aluminizing heat pipelines and implementation of new insulation materials based on porous foam plastics and composites;
- ◇ making temperature regime of heat mains more efficient;
- ◇ mastering production of up-to-date domestic boiler units with capacity 500, 670, 1000 T/hours, boiler units for GTCC and equipment for intra-cycle coal gasification and their implementation.
- ◇ **Electric power networks:**
- ◇ creation of three trunk cables VL 750 KW, which together with cross-linkage communication, will provide resourcefulness of Joint Power Network (JEN) of Ukraine;
- ◇ rise reliability and stability of NPP work due to the introduction of network objects;
- ◇ setting up the production of more safe bearings, cable lines of 110-330 KW with polymeric insulation in Ukraine and their introduction;
- ◇ reconstruction of power substations;
- ◇ compensation of reactive power in power networks;
- ◇ reduction of technological power consumption during its transfer in power networks;
- ◇ switch power networks to higher capacity;
- ◇ setting mass production of and steel aluminum wire, armored cable, complete transformer substations, switches in Ukraine and their introduction.

- ◇ improvement of control and carrying out investigation to identify points of irrational energy use;
- ◇ introduction of modern devices and system of control, automation and management;
- ◇ training personnel, energy conservation popularization.

R&D measures:

- ◇ estimating energy saving potential and development of recommendations on its realization;
- ◇ development of energy conservation programs on national, sectoral and regional scales;
- ◇ creating scenarios and seeking for efficient ways of the power sector development;
- ◇ analysis of factors and identification of the most important trends of accelerated transfer of regional energy economy to energy saving regime;
- ◇ the creation and use of database on production and implementation of energy efficient equipment, technologies and apparatus;
- ◇ scientific and methodical grounding and developing strategy and tactics of energy conservation management.

National Program	Comprehensive State Energy Conservation Programme of Ukraine
Energy Saving Potential, PJ	267
GHG Emissions Reduction Potential, thousands t CE	5513

	Project #1	Creation of high efficient gas turbine combined cycle (GTCC) with capacity 3000 KW for local power consumers and its implementation
1.1	Manager	Sevastopol State Technical University and machine building design office «Progress», Zaporizhzhya
1.2	Contributors	Research and Production Enterprise «Mashproject», Nikolayev; Joint Stock Company «Motor Sich», Zaporizhzhya
1.3	The Project implementation site	Joint Stock company «Ukrasprom», Ministry of Industrial Policy, individual enterprises of industrial port zone and others
1.4	Brief description	<p>The principal idea is to set up combined production of electric and heat power at self-contained power scheme. To achieve this goal, a co-generation unit based on gas turbine engine (GTE), combined with turbine compressor utilizer (TCU) is to be created. Under exhaust gas utilization, the engine efficiency increases 1.1 - 1.6 times depending on temperature and pressure rise rate in the engine, level of fuel heat use reaches 75-85%. The project realization will allow to create heat and power generation unit on the base of gas turbine engine, produced by domestic industry.</p> <p>GTCC is to have the following indicators:</p> <ul style="list-style-type: none"> - nominal power capacity (peaking operation) - 3000 KW, - thermal capacity - 4500 KW, - GTE with TCU efficiency (ISO conditions) 30-33%, - heat (full) efficiency 75-85%.
1.5	Financial indicators	<p>Total cost of the Project - \$2.1 mln (UAH3.9 mln). Part of the total cost to be covered by equities - \$ 1.3 mln (UAH2.4 mln). Volume of outside investments, to be obtained for the Project implementation — \$0.8 mln (UAH1.5 mln). Payback period - nearly 2 years.</p>
1.6	Power indicators	<p>The estimates of average energy resources consumption per year before and after realization of the Project (tce): for one unit of 3000 KW capacity before the realization— 10.3 thousand tce per year, after the realization — 6.5 thousand tce per year. Energy resources saving to be achieved in the result of the implementation of the project with 5 TCU makes 19 thousand tce per year.</p>
1.7	Greenhouse gas emissions reduction	11.50 thousand t CE
1.8	The Project life-cycle expected	<p>Design and development - 9 months; construction of the objects, scheduled by the Project - 18 months; exploitation of the objects - 120 months.</p>

	Project #2	Design and implementation of package condenser plant for reactive power compensation
2.1	Customer	Ministry of Energy of Ukraine
2.2	Manager	«Ukrenergoeffektivnost'» enterprise
2.3	The Project implementation site	Enterprises of distributive electricity supply networks and enterprises - energy consumers, located in areas under supervision of Dniprovsky regional power dispatching center
2.4	Brief description	Compensation of reactive power allows to reduce power costs and improve voltage regime in distributive power networks and at the consumers. For this purpose control capacitor banks are widely used. Specific energy saving effect of their implementation makes about 250 KW·h annually per 1 KVAR of capacitor bank's capacity. Taking into account the fact that Ukraine lacks the commercial production of condensers and means for their regulation, it is supposed to introduce complete cycle of design and implementing works to develop and set up the full-scale production of package condenser plants for reactive power compensation. The main components of these plants (power capacitor, starter, electric controllers) will be manufactured in Ukraine. An improved controller will allow to establish a necessary reactive power control regime and monitor the most important parameters of power supply.
2.5	Main technical indicators	<ul style="list-style-type: none"> - nominal capacity of regulated power network - 0.38 KW; - condenser plant's capacity - 60....480 KVAR; - control channels number - 1....8; - compliance with National Standards (GOST) requirements 27389-87.
2.6	Expected production volumes	<ul style="list-style-type: none"> - 1998 - 10 thousand KVAR (pilot-scale batch) - 1999 - 100 thousand KVAR (setting batch) - 2000 - 500 thousand KVAR (series production) - 2001-2005 - 700 thousand KVAR (series production)
2.7	Financial indicators	<p><u>Implementation costs</u> will make - \$170 thousand (UAH310 thousand), including design and development works - \$65 thousand (UAH 120 thousand), the production pre-starting and equipment purchase - \$50 thousand (UAH90 thousand). <u>Specific capital investments</u> for the purchase, mounting and start-adjusting works together with putting into operation the package condenser plant will make 30 UAH/KVAR of installed capacity.</p> <p><u>The payback period</u> will last for 4 years, though for a specific condenser plant it could make 2-3 years depending on the power tariff rates, a unit's capacity and term of implementation.</p>
2.8	Energy resources saving	<ul style="list-style-type: none"> - 1998 - 2.5 mln KW·h - 1999 - 27.5 mln KW·h - 2000 - 152.5 mln KW·h - 2001-2005 - 327.5 mln KW·h - 2006-2010 - 502.5 mln KW·h
2.9	Greenhouse gas emissions reduction	<ul style="list-style-type: none"> - 1998 - 0.1865 thousand t CE - 1999 - 2.0517 thousand t CE - 2000 - 11.3777 thousand t CE - 2001-2005 - 24.4341 thousand t CE - 2006-2010 - 37.4906 thousand t CE
2.10	The Project life-cycle expected	<ul style="list-style-type: none"> - Design and development - 18 months; - launching production - 6 months; - exploitation of the unit installed - 12 years.

3.6.3 Alternative and Renewable Energy Sources

Ukraine has a considerable potential of renewable energy sources which allows to curtail consumption of fossil fuel for generation of electric and heat power.

Hydroelectric power. Installed capacity of large hydropower plants (HPP) in Ukraine makes 4,700 MW. Potential energy resources of small rivers, where construction of micro and mini HPP with 5-250 kW capacity is reasonable, are about 2,400 MW.

When evaluating potential stocks of small and medium rivers of Ukraine, the construction of over 2,300 small and medium-sized HPPs with annual generation of some 4 bn. kWh of electric power is possible. According to [5], capacity of small, mini and micro HPPs may approach 590 MW in 2010; this may provide for fuel saving of 1.0 million tce per year, and reduction of GHG emissions to the amount of 605.5 thousand tons CE.

Wind power engineering. Energy potential of wind power engineering in majority of Ukrainian regions with relative low wind velocity is rather high and can provide for annual fuel saving of 20-30 million tce, and reduction of GHG emissions to the amount of 12-18 million tons CE.

At present stage of wind power engineering development, preference is given to use of wind energy equipment with rated capacity of 200 kW and more.

According to [5], the construction by 2010 wind electric plants network with total capacity of 2,000 MW is planned. This will provide for fuel saving of about 1.8 million tce yearly, and reduction of GHG emissions to the amount of some 1 million tons CE.

Industrial potential of Ukraine allows to manufacture and put into operation wind energy equipment with total capacity of some 2-3 thousand MW a year. The efficiency of wind energy utilization (with consideration of theoretical resources, namely, the kinetic energy which can be utilized under contemporary development of wind energy equipment) is 35% in average and is comparable with traditional power engineering.

Solar power engineering. As a whole, Ukraine may be referred to the zone of temperate intensity of solar energy. Annual exposure to solar radiation makes 987-1,435 kWh/m².

The best conditions for solar power engineering development are in the Crimea, in southern and southern-western regions of Ukraine.

By 2010, it is anticipated to put into operation solar energy systems for hot water supply, having area of solar collectors up to 3.3 million m², what is equivalent to reduction of annual consumed fuel by 0.43 million tce [5]. In the future, industry of Ukraine can provide for manufacture of relative inexpensive solar collectors up to 4-5 million m² per year.

By 2010, it is also planned to put into operation photoelectric equipment with total capacity of 96.5 MW; this will allow to save some 56 thousand tce a year in autonomous power supply systems and to reduce GHG emissions to the amount of 34 thousand tons CE.

Geothermal resources. According to various assessments, potential resources of geothermal energy in Ukraine are enough to operate geothermal power plants (GTPP) with overall capacity of 200-250 million kW [4].

It is planned that in 2010 GTPPs with overall capacity up to 300 MW will function in Ukraine, together with geothermal heat supply systems with capacity up to 1,170 MW. These will allow to save up to 1.5 million tce [5] and to reduce GHG emissions to the amount of some 900 thousand tons CE.

Biotechnologies, waste utilization. Renewable resources of biomass energy (household and industrial wastes, non-commercial wastes of agriculture and forestry, urban liquid wastes and agricultural production wastes) are evaluated by experts as 46 million tce a year and as reduction of GHG emissions to the amount of some 28 million tons CE.

For example, use of microbiology technologies for waste utilization from large livestock farms only allows to obtain biogas which energy equivalent exceeds 200 thousand tce. Overall volume of produced gas may achieve 9 bln m³ in 2000.

Biomass wastes stock in Ukraine amounts 40 million tons/year that is equivalent to 25-30 bln m³ of gas a year; wastes of livestock production are 32 million tons of dry and 10.3 bln m³ of gaseous substances a year.

The Comprehensive State Energy Conservation Programme envisages achievement of total capacity of small TPPs, using wastes and

biomass, up to 410 MW, and with heat generation – up to 970 MW in 2010. It is equivalent to the replacement of traditional fuel to the amount of 2.1 million tce per year and to the decrease of GHG emissions, amounting some 1.3 million tons CE. Increased utilization of renewable fuel types (firewood, wood chips, fuel bricks, biogas) after primary preparation can constitute 4.4 million tce a year in 2010 and can reduce GHG emissions by 2.7 million tons CE. It is planned to introduce necessary equipment and to approach yearly output of biogas up to 0.3 bln m³ in 2000, and up to 5 bln m³ in 2010. This is equivalent to 4.3 million tce a year and to reduced GHG emissions to the amount of 2.6 million tons CE.

Alternative motor fuel. This type of fuel includes a mix of petrol and ethanol, produced from special raw materials. The addition of ethanol to petrol increases the octane number and improves engine efficiency.

The utilization of wastes of processing industry in conditions of Ukraine, taking into account prevalence of alcohol plants and sugar mills, will considerably reduce the cost of fuel ethanol with its approaching to the cost of petrol.

Through additional equipping alcohol plants and sugar mills, bearing in mind creation of special production in the future, it is planned to increase annual output of fuel ethanol to 0.25 million tons in 2000 and to 2 million tons in 2010. Taking into account energy cost of its production, this will allow to obtain fuel saving of 1.7 million tons with reduction of oil products consumption by 2.24 million tons a year [5].

Alternative energy sources also include thermal pumps, which allow to utilize low-temperature secondary resources and energy of the environment. Overall thermal capacity of thermal pumps will be 1,860 MW in 2010; it will make possible to replace deficient fuel types consumption of 1.5 million tce and to save 0.3 million tce and to reduce GHG emissions by 181 thousand CE.

Project #3		Construction and exploitation of underground geocirculation systems for heat and hot water supply of settlements of the flat part of Crimea (Saksky, Chervonogvardejsky, Dzhankojsky regions)
3.1	Customer and Developer	State Enterprise «Crymgeologia» State Committee for Geology of Ukraine
3.2	The Project Implementation Site	Ministry for Agriculture, Autonomous Republic Crimea
3.3	Brief content	<p>The purpose of the Project is to use thermal water, found at a depth of 1000-2300 m in the flat part of Crimea. Together with that, environmentally clean underground geocirculation systems will be used with pumping exhaust thermal water in the same layer.</p> <p>Geocirculation two-circuit system (GCS) consists of two wells (extracting and pumping) and overland equipment grouped into a single unit.</p> <p>At the first stage it is supposed by the Project to use existing wells, that will allow to construct 7-8 GCS. At its second phase - to create new GCS on the base of operating single wells together with drilling another wells.</p> <p>At the third stage of the Project realization prospecting works will be carried out, and new GCS will be developed on the results of such work.</p> <p>It is supposed to accomplish the first stage of the Project prior to the realization and investment - construction and exploitation of 8 GCS on the basis of operating pairs of wells.</p>
3.4	Expected production volumes	for 8 GCS - 223.6 thousand GJ/year
3.6	Financial indicators	<p>The total Project costs - \$900 thousand (UAH1.8 mln).</p> <p>Capital expenses for the purchase and fitting equipment - \$600 thousand (UAH 1.2 mln).</p> <p>Payback period - 3 years.</p>
3.7	Energy resources saving	<p>Average annual fossil fuel consumed in boilers of settlements for the heat supply makes before the Project implementation - 10 thousand tce, after realization - 2.4 thousand tce.</p> <p>As the result of the Project implementation power resources saving is expected to be 7.6 thousand tce per year.</p>
3.8	Greenhouse gas emissions reduction	4.6019 thousand t CE
3.9	The Project's life-cycle expected	<p>Design and implementation - 6 months,</p> <p>construction of the objects, scheduled by the Project - 12 months,</p> <p>exploitation of the objects - 10 years.</p>

	Project #4	Setting production of thermal solar collectors and heat water supply systems on their basis- high efficient, environmentally clean, renewable, energy saving heat sources for industrial consumption and individual use.
4.1	Customer	Ministry of Industrial Policy
4.2	Developer	Production Enterprise «Znamya» (c. Poltava)
4.3	The Project implementation Site	Ministry of Industrial Policy, Poltava region
4.4	Brief content	The purpose of the Project is to design solar collectors, technology of production of which can be based entirely on the use of super high-precision electrovacuum devices manufactured by conversion enterprises. A solar collector of 5 m ² area can supply a family living in separate private house with warm water.
4.5	Expected production volumes	After the Project implementation the Enterprise «Znamya» will be able to manufacture 100 thousand m ² of solar collector per year, that will generate 63 mln KW·h of thermal power.
4.6	Financial indicators	The total Project costs - \$7 mln (13.3 mln UAH). Volume of outside investments - \$3 mln (5.7 mln UAH). Capital investments \$3 mln, including: - design - \$0.2 mln; - purchase of the equipment - \$2.8 mln.
4.7	Payback period	4 years
4.8	Energy saving effect and greenhouse gas emissions reduction	The Project implementation in the volume of 100 thousand m ² of collectors will allow to save 24 tons r.f. per year Greenhouse gas emissions reduction will make 14.5323 thousand t CE.
4.9	The Project's life-cycle expected	20 years

3.7 ENERGY CONSUMPTION SECTOR

3.7.1 Current Situation in the Sector

Metallurgy, machinery and equipment, public services and utilities, chemical and petrochemical industry, building materials industry and construction, agriculture and transport are the less efficient sectors of the national economy.

One of the principal indicators of FER utilization efficiency – energy intensity of the most important products – is still growing. Basic reasons for this phenomenon are:

- production recession in the industrial sector;
- practical absence of restructuring of the economy;
- low efficiency of soft technology equipment use;
- enhancing misbalance of inter-industry and inter-region productive connections;
- slight influence on the part of price factor over efficiency of energy utilization;
- high level of use of outmoded equipment;
- low rates of technical re-equipment;
- slow implementation of energy saving policy.

According to data of the Complex Programme on Energy Saving in Ukraine, under overall potential of energy saving up to 145-170 million tce in all industries, the expected volumes of energy saving and reduction of GHG emissions by the sectors are given in 2.

Table 3-1. Estimated energy saving and GHG emissions reduction potential in Ukraine for the base 1990 year

Fuel and energy consumers	Fuel, mln tce	Electric power, bln kWh/year	Heat energy, mln Gcal	Total, mln tce	GHG emissions reduction potential, mln t CE
Fuel and Energy Complex - TOTAL:	13.7-20	17-22	48-64	27.5-38.2	16.6-23.1
including					
Fuel industries	3-4	2-3	3-4	4.2-5.7	2.5-3.5
Power industry	7.7-11	11-14	-	11.3-15.6	6.8-9.4
Energy resources transportation	3.5	4-5	45-60	12-16.9	7.3-10.2
Industry, TOTAL	39.3-43.3	87.9-96.4	99.4-113.5	84.8-94.1	51.4-57.1
including:					
Cross-sectoral measures	12-13	68-70	47-50	42.1-44.4	25.5-26.9
Metallurgical complex	9.5-10	6-7	5-6	12.3-13.3	7.5-8.1
Machinery and equipment	6.5-7	4-5	4-4.5	8.5-9.4	5.2-5.7
Chemical and petrochemical industry	2.5-3	2.5-3.5	8-9	4.7-5.6	2.8-3.4
Building material industries	3.9-4.0	1.6-2	5-6	5.2-5.7	3.2-3.5
Food industry	3.5-4.0	1.9-2.0	17-18.5	7-7.8	4.2-4.7
Other industries	1.4-2.3	3.9-6.9	13.4-19.5	5-7.9	3.0-4.8
Public services and utilities	6.5-7	12-13	40-45	17.3-19	10.5-11.5
Agriculture	4-5	2-3	-	4.7-6	2.8-3.6
Transport	9.3-9.8	1.8-5	0.5-0.9	10-11.6	6.1-7.0
Construction	0.5-0.8	0.2-0.4	0.7-1.0	0.7-1.1	0.4-0.7
TOTAL	73.3-85.9	120.9-139.8	188.6-224.4	145-170	87.8-103.0

The above-mentioned indicators show considerable potential to increase energy efficiency in the energy consumption sector, to reduce volumes of fuel and energy consumption and to decrease greenhouse gas emissions respectively.

3.7.2 Energy Saving Measures in Metallurgy

Being the basic industry of Ukraine, metallurgy includes ferrous and non-ferrous industries.

Major kinds of metal products, manufactured by ferrous metallurgy facilities, are: cast iron, steel (open-hearth, oxygen converter, arc steel), rolled products, steel and cast iron pipes.

Productive capacities of ferrous metallurgy facilities, which is represented by 190 enterprises, are assessed as 54 million tons of steel, 52 million tons of cast iron and 41 million tons of rolled products a year. However, since 1990, metal production volumes was decreasing every year.

The major factor of production scope reduction in the ferrous metallurgy is a decrease in demand for metal.

Basic energy-efficient indicators of the industry are given in t

Table 3-2. Main energy saving indicators in Metallurgy

Product	1990			1995			1995 indicators as a ratio to 1990		
	Production, mln t	Specific power consumption per unit produced tce/t	Energy consumption, mln tce	Production, mln t	Specific power consumption per unit produced tce/t	Energy consumption, mln tce	Production, %	Specific power consumption per unit produced, %	Energy consumption, %
Cast iron	44.9	0.653	29.3	18.0	0.708	12.7	40	108	43
Open-hearth steel	27.7	0.126	3.5	11.5	0.130	1.5	42	103	43
Oxygen-converter steel	21.3	0.008	0.16	9.5	0.012	0.11	45	154	69
Electric arc steel	0.44	0.036	0.016	0.78	0.016	0.01	177	43	76
Steel pipes	6.5	0.097	0.63	1.5	0.167	0.25	23	172	40
Cast iron pipes	0.42	0.107	0.045	0.03	0.467	0.01	7	435	31
Rolled metal	43.1	0.132	5.7	18.3	0.136	2.49	42	103	44

It is necessary to note that the industry uses outdated equipment and energy intensive technologies with a restricted range of output products. As of the energy indicators, an analysis of reported data on the industry shows that, despite considerable reduction of energy consumption in the industry, the rates of production recession are higher of those of energy consumption reduction.

An urgent problem of **metallurgy** is the necessity to increase competitiveness of its products. To complete this task, the following measures have to be implemented:

- utilization of coal-dust fuel for the cast-iron production;
- improvements in the structure of steel-melting and expansion of the output of continuous casting. Expanding the output of continuous steel casting and the introduction of new techniques, combining continuous casting and rolling, are very prospective. This technology allows to utilize 1 m. tonnes of steel half-finished products to produce 100-120 thousand tonnes of rolled metal, saving 150-160 thousand tce;
- improvement in the aluminum production technology by using burnt anodes and implementing automatic control.

Energy saving potentials, obtained on account of production reconstruction, replacement of obsolete processes with modern ones, implementation of facilities to optimize technological duties, as well

as implementation of modern methods, facilities and systems of checking and control, may approach to 12-13 million tce approximately.

Non-ferrous metallurgy in the country is represented with 34 enterprises, main products of which are: alumina, nickel, tin, aluminum, zinc, titanium, zirconium, silicon, non-ferrous rolled products etc.

An analysis of economic indicators of this industry evidences that the latter has the same adverse trends, as the ferrous metallurgy does.

Energy saving potentials of non-ferrous metallurgy facilities are 0.3 - 0.7 million tce. A potential to reduce greenhouse gas emissions may approach 350 thousand t CE.

As of the barriers on the way to energy saving in metallurgy, the factors, listed in Section 2.5, are immanent to the industry under consideration as well. However, these are aggravated by large extent of pipe networks; this increases the cost of their isolating.

Ferrous and non-ferrous metallurgy: energy saving measures		
<i>High and medium-cost measures</i>	<i>Low-cost measures</i>	
<p><u>Mining industry:</u></p> <ul style="list-style-type: none"> ◇ introduction of effective methods of iron ore extraction and concentration; ◇ introduction of hydraulic drilling rigs; ◇ design and introduction of magnetic separators with permanent magnets; ◇ introduction of the cyclone-stream flow technology; ◇ introduction of self-propelled crushing loading machines. <p><u>Coking industry:</u></p> <ul style="list-style-type: none"> ◇ installation of dry coke quenching units; ◇ introduction of the equipment for coal charge preparation; ◇ introduction of the equipment for formed coke production; ◇ introduction of thermal treatment of the coal charge before coking. <p><u>Sintering production:</u></p> <ul style="list-style-type: none"> ◇ employment of the granulated crushed coal technology; ◇ separate preparation of agglomerate components; ◇ the use of intensifiers; ◇ increase in the height of the sinter's layer; ◇ implementation of new highly productive exhausters; ◇ implementation of linear sinter coolers with sorting of cooled sinter without separate hot dust fractions; ◇ implementation of modern charge mixers of greater length; ◇ cooled air re-circulation from sinter cooling chambers to ignition devices in sintering machines; ◇ replacement of gas cleaning equipment in sintering machines with new scrubbers of wet cleaning; 	<ul style="list-style-type: none"> ◇ complete isolation of all processes in sinter shops to minimize dust emissions due to the installation of the covering equipped with the dust catchers; ◇ improvement of the procedure of sinter quality testing; ◇ extraction of coarse fraction from the gas cleaning system together with re-breakage and dewatering in thickeners of concentrating mills; ◇ grinding and dosing of lime prior to its addition to concentrate-slag mixture; ◇ separate processing of lime and dolomite before them to be added to sintering mixture; ◇ pre-sorting of solid fuel prior to the refining; ◇ dosing of the return with a belt-conveyer weigher. <p><u>Blast-furnace production:</u></p> <ul style="list-style-type: none"> ◇ injection of hot reduced gases and coal dust fuel in the furnace; ◇ introduction of coneless loading devices; ◇ reconstruction and modernization of coke-oven batteries; ◇ employment of non-coke metallurgy processes, based on solid-phase reduction processes; ◇ use of modern technologies in coal preparation processes; ◇ increase in the number of air injectors and placing another doors in blast-furnaces. <p><u>Melting production:</u></p> <ul style="list-style-type: none"> ◇ scrap iron remelting in units "scrap - steel"; ◇ combining processes of steel casting and metal rolling in a unified complex; ◇ shift from the open-hearth production to converters and electric furnaces; ◇ decrease in the rolled metal's temperature; ◇ reduce overconsumption of oxygen and other gases used in the production in blast-furnace and open-hearth shops; ◇ liquidation of excessive blast losses; 	<ul style="list-style-type: none"> ◇ reduction of unscheduled hot downtime in open-hearth furnaces; ◇ improvement of automated coke gas losses control system; ◇ introduction of automated system to control technological processes and modes of metal thermal processing; ◇ the use of the heat of waste gases to warm scrap; ◇ development and introduction of efficient electrophysical and electrochemical methods of metal surface hardening and protection against rust; ◇ introduction of precision casting and forming; ◇ re-use of cooled air in agglomeration area; ◇ introduction of new ventilation shed over the area of sinter removing; ◇ cleaning of buildings and indoor premises from dust and garbage; ◇ insulation of airways for cold blowing between compressors and blast-furnace; ◇ regulation of burning processes in air heaters of a blast-furnace; ◇ introduction of automated combustion control system in the main fuel equipment; ◇ introduction of cos F compensators; ◇ shift in lighting to more efficient lamps; ◇ development and introduction of methodical recommendations for conducting energy audit; ◇ introduction of modern energy management devices and methods; ◇ providing certification and developing inventory of energy consuming equipment; ◇ raising load factor for power and production equipment; ◇ switch to technology of continuous steel casting; ◇ use of combined blow down of converters; ◇ use large-capacity electric arc furnaces;

- ◇ use of physical and chemical heat of the oxygen-converter gases;
- ◇ use of physical heat of electric furnaces;
- ◇ employment of the dry cleaning of process gas;
- ◇ use of oxygen burners, which reduce casting time, or burners with flat jets and radiation flows;
- ◇ rising quality of refractories;
- ◇ increase in the share of the technology of hot loading of heating furnaces;
- ◇ use of modern control devices for combustion processes in furnaces.

Rolling production:

- ◇ combining steel casting and rolling processes;
- ◇ introduction of technology of slab rolling without its heating in furnaces;
- ◇ introduction of the technology of low-temperature rolling;
- ◇ cold seamless sink drawing;
- ◇ introduction of high-temperature regulators;
- ◇ increase in the share of plate rolling produce and share of non-heated slab;
- ◇ increase in the volume of high-quality steel output with reduced ferroalloys' share in the production;
- ◇ automation of rolling mills with the use of modern control devices and systems.

Non-ferrous metallurgy:

- ◇ introduction of modern methods and technologies for non-ferrous metals casting (centrifugal casting, chill casting, pressure die casting);
- ◇ development and introduction of new series of capacious aluminum electrolyzers with side power supply;
- ◇ introduction of modern technology for the production of aluminum (copper) plates and flat bars by the method of non-ingot rolling;
- ◇ introduction of continuous casting method for the production of thick-walled bronze tubes and rods;
- ◇ utilization of heat of sinter flat bars;
- ◇ development and introduction of gas burners with regulated flame characteristics;
- ◇ introduction of technologies of aluminum hydroxide calcination in the alumina production;
- ◇ replacement of carbon electrodes in electrosmelting furnaces with graphitized ones;
- ◇ utilization of technological heat of hot products for preliminary heating for the following batch production.
- ◇ elimination of idle work of the equipment;
- ◇ optimizing repair and preventive maintenance works;

- ◇ increase in the level of air-tightness in buildings, constructions, production and processing chambers;
- ◇ improving control and elimination of leakages of pressed air in networks, locking armature and processing equipment;
- ◇ liquidation of losses of gas, steam and other energy carriers from flange junctions, locking armature, joints;
- ◇ introduction of the automated charging and casting control system;
- ◇ the use of the heat of waste gases;
- ◇ optimizing the casting regimes;
- ◇ improvement and extension of methods of out-of-furnace metal processing;
- ◇ optimizing the selection of electrode diameters;
- ◇ providing impermeable, safe contacts in electrode holders;
- ◇ furnaces encapsulation through elimination of looseness in charging doors, thermocouples openings.

National Program	Comprehensive State Energy Conservation Programme of Ukraine	
	General Energy Saving Potential, PJ	260
	General Potential of GHG Emissions Reduction, thousands t CE	5375

Project #5		Utilization of excessive coke gas for the power and steam production
5.1	Customer	Joint stock company "Avdeyevka by-product coke plant"
5.2	The Project implementation site	Joint stock company "Avdeyevka by-product coke plant"
5.3	Brief description	<p>Currently, excessive coke gas is emitted into the atmosphere due to the lack of its consumer in the volume of 10-20 thousand m³/hour in winter time and 40-50 m³/hour in summer time.</p> <p>It is supposed to install a gas steam turbine to produce power and steam with the use of a portion of the excessive coke gas. The unit is made of the gas turbine engine GTD -15000, turbo-generator T-20, heat recovery boiler KUP-2500. The unit is supplied as a set.</p> <p>The electric energy capacity will make 14.5 MW, steam production - 26.7 t/hour, coke gas consumption - 11,790 m³/hour.</p> <p>The project includes the installation of a compressor to press coke gas with the productivity 12-14 thousand m³/hour, pressure to be 2.5. MPa.</p>
5.4	Technical and economical indicators	It is expected that once the Project is implemented, coke gas emissions will be reduced by 70.7 mln m ³ /year. It is expected to obtain 109.8 mln KW·h of power and 160.2 thousand tons of steam per year.
5.7	Financial indicators	<p>The total Project costs - \$8.75 mln (UAH16 mln)</p> <p>Capital expenditures:</p> <ul style="list-style-type: none"> - purchase of the equipment - \$6.85 mln; - design works - \$0.1 mln; - building and installation works - \$1.8 mln; - payback period - 4.5 years.
5.8	Power resources saving	Electric power - 137,313 MW/year, heat power - 172,115 GCal/year
5.9	Greenhouse gas emissions reduction	30.0927 thousand t CE
5.10	The Project's life-cycle expected	20 years

3.7.3 Energy Saving Measures in Machinery and Equipment

Machinery and equipment industry is a producing complex, comprising about a thousand of enterprises, which supply their products to almost all industries of the national economy of Ukraine.

Structural changes in the industry are aimed at:

- application of new technologies of low energy consumption making use of heat waste;
- employing special machinery and outfit which shall control and adjust technological processes of industrial production;
- introduction of the equipment with low specific energy consumption; this shall bring the power inputs down to the world level;
- wide introduction of agricultural machinery that combines several technological operations;
- bringing in "one technological production line full produce processing" techniques;
- designing and production of energy-saving machinery for the fuel and energy complex;
- increasing the output of the durable consumer goods;
- putting into production the environmental protection outfit.

Energy saving potential in the industry, as compared with energy consumption indicators in 1990, makes: for fuel – 6.5-7.0 million tce; for electric power – 4.0-5.0 bn. kWh, for heat energy – 4.0-4.5 million GCal. Overall potential of reduction of greenhouse gas emissions approaches to almost 1,800 thousand t CE.

The highest energy saving potential in the machinery and equipment industry is related to the technological processes, provision of which requires 70-75% of boiler-furnace fuel (mainly natural gas), 90-95% of electric power and up to 45% of heat.

Factors, retarding the process of energy saving policy implementation in the machinery and equipment industry, are listed in Section 2.5.

Additional reasons, impairing efficiency of energy utilization in the industry, are the problems related to conversion of defence-oriented enterprises, to re-orientation of their production and wide range of their products.

Machine Building: energy saving measures	
<i>High and medium-cost measures</i>	<i>Low-cost measures</i>
<ul style="list-style-type: none"> ◇ bringing the advanced technologies into out-of-furnace metal processing and use of oxygen blasting and improvement in the quality of furnace charge; ◇ preliminary charge warming prior to melting; ◇ equipping of blast cupola with two-line tuyeres and blast warming installations; ◇ equipping electric-arc furnaces with more powerful transformers; ◇ use of fuel-oxygen burners for charge melting and out-of-furnace molten metal finishing; ◇ introduction of centers for production of half-finished products of heightened readiness; ◇ replacement of cutting processing with fine punching; ◇ improvement of design and thermal insulation of heating furnaces; ◇ shift from electric power warming regime to gas one in heating furnaces; ◇ introduction of new upgraded burners in heating furnaces; ◇ introduction of automated technological processes control in heating furnaces; ◇ introduction of thyristor transformers in heating systems; ◇ use of energy saving types of rolled metal, polymers, non-metal tubes; ◇ introduction of duplex-method of pig iron casting; ◇ replacement of blast cupolas with single furnaces; ◇ secondary resources utilization; ◇ employment of induction motors with thyristor control; ◇ development and introduction of modern energy consumption control, audit and management systems; ◇ replacement of worn out and outdated power equipment; ◇ use of energy saving technological processes of electrolytic polishing, ultrasonic, spark and electrochemical metal processing; ◇ introduction of electric plasma and diffusion welding; ◇ replacement of mechanical working with cold forming and hot knurling; ◇ introduction of flexible continuous production lines; ◇ introduction of the technology of oxygen lancing of liquid steel; ◇ introduction of radiation pressurization at compressors; ◇ wide-spread use of machines with digital control and robots; ◇ rising load factor for power and production equipment; 	<ul style="list-style-type: none"> ◇ decrease in the time of idle work of the equipment; ◇ decrease in the volume of output of the waste and out of demand products; ◇ decrease in the accident rate and rise of fail-safety work of machines and devices; ◇ liquidation of excessive idle work of the equipment; ◇ timely cleaning of ventilation systems, lodgements; ◇ improvement of power and lighting systems; ◇ development and introduction of progressive norms and standards for energy consuming equipment; ◇ improvement of technological and productive discipline; ◇ creation of local public institutions (committees, headquarters, councils) to control energy efficient use of the equipment; ◇ timely carrying out the repair and preventive maintenance works; ◇ systematically cleaning windows, lamps and other lighting armatures; ◇ increase in the level of air-tightness in buildings, indoor premises and processing chambers, sewage pits; ◇ upgrading heat supply systems and heat ventilation systems; ◇ improvement of heat insulation quality; ◇ the use of slashing covering; ◇ testing gas, water and heat supply systems against design plans and for the location of non-designed incuts; ◇ following the schedule and process charts for the energy equipment loading; ◇ employment of the devices which balance the air-gas rate during natural gas burning in industrial furnaces and boilers; ◇ introduction of technologies of metal working with hard-alloy and diamond tools; ◇ the use of raw materials and high quality materials with low energy consumption; ◇ optimization of operating regimes of heating furnaces; ◇ popularization of energy conservation issues; ◇ broad use of internal and external warming of walls in industrial and administrative buildings; ◇ the use of new fiber materials for pipelines heat insulation;

◇ i implementation of continuous manufacturing methods with less number of the units employed.

- ◇ introduction of methods of local radiation warming in production areas;
- ◇ the use of updated dryers, equipped with double-wire burners, and automated drying control system;
- ◇ providing certification and developing inventory of energy consuming equipment;
- ◇ introduction of modern energy control and management means;
- ◇ development and acceptance of administrative decisions on the rise of efficiency of power consumption on the national, sectoral and regional levels.

National Program Comprehensive State Energy Conservation Programme of Ukraine	
Energy Saving Potential, PJ	85
Potential of GHG Emissions Reduction, thousands t CE	1,757

Project # 6		Developing and settling production of induction motors with the height of spin axis 63 - 315 mm in compliance with Western European standards "CENELEC"
6.1	Customer	Ministry of Industrial Policy of Ukraine
6.3	Developer	Joint stock company "Southern Electric Machine Building Factory", Institute of Electrodynamics of National Academy of Sciences of Ukraine; Electrical Engineering Factory, Vinnitsa; Factory of Electric Motors, Uzhgorod; Factory of Electric Motors "Electrodivgun", Poltava; Electrical Engineering Factory, Kharkov; Electromechanical Factory, Dnipropetrovsk
6.4	Brief description	Induction motors (IM) are practically used in all sectors of the national economy and consume about 60% of total power produced. Actually, small decrease of mass overall dimensions and rise of IM power consumption efficiency on the country's scale will bring considerable efficiency. For further efficiency growth in the use of IM the following tasks should be accomplished: improvement of starting, regulating, dynamic and vibroacoustic features; combining the motor and a mechanism in a single unit (for example, pump-motor, ventilator-motor, wheels-motor and others).
6.5	Expected production volumes	IM production volumes in Ukraine will reach the level of 4-5 mln pieces per year.
6.6	Financial indicators	The total Project costs - UAH1,230 mln (\$ 650 mln). The part of the total cost to be covered by the equities - UAH980 mln (\$520 mln). Volume of outside investments, to be obtained for the Project implementation - UAH250 mln (\$ 130 mln). Capital investments directed to the purchase of new production equipment - UAH270 mln (\$ 150 mln). Payback period - 2-3 years.
6.7	Power indicators	Yearly volume of FER saved in the result of the Project implementation will make: – power (in production) - 3 mln KW·h, – power (in consumption) - 415 mln KW·h, – coal - 148 thousand t, – fuel oil - 18 thousand t, – natural gas - 33 mln m ³ . Besides, yearly materials saving will make: – copper - 453 t, – aluminum - 357 t, – rolled ferrous metal - 6,162 t.
6.8	Greenhouse gas emissions reduction	33.33 thousand t CE
6.9	The Project's life-cycle expected	Design and implementation - 2 years, construction of the objects, scheduled by the Project - 2 years, exploitation of the objects - 10 - 15 years.

3.7.4 Energy Saving Measures in Residential Sector

As of the energy consumption, the residential sector of Ukraine takes the third place behind the industry and fuel-energy complex; enterprises of this sector consume some 10 bln kWh of electric power, over 6 million tce, and some 8 bln m³ of natural gas a year.

It is planned to curtail scope of living space construction in the residential sector on account of the State Budget and to increase such construction on account of non-governmental means. Governmental support of such construction has to be provided through formation of favourable economic conditions and, first of all, through granting of preferential credits. Development of the residential sector in country-side will be of top priority. Development of production of equipment and appliances of local application (water and sewage utilities, heat and gas supply) becomes of great importance.

Special attention has to be paid to the effectuation of measures on rational consumption of drinking water, electric and heat power, gas in the residential sector on account of implementation of efficient equipment and devices for accounting, regulation and control of these.

Energy saving potential of the residential sector facilities, as compared with consumption indicators in basic year of 1990, according to data of the Comprehensive State Energy Conservation Programme of Ukraine, are: for fuel – 6.5-7.0 million tce, for electric power – 12.0-13.0 bn. kWh, for heat power – 40-45 million GCal.

These figures are caused by the fact that, due to low heat-insulating properties of protecting structures of living houses, 30-40% of heat power are lost; the same large losses take place in engineering service lines due to emergency conditions of these, and the like.

As of the obstacles on the way to energy saving, the majority of the above-listed ones are immanent for the industry under consideration as well.

However, it is necessary to note that artificial reduction of tariffs for energy carriers for the population (with use of governmental allowances) does not encourage either producers or consumers; considerable rise in tariffs for water and heat, consumed by industrial enterprises (as compared with the tariffs for the population), does not yield any positive effect.

State Housing and Communal services and Residential sector: energy saving measures	
<i>High and medium-cost measures</i>	<i>Low-cost measures</i>
<ul style="list-style-type: none"> ◇ replacement of the obsolete boilers in boiler houses with more efficient ones; ◇ replacement of automating and controlling devices with an advanced outfit in intra-house heat and water supply systems; ◇ introduction of advanced heat networks and boilers systems; ◇ introduction of automated systems of control over technological processes of generating and supply of heat power; ◇ equipment of boilers with exhaust gas heat utilizes; ◇ equipment of the hipped roofs; ◇ equipment of existing boilers with water treatment devices to remove sinter and prevent corrosion; ◇ equipment of operating boilers with modern automatic machinery with the use of air-gas ratio regulators and transducers of oxygen concentration in waste gases; ◇ replacement of heating systems with enamel pipes insulated with polyurethane foam covering using non-channel method; ◇ equipping heating stations with automated heat power and hot water control and audit systems; ◇ equipping heat power consumers with single heating stations; ◇ equipping heat power consumers with independent heat supply sources; ◇ mounting and introduction of automated electric drives in boiler houses; ◇ development and introduction of automated power control, audit and management systems; ◇ equipping cooler parts of boiler units with exhaust heat utilizes; ◇ introduction of modern technical methods and software in power supply units to provide an automated management systems; ◇ replacement in street lighting mercury lamps with sodium ones; ◇ introduction of lighting systems based on fluorescent lamps with in-built ballast of KLB-1 TBTs type; ◇ design and introduction of self-regulating street lights, consuming solar energy; ◇ introduction of the technology of local radiation gas heating in industrial and communal premises. 	<ul style="list-style-type: none"> ◇ development and introduction of scientifically grounded norms and standards on power consumption and repair and exploitation needs of housing fund; ◇ development and introduction of the set of economical intensives, organizational and engineering decisions, focused on energy conservation; ◇ development and introduction of progressive engineering decisions and technologies of exploitation and repair works of the housing, focused on the improvement of heat insulation and energy saving characteristics; ◇ replacement of existing lighting with more efficient one; ◇ glazing and weather stripping balconies; ◇ equipping heating devices in apartments in residential buildings with thermostatic regulators and heat meters; ◇ introduction of FER consumption control and audit devices, including cold and hot water meters, introduction of per-house and per-apartment heat meters, gas meters; ◇ development of regulating documents on energy efficient measures implementation; ◇ creation of demonstration zones in the region (city) on energy conservation propaganda; ◇ development and installation of lighting control equipment for public use places in residential buildings and constructions of communal-general purpose; ◇ weather stripping doors and windows in entrances, stairwells, attics entrances, basements coating and entrances; ◇ development and realizations of organizational and technical measures for preparation for the fall-winter season; ◇ on-site examining of gas, water and heat supply to locate joints, armature where power losses are probable; ◇ optimizing the temperature level in centralized heat and water systems according to sanitary norms; ◇ testing gas, water and heat supply systems against design plans and location of non-designed in-cuts; ◇ installation of high pressure sodium lamps in street lighting; ◇ the transfer of the experience of the organizations, obtained considerable energy saving effect; use of devices to balance the air-gas rate at natural gas combustion in boiler houses;

- ◇ shift from steam to water heating at the enterprises not consuming steam, lowering the temperature in the offices on weekends;
- ◇ development and introduction of progressive power consumption norms;
- ◇ preparing and conducting elucidatory work among the public and in educational institutions on energy conservation issues.

National Program	Comprehensive State Energy Conservation Programme of Ukraine	
	Energy Saving Potential, PJ	325
	Potential of GHG Emissions Reduction, thousands t CE	6719

Project #7		Introduction of energy saving electric drives with variable speed to control the productivity of pumps in hot water supply systems of the "Vinnitsateplocommunenergo" enterprise
7.1	Customer	"Vinnitsateplocommunenergo"
7.2	Developer	"Vinnitsateplocommunenergo"
7.3	The Project implementation sector	Municipal economy
7.4	Owner	The state_
7.6	Brief description	<p>The employment of adjustable power drives in hot water supply systems to maintain a specified water pressure in pipelines, when the water supply varies in the volume with the day-time. This will make possible to vary the rotation speed of drive shaft in a power drive and electric motors capacity.</p> <p>Such a regulation has the following advantages against the current power drive:</p> <ul style="list-style-type: none"> - decreases in power consumption, its savings will make 45-55%; - prevents electromechanical equipment from pick loads; - eliminates expenses related to excessive designed pumps capacity and losses during overcoming resistance of actuator valves; - excludes the necessity of equipping power motors with accessory condensers; - reduces expenses for the system maintenance, improves results of adjustment, creates a background for remote control use.
7.7	Financial indicators	<p>Cost of the Project - \$0.4 mln (UAH0.76 mln).</p> <p>Part of the total cost to be covered by the equities - \$0.2 thousand (UAH0.37 mln).</p> <p>Payback period - 1.4 years.</p>
7.8	Power indicators	<p>Estimated yearly power resources (electric power):</p> <ul style="list-style-type: none"> - before the Project realization - 13.2 mln KW·h; - after the realization - 6.6 mln KW·h. <p>Electric power savings in the result of the Project realization - 6.6 mln KW·h per year.</p>
7.9	Greenhouse gas emissions reduction	0.49 thousand t CE
7.10	The Project's life-cycle expected	<p>Design and development - 6 months;</p> <p>construction of the objects, scheduled by the Project - 12 months.</p>

3.7.5 Energy saving Measures in Chemistry

The industry includes over 120 enterprises of Ukraine; these produce ammonia, nitrogen and phosphoric fertilisers, polystyrene, dyes, sulphuric acid, soda, synthetic detergents, tar, man-made fibre and other articles.

Energy consumption share of the chemical industry in overall scope of FER consumption is: for boiler-furnace fuel – some 7%, for electric power – over 10% and for heat power – 22%. A considerable part of the fuel is used by the industry as raw materials for production of a number of chemical products.

Economic crisis in the country had caused steep downfall of production scopes in the industry. Thus, production output in 1995 was reduced by 75-80% against the same in 1990.

To reduce consumption of fuel-energy resources in the industry, the following priority ranks were established:

- reequipping of the enterprises producing fertilisers with modern machinery and appliances and introduction of energy saving technologies;
- creation of the domestic source of raw materials for the chemical industry to become less dependent upon the imported raw stuff;
- reequipping of soda, sulphur and sulphur-acid subbranches with modern high-tech machinery and appliances, so that the increased capacities could meet the national demand for their products;
- creation of additional capacities for progressive polymer production (the production has not been started in the country yet), with raw materials coming from domestic oil-refining, coking and other industries;
- creation of new complexes on production of effective fibres and threads to be used in other sectors of the national economy;
- creation of the domestic source of synthetic rubber and chemical finished mixings so that high quality goods shall be produced and shall compete in the world market.

Energy saving potential of chemistry facilities, as compared with energy consumption indicators in 1990, makes: for fuel – 2.5-3.0 million tce, for electric power – 2.5-3.5 bln kWh, for heat power – 8.0-9.0 million GCal.

Principal energy saving potential in the industry are borne by the measures on implementation of new high-technology processes and more efficient equipment, by reconstruction and modernisation of operating equipment.

As of the barriers and obstacles on the way to energy saving in the chemistry, the majority of listed before ones are characteristic of this industry as well. These may be supplemented with the factor of practical absence of own raw materials base for chemistry of Ukraine.

Chemistry and Petrochemical Industry: energy saving measures**High and medium-cost measures****Low-cost measures**

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| <ul style="list-style-type: none"> ◇ installation of the equipment for hydrogen recovery from blowing gases; ◇ reconstruction of checkerworks of the ammonia synthesis towers and introduction of AK-30 units for air separation; ◇ replacement of soda furnaces with steam calcining kilns; ◇ employment of cyclic technologies; ◇ introduction of effective gas burners at drum furnaces; ◇ modernization of heat generators of drying drums; ◇ introduction of the selective catalytic cleaning; ◇ implementation of nitrogen oxide production technology to manufacture related nitrogen products; ◇ introduction of furnace gas utilization plants; ◇ introduction of computer-aided power consumption control and management systems; ◇ replacement of worn and obsolete boilers with new high-efficient ones; ◇ introduction of technology of lime burning in vortex flow; ◇ employment of cyclical methods and replacement of ammonia with diethylamine; ◇ construction of new turbine compressor plants; ◇ installation of cyclones for gases as they leave the recuperator, and recycling of the waste air in ventilation systems; ◇ modernization of the converter nozzles in the ammonia synthesis plants; ◇ adoption of the technology of high silicon ferroalloys smelting; ◇ modernization of a vacuum unit, crystallizing sodium sulphate from the technological agents of viscose production; ◇ “pellicular interpenetrating twin” type modernization of contact process evaporating scrubbers of the setting basins; ◇ introduction of the technology of collection and utilization the heat of plastic water. | <ul style="list-style-type: none"> ◇ improvement of combustion processes in the burners of boilers; ◇ introduction of automated blow-down in existing boilers; ◇ recycling ventilation air; ◇ development and introduction of guidelines on conducting energy audit; ◇ introduction of modern energy management means; ◇ providing certification and development of the inventory of energy consuming equipment; ◇ raising load factor for energy and production equipment; ◇ elimination of idle work of the equipment; ◇ the rise of operating rhythm of the equipment; ◇ implementation of means and systems for optimizing processing methods; ◇ optimizing repair and preventive maintenance works; ◇ increase in the level of air-tightness in buildings, constructions, processing chambers; ◇ systematic cleaning windows, lamps and other lighting armature; ◇ improving control and elimination of leakages of pressed air in networks, locking armature and processing equipment; ◇ efficient use of ventilation systems; ◇ elimination of looseness of sewage header hatches and penetration of storm water there; ◇ heat insulation improvement; ◇ doors warmth-keeping and liquidation of spontaneous air flows through openings; ◇ replacement of incandescent lamp with more efficient ones. |
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National Program	Comprehensive State Energy Conservation Programme of Ukraine
Energy Saving Potential, PJ	115
Potential of GHG Emissions Reduction, thousands t CE	2377

	Project #8	Decrease in the power consumption during cord thermal treatment in tyre production
8.1	Customer	The State Committee of Ukraine for Energy Conservation
8.2	Developer	- Ukrainian State Chemical Engineering University
8.3	Project implementation site	Joint Stock company "Dniproshina", Tyre Factories, Bila Tserkva
8.4	Brief description	Reduction of specific consumption rates in furnaces of cord thermal treatment will be obtained due to recycling of the combustion products, one their part being used in the cord drying process, another part - in pre-treatment mixing with recycled air. Considerable reduction of heat power consumption will be obtained for account of the intensification of heat transfer from radiation pipes to recycling air. This will be done by installation of auxiliary partitions in the furnace, that will lead to growth of the rate of furnace gases as well as the heat exchange rate. Fuel consumption will decrease by 18-20%.
8.5	Financial indicators	Total cost of the Project makes UAH84 thousand (\$42 thousand). Part of the cost to be covered by the equities of the enterprise - UAH28 thousand. Outside investments - UAH56 thousand. Construction works are not scheduled. Payback period - up to 1 year.
8.6	Energy saving	Power resources saving - 1.6 thousand tce per year
8.7	Greenhouse gas emissions reduction	0.97 thousand T CE
8.8	The Project's life-cycle expected	Design and development - 2 years; Exploitation - 10 years.

3.7.6 Energy saving Measures in Construction Materials Industry and in Construction

Principal constituents of the construction industry sector of Ukraine are the construction materials industry, industrial and public construction.

Construction materials industry comprises industries of cement, brick, glass, ceramics, production of wall and heat-insulating materials.

Priority ranking in development of the construction industry is as follows:

- bringing the advanced technologies into the industry;
- for the cement industry - changing the mode of production in the concrete-manufacturing industry to the dry one, making use of solid fuels; constructing a facility for parcelling, packing and dispatch of cement for marine export, the starting capacity shall be 2 m. tons, reaching 4-5 m. tons per year in the future;
- for the wall materials producing industry - taking obsolete enterprises with high specific energy consumption out of operation, decreasing the power-intensity of mural materials by expanding the output of void bricks and porous concrete products and by utilizing secondary energy resources;
- for the glass industry - changing of the window glass production to floating process and production of triplex automobile glass for vehicles and urban transport;
- for the non-ore industry - expanding the source of raw materials by operating quarries, introduction of advanced technologies at the basic enterprises which produce blocks and slabs; this shall extend the export of Ukrainian products;
- for the ceramic industry - restructuring and reequipment of running enterprises with modern machinery and appliances, which shall widen the production line and improve the quality of tiles and medical-ceramic products in order to meet the requirements of the world market. Domestic raw materials are supposed to replace imported ones.

Energy saving potentials of the construction materials industry, as compared with energy consumption indicators in 1990, are:

for fuel – 3.9-4.0 million tce;

for electric power – 1.6-2.0 bln kWh;

for heat power – 5.0-6.0 million GCal.

Building Materials and Construction: energy saving measures
High and medium-cost measures

Low-cost measures

Cement production:

- ◇ switching the plants to the dry and semi-dry methods of cement manufacturing;
- ◇ modernization of enterprises with installation of cyclones for heating air and preliminary calcining;
- ◇ transfer of existing grinding equipment into combined units with roll presses;
- ◇ switch the furnaces to coal combustion;
- ◇ employment of an adjustable electric drive;
- ◇ introduction of modern power consumption control, audit and management means;
- ◇ reduce water content of the raw materials due to the use of sulphide chloride of lime, soda tripoliphosphate and others;
- ◇ rise the level of use of cement additions;
- ◇ introduction of the equipment for preliminary calcining;
- ◇ utilization of the liquid combustible wastes in calcining furnaces;
- ◇ rise of calcining process stability due to the homogeneity of clinker;
- ◇ raising load factor for energy and production equipment.

Glass industry:

- ◇ transfer to modern glass production technologies;
- ◇ rise the level of regenerator cleaning;
- ◇ monitoring oxygen content in the furnace exhaust gases;
- ◇ rise the level of using crushed glass as an addition to the mass;
- ◇ replacement of refractories and isolation materials;
- ◇ burners modernization;
- ◇ cooling the working leads for account of direct radiation.

Brick industry:

- ◇ restructure of the production and introduction of modern technologies;
- ◇ improvement of the quality of clay preparation;
- ◇ decrease in the raw materials and power consumption through lessening average weight of a product from 3.5 kg to 3.0 kg;
- ◇ rising thermal resistance of hot water systems;
- ◇ increase in the output of hollow concrete and bricks and heat insulating basalt products;
- ◇ introduction of energy saving grinding units;
- ◇ introduction of new equipment for input of granular slab and burning of wastes;
- ◇ installation of fans for exhaust gases recycling;
- ◇ introduction of modern automated technological processes management means.

- ◇ development and introduction methodological recommendations on typification of engineering decisions;
- ◇ development and introduction of progressive standards for the fuel and power consumed during production processes and used for manufacturing some types of the produce;
- ◇ development and introduction of guidelines on conducting energy audit;
- ◇ implementation of modern energy management devices and methods;
- ◇ conducting certification and inventory of energy consuming equipment;
- ◇ elimination of idle work of the equipment;
- ◇ rise of operating rhythm of the equipment;
- ◇ optimizing repair and preventive maintenance works;
- ◇ increase in the level of air-tightness in buildings, constructions, processing chambers;
- ◇ timely cleaning windows, lamps, equipment and lighting armature;
- ◇ improving control and elimination of leakages of pressed air in networks, locking armature and processing equipment;
- ◇ elimination of looseness of sewage header hatches and penetration of storm water there;
- ◇ liquidation of losses of gas, steam and other energy carriers from flange junctions, locking armature, joints;
- ◇ improvement of heat insulation;
- ◇ doors warmth-keeping and liquidation of spontaneous air flows through openings;
- ◇ replacement of incandescent lamp with more efficient ones;
- ◇ improvement of the forming produce process;

Construction:

- ◇ development of the residential building base taking into account the new trends in the house building;
 - ◇ modernization of the fence constructions of the buildings;
 - ◇ increase in the heat insulation features of external fences;
 - ◇ modernization of engineering equipment;
 - ◇ wide-scale introduction of efficient light metal bearing constructions for modern buildings;
 - ◇ production of heat saving building materials;
 - ◇ introduction of efficient heating systems in industrial and residential buildings;
 - ◇ creation of demo projects for the presentation of energy efficient buildings and constructions;
 - ◇ introduction of renewable and unconventional energy sources;
 - ◇ increase in the output of door and window blocks and other products made from aluminum alloys and plastic, replacing timber.
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- ◇ introduction of new methods of stacking bricks in dryers;
-
- ◇ reduce the excess of air by 25%;
 - ◇ replacement of burners and employment of regulator devices;
 - ◇ following the new norms and standards for heat insulation in buildings.

National Program	Comprehensive State Energy Conservation Programme of Ukraine	
Energy Saving Potential, PJ	102.5	
Potential of GHG Emissions Reduction, thousands t CE	2119	

	Project #9	Project "Energy Efficiency in Kiev institutional buildings"
9.1	Customer	The State Committee for Energy Conservation of Ukraine
9.2	Developer	Pacific Northwest National Laboratories of US Department of Energy, Agency for Rational Energy Use and Ecology (Ukraine)
9.3	The Project implementation site	Institutional buildings in Kiev
9.4	Brief description	<p>The Project proposals contain estimates the energy saving potential for buildings in Kiev. These buildings are in the state and municipal ownership. Buildings which belong to the health care, education and culture were considered in the Project as well.</p> <p>Total number of the buildings makes 1678 with living area of 7.2 mln m².</p> <p>Yearly heat power consumption in the buildings reaches 2.8 mln GCal.</p> <p>The purpose of the Project is to modernize the buildings and implement energy saving measures, including the following ones:</p> <p><u>on the buildings' design</u>: warming out external walls, improvement of heat insulation of roofs, attics, basements, filling up the chinks, additional glazing and others;</p> <p><u>on hot water supply</u>: pipelines insulation improvement, installation of hot water meters, water heating in reservoirs, installation of heat exchangers and others;</p> <p><u>on heating system</u>: heating systems modernization, installation of heat meters in buildings and control devices;</p> <p><u>on ventilation</u>: recovery of the heat of ventilation air, installation of fans in ceiling.</p>
9.5	Financial indicators	Total cost of the Project - \$38 mln, including capital investments - \$31 mln.
9.6	Energy saving	<p>It is envisaged that obtained in the buildings energy efficiency will reduce budget expenses by more then \$9 mln per year and lessen natural gas consumption by nearly 57 mln m², fuel oil - by 81 thousand tons annually, that will total \$5.8 mln per year.</p> <p>Necessary investments for energy saving will reach from \$3.5 to \$6 per one m².</p>
9.7	Greenhouse gas emissions reduction	23.3 thousand t CE
9.8	Period of realization	5 years.
9.9	Payback period	5 years.

3.7.7 Energy saving Measures in Agriculture

The agricultural sector includes the facilities directly dealing with production of agricultural goods and processing of these (food industry, including sugar, bakery, meat-dairy, beer and alcohol beverage industries).

The following considerable changes are planned in agricultural sector:

- perfecting the structure of technological means and optimizing their energy consumption level;
- elaboration of technological processes for the equipment and improvement of corn drying and storing technologies;
- fixing the rates and accounting for the fuel and energy consumption;
- implementing means to reduce oil and fuel consumption changing gasoline type engines to the diesel and gas-cylinder ones;
- utilizing wind, water, solar power, alternative biomass fuels, etc.

The priorities for the food industry are:

- the production technical base restructuring and reequipment of enterprises and constructions with modern machinery and appliances, and the replacement of the obsolete and worn-out machinery. The priority shall be given to the fuel and energy saving technologies and to the equipment, utilizing progressive fuels and waste energy;
- the production of ready-to-use products, semiproducts, cookery, other products made of new kinds of raw-materials;
- the increase in output, especially in the exporting branches (sugar, oil and fat, spirits, etc.)

Energy saving potential, as compared with energy consumption in 1990, makes:

In agriculture:

for fuel – 4.0 - 5.0 million tce, for electric power – 2.0 -3.0 bn. kWh,

In food industry:

for fuel – 3.5 - 4.0 million tce, for electric power – 1.9 -2.0 bln kWh and for heat power –17.0 - 18.5 million GCal.

Agricultural sector: energy saving measures	
<i>High and medium-cost measures</i>	<i>Low-cost measures</i>
<p><u>Crop production:</u></p> <ul style="list-style-type: none"> ◇ optimize the structure of areas under crops with the purpose to limit the production of energy-consuming cultivars and to increase the areas under low power-consuming ones; ◇ curtail ploughing up of low-productive eroded lands and, instead of this, creation of pastures; ◇ shift from spring ploughing with surface ground treatment; ◇ introduction of energy saving methods of growing of wheat, oats, barley and corn; ◇ employment of the method of spreading crushed straw of winter wheat and corn stalks on eroded lands; ◇ reconstruction of grain dryers and optimizing the regimes of drying. <p><u>Livestock production:</u></p> <ul style="list-style-type: none"> ◇ improvement of the herd structure by growing highly productive breeds of cattle for account of special meat and milk breeds; ◇ introduction of modern methods of mixed fodder production at the farms on the base of small-size mixing fodder machines; ◇ introduction of thermocompressors for the discharged air heat recovery in cattle premises; ◇ switch feed ration of the young cattle from annual herbs and corn to green fodder of perennial herbs; ◇ employment of independent helio-wind power unit. <p><u>Baking industry:</u></p> <ul style="list-style-type: none"> ◇ development and introduction of modern intensive technologies with the use of raw materials with improved biological and technological characteristics; ◇ creation of wide range of complex components to control baking properties of the flour and improve the bread qualities; ◇ development and introduction of multi-purpose energy efficient equipment to be installed in bakeries of various types. The purpose of the bakeries is to enlarge the range of bakery and confectionery produce; ◇ modernization and replacement of heat power equipment with the more efficient one (boilers, furnaces, burners); ◇ automation of energotechnological equipment; ◇ increase in the level of use of the secondary resources; ◇ introduction of modern automated energy control, audit and management means and systems. <p><u>At the objects of Meat and Milk industry:</u></p> <ul style="list-style-type: none"> ◇ technical reconstruction of the plants; ◇ introduction of modern methods for warming, cooling, evaporating, condensing and drying milk products; ◇ improvement of separation process, thermal and mechanical treatment, homogenization, bottling and preservation of milk products; ◇ modernization and introduction of efficient steam systems and equipment; ◇ elimination of direct discharge of the condensate into sewerage system; ◇ use of condensate-tappers at their full productive capacity; 	<ul style="list-style-type: none"> ◇ decrease in the humidity and the rise steam quality; ◇ timely conducting high-quality repair and preventive maintenance works; ◇ keep in operating condition an automated system of pressure and temperature control; ◇ development and introduction of guidelines on conducting energy audit; ◇ introduction of current energy management means and methods; ◇ conducting certification and inventory of energy consuming equipment; ◇ raising load factor for energy and production equipment; ◇ elimination of idle work of the equipment; ◇ rise of operating rhythm of the equipment; ◇ implementation of means and systems for optimising processing regimes; ◇ optimising repair and preventive maintenance works; ◇ increase in level of air-tightness in buildings, constructions, production and processing chambers; ◇ timely cleaning windows, lamps, equipment and lighting armature; ◇ improving control and elimination of leakages of pressed air in networks, locking armature and processing equipment; ◇ efficient use of ventilation systems; ◇ elimination of looseness of sewage header hatches and penetration of storm water there; ◇ employment of secondary energy resources; ◇ rise of the load factor for energotechnological equipment;

- ◇ employment of high-tech complex technologies and multi-purpose schemes for separation of pork and beef;
- ◇ dividing cooling and freezing processes of the produce for stages;
- ◇ raising efficiency of vacuum systems of heat insulation equipment through softening and phosphorization of water in circulating water supply system;
- ◇ employment of the method of block meat processing;
- ◇ introduction of efficient systems for abstraction, collection and supply of heat condensate and its maximum employment for feeding steam boilers;
- ◇ reconstruction and replacement of heating systems and heat insulation equipment, repair of heat insulation and locking and regulating armature;
- ◇ installation of water cleaning systems against scale-forming components and other pollutants;
- ◇ introduction of automated heat consumption metering and audit system.

At the factories of the Brewing industry:

- ◇ optimizing the work of furnaces and heat transfer control;
- ◇ increase in the quality of barley and hop;
- ◇ heat reuse in the furnaces;
- ◇ utilization of wort and rinsing water;
- ◇ separation of wort and hop with further wort utilization;
- ◇ utilization of the heat of brew kettles;
- ◇ collection and use of the excess of brewer's yeast and beer utilization;
- ◇ installation of the machine for bottles washing;
- ◇ optimizing compressor plant's work;
- ◇ employment of power co-generation systems;
- ◇ introduction of modern systems for steam separation;
- ◇ introduction of efficient power drives;
- ◇ installation of pouring and packing lines.

At the factories of Distillation industry:

- ◇ reconstruction an technical re-equipping the production, introduction of technological innovations;
- ◇ introduction of high efficient rectifying stills;
- ◇ design and introduction of methods for water and drains cleaning;
- ◇ setting technical spirit production;
- ◇ development of technology for fuel ethanol production, creation of industrial basis and setting the production;
- ◇ development and introduction of high-octane water containing agents to be added to gasoline;
- ◇ secondary resources utilization;
- ◇ introduction of energy consumption control, audit and management systems.
- ◇ liquidation of losses of gas, steam and other energy carriers from flange junctions, locking armature, joints;
- ◇ improvement of heat insulation;
- ◇ doors warmth-keeping and liquidation of spontaneous air flows through openings;

- ◇ replacement of incandescent lamp with more efficient ones.

In Sugar industry

- ◇ decrease in the level of diffusion juice dilution;
- ◇ reduce evaporation temperature down to 130°C at the first stage of evaporation system;
- ◇ decrease in the level of current velocity in squeezing machines to reduce the moisture content in the presses of some factories;
- ◇ increase in the level of return juice for the diffusion process;
- ◇ optimizing burning regimes in tanks.

At the factories of the Sugar Industry:

- ◇ installation of new equipment for sugar-beet washing;
- ◇ installation of modern technologies for extracting sugar from sugar-beet;
- ◇ installation of more efficient squeezing aggregates;

- ◇ automation of beet supplying process;
- ◇ raising the level of evaporation;
- ◇ automation of syrup concentration process;
- ◇ installation of continuous crystallization lines;
- ◇ automation of the process of crystallization;
- ◇ introduction of technology for preliminary heating of diffusion juice of crushed beet;
- ◇ improvement of syrup purification and filtration;
- ◇ improvement of heat insulation properties of the pipelines.

National Program	Comprehensive State Energy Conservation Programme of Ukraine	
	Energy Saving Potential, PJ	450
	Potential of GHG Emissions Reduction, thousands t CE	9303

Project # 10		Bio-energy complex on the treatment of poultry-farm wastes into energy carriers.
10.1	Customer	Poultry-farm "Berezans'ka"
10.2	Developer	Scientific and production enterprise "Al'tek "
10.3	Brief description	<p>At the poultry-farm, raising 1.0 mln layers per year, near 400 m³ of chicken dung is accumulated. On the base of previously accomplished R&D works and commercial tests of single units, fundamentally new technology for treatment of poultry dung into biogas, fertilizers and electric power was created. This technology was patented in the State Patent of Ukraine. It includes know-how on the process realization and design and development documents on the processing line construction and equipment.</p> <p>The processing scheme of the unit is made of the main following parts:</p> <ul style="list-style-type: none"> - a unit for dung preparation before the treatment; - a unit for bio-conversion of the dung; - a unit for electric power production.
10.4	Expected production volumes	The use of poultry dung as an power source at the poultry-farm "Berezans'ka" will allow to produce 9.5 mln m ³ of bio-gas per year (methane content being 90%) and 13.0 mln KW·h of electric power.
10.5	Financial indicators	<p>Total costs of the Project - UAH3.5 mln (\$1.8 mln), including:</p> <ul style="list-style-type: none"> - capital expenditures - UAH1.8 mln; - design - UAH0.2 mln; - construction - UAH1.3 mln; - start-adjusting works - UAH0.2 mln. <p>Payback period - up to 3 years.</p> <p>Sources of the Project financing could be both the equities of the farm and borrowed from foreign and domestic banks' money.</p>
10.6	Energy saving	FER saving due to the Project realization will make 6 mln m ³ of gas and 4 mln KW·h of electric power, that is about 11.0 thousand tce per year.
10.7	Greenhouse gas emissions reduction	6.66 thousand t CE
10.8	Project's life-cycle expected	<p>Design and development of non-standard equipment - 0.5 years.</p> <p>Construction of objects scheduled by the Project - 0.5 years.</p> <p>Period of exploitation of the processing line - 10 years.</p>

3.7.8 Energy Saving Measures in Transport

Transport sector of Ukraine includes: railway, aviation, marine, river and car types of the transport.

To provide for transport needs of the national economy of the country, over a half of light oil products, some 5% of boiler-furnace fuel, 1% of heat power and about 5% of electric power of the overall consumption of fuel and energy in the country are consumed.

Quantitative parameters of transport facilities of Ukraine are characterized with the following data for 1996.

Transport fleet structure	Number of pieces
Locomotives	8 thousand
Goods wagons	270 thousand
Carriages	11 thousand
Trucks	870 thousand
Motor cars	4 mln
Buses	126 thousand
Trams	5 thousand
Trolley buses	7 thousand
Metro cars	0.7 thousand
River cargo boats	0.7 thousand
River crafts	0.2 thousand
Air crafts	0.1 thousand

The main directions of long-term development of transport fleet are:

In automobile transport:

- elaboration and adoption of legislative acts with the purpose of encouraging production and imports of energy-efficient automobile transport facilities and engines, as well as stimulation of production of high-quality motor fuel at domestic oil refineries;
- creation of productive capacities to manufacture diesel and gas cylinder cars of small and medium load-carrying capacity;
- extension of diesel vehicles use in carriage by automobiles;
- arrangement of production of high-octane petrol in Ukraine with addition of 10-12% of ethanol that is equivalent to increase of petrol production for 10-12%;
- optimization of automobile fleet structure and implementation of a system for optimal traffic control of public transport in large cities;
- use of alternative types of fuel in automobile transport (natural gas and methanol);
- reconstruction of highways.

In railway transport:

- extension of electrification of cargo and passenger transportation, curtailment of application of diesel locomotive traction;
- replacement of obsolete types of rolling stocks with modern ones;
- development of pipe transport;
- technical and technological modernization of the rolling stock with consideration of changes in freight traffic structure;
- creation of productive capacities to manufacture passenger carriages, electric locomotives, railroad-repairing machinery and equipment.

In marine and river transport:

- construction of vessels with increased weight-carrying capacity, tankers and specialized vessels, as well as vessels of «river-sea» type;
- wide application of water-fuel emulsions for propulsion engines and steam boilers of sea vessels.

In aviation:

- creation of new types of fuel-efficient aircraft with increased comfort;
- replacement of old aircraft with contemporary energy-efficient ones.

As a whole, energy saving potential in the transport of Ukraine (as compared with energy consumption in 1990) is estimated as follows: for fuel – 9.3-9.8 million tce, for electric power – 1.8 - 5.0 bln kWh and for heat power – 0.5 - 0.9 million GCal.

As barriers on the way to the improvement of fuel utilization efficiency in the transport, besides those listed in sub-section 2.5, we may refer to a number of the following factors:

- poor arrangement of spare parts production;
- poor level of services;
- insufficient level of diagnostic and control facilities' provision.

		Transport: energy saving measures			
		<i>High and medium-cost measures</i>	<i>Low-cost measures</i>		
Rail-road transport:		<ul style="list-style-type: none"> ◇ transfer railroads to the electric; ◇ introduction of the modern energy saving equipment and moveable stock; ◇ introduction of efficient systems for freight flow and sorting management; ◇ decrease in the weight of the movable stock; ◇ electrification of spur-tracks and intra-factory rail roads; ◇ employment of goods trucks with the bottom of parabolic form; ◇ use of modern diagnostic means; ◇ increase in the tonnage of the cars and locomotives' capacity; ◇ improvement of the quality of the rail roads; ◇ increase in the load factor of power-generating equipment. 	<ul style="list-style-type: none"> ◇ introduction of modern fuel consumption diagnostic and control systems; ◇ improvement of the condition of railroad and tram-lines; ◇ enhance the drivers' experience to save fuel and combustive-lubricating materials; ◇ improvement of the provision of spare parts system; ◇ improvement of movable stock maintenance; ◇ implementation of modern energy management devices and methods; ◇ optimizing repair and preventive maintenance works; ◇ development and introduction of progressive norms for fuel and power consumption; ◇ elimination of idle work of the equipment; ◇ implementation of modern energy audit and management systems; ◇ introduction of modern systems for optimizing freight flow routes; ◇ optimizing vehicles traffic regimes; ◇ introduction of modern systems for public transport traffic management; ◇ improvement of services provided by taxis and buses fleets; ◇ optimizing transport structure in cities (for buses, trolley-buses and trams); ◇ optimizing vessels routes. 		
Motor transport:					
<ul style="list-style-type: none"> ◇ replacement of the transport fleet with energy efficient and ecologically safe motor cars; ◇ improvement of the quality of roads covering; ◇ production of the materials, equipment and services necessary for energy saving measures implementation; ◇ employment of diesel engines instead of petroleum ones; ◇ switch gasoline engines in motor cars to natural gas ones; ◇ increase in the fuel quality, use of fuel additives, etc.; ◇ improvement of the engines' design towards the decrease of fuel consumption. 					
Air transport:					
<ul style="list-style-type: none"> ◇ replacement of existing stock of air motors with more efficient ones; ◇ improvement of quality of the fuel to eliminate sub-combustion and pollution, connected with its injection into the motor; ◇ improvement of the provision of spare parts, diagnostic methods and energy saving control means; ◇ employment of the special covering of the air-crafts to reduce air resistance; ◇ employment of motor vehicles in airports to shorten the self-moving way of aircrafts to their take-off; ◇ improvement of the quality of the strip covering. 					
Marine and River transport:					
<ul style="list-style-type: none"> ◇ switch diesel motors and oil-fired boilers to aqueous fuel emulsions; ◇ employment of right-handed and right-handed screws. 					
				National Program	Comprehensive State Energy Conservation Programme of Ukraine
Project #11				Energy Saving Potential, PJ	
11.1	Customer			Th	200
				Potential of GHG Emissions Reduction, thousands t CE	
				4135	

11.2	Developer	Joint Stock company "VNIPTranogas"
11.3	Project implementation site:	Dolinsky oil processing plant
11.4	Brief description	Installation of the addition "Molicar" in internal combustion engines of motor, railway and water transport will provide: <ul style="list-style-type: none"> - liquid fuel saving; - decrease in losses of engine's capacity; - extension of overhaul life of the engine; - facilitating the engine's starting; - decrease in the volume of pollutants in the exhaust gases; - reduction of the level of the noise performances.
11.5	Expected production volumes	The unit will allow to manufacture 160 tons of the addition per year.
11.6	Financial indicators	Total costs of the Project - UAH4.8 mln (\$2.6 mln). Part of the costs to be covered by the equities - UAH1.4 mln (\$0.77 mln). Volume of outside investments - UAH3.4 mln (\$1.8 mln). Capital investments directed to the purchase and installation of the equipment - UAH2.4 mln, including: <ul style="list-style-type: none"> - construction - UAH1.0 mln; - design and search works - UAH0.3 mln; Payback period - up to 1 year.
11.7	Energy saving	Motor fuel savings in the result of the Project implementation will reach 80 thousand tones yearly (120 tce).
11.8	Greenhouse gas emissions reduction	85.87 thousand t CE
11.9	Project life-cycle expected	Design and development - 9 months; construction of the objects, scheduled by the Project - 15 months; exploitation of the objects - 15 years.

3.8 CROSS-SECTORAL ENERGY SAVING MEASURES

There is a number of energy consuming equipment types, productive functions and technological operations of cross-sectoral nature, which are used in various sectors of the national economy of the country.

Such energy-consuming equipment include boilers, electric motors, lighting and measuring devices, pneumatic and hydraulic machinery and others.

Gas, electric and heat supply; ventilation, welding; supply of water, compressed air, process steam; personnel training and other may be referred to the functions of cross-sectoral type. Among technological operations, used in various branches of the national economy, we may note such as measuring, cutting, quenching, conducting of ancillary jobs, including conveying, storing, batching and others.

Taking into account multi-sectoral nature of such equipment, functions, technologies and services, a necessity appears to conduct a uniform technical policy aimed at improvement of energy use efficiency.

Cross-sectoral energy saving potential in Ukraine (as compared with energy consumption indicators in the reference year of 1990) is rather considerable: 42.0-44.0 million tce, including 12.0-13.0 million tce for fuel, 68.0-70.0 bln kWh for electric power and 47.0-50.0 million GCal for heat power. Overall potential of reduction of greenhouse gas emissions approaches to 16,538 thousand t CE.

Cross-sectoral energy saving measures may be considered as follows:

- replacement or modernization of boilers with more energy-efficient ones;
- control over boilers' combustion duties;
- transition of boilers into HPSP;
- improvement of feeding water treatment quality;
- reduction of air suction into air heaters and furnaces;
- determination of places and liquidation of gas, steam, water, air and other energy carriers leakages;
- enhancement of heat resistance of heat pipeline insulation;
- implementation of modern means to control the demand for energy carriers;
- implementation of modern facilities to account, check and control over energy consumption;
- elaboration and implementation of power electronics facilities, including controlled electric drive;
- creation of a new range of energy saving electric motors;
- reactive power compensation;
- increase of load factor for energy-technological equipment;
- arrangement of double glazing for windows;
- regulation of revolution numbers of pump motors;
- application of contemporary methods and ways of energy management;
- creation of demonstration areas of energy-efficient facilities;
- application of modern methods to audit, inspect and expertise energy-consuming facilities;

- improvement of personnel qualification level; professional training and education;
- creation of data centers on popularization of energy saving;
- arrangement and conduct of broad- and telecasting dedicated to saving of fuel and energy;
- utilization of secondary resources;
- creation and implementation of a new generation of energy saving light sources, including low-voltage incandescent halogen lamps, compact halogen lamps, low-power high-pressure gas-discharge lamps (sodium and metal-halogen), and others;
- implementation of automatic control systems for productivity regulation of compressors, pumps, ventilators;
- use of preliminary and interim cooling of air in compressor plant systems;
- liquidation of idling time of energy-technological equipment;
- optimization of selection of a composition of operated energy-technological equipment, including transformers and electric motors;
- use of controlled drives for ventilators, pumps, compressor plants and other consumers;
- implementation of facilities to prevent over-voltage in electric networks;
- elaboration and application of autonomous equipment to produce electric and heat power, of gas engines, generators and the like;
- application of modern software methods of optimization of technological processes and productive-economic activities;
- elaboration and application of multi-purpose laser technologies (for cutting, welding, quenching and others);
- use of modern energy saving, pollution-free methods and means to carry on welding jobs;
- improvement of repair and preventive maintenance quality;
- application of modern technical facilities and methods to diagnose energy-technological equipment;
- elaboration and implementation of contemporary technologies to protect fuel-grease materials against microbiological impairment.

A par with the above-listed, a number of administrative, organizational, technological and scientific-research measures may be referred to the cross-sectoral energy saving ones as well. These also may include elaboration and administrative decision making, elaboration of regulative and methodical documents related to improvement of energy utilization efficiency, and others.

Undoubtedly, the most important things in implementation of state policy are financial-economic measures, to which the below measures may be referred:

- elaboration of measures and formation of price and tax policy, conducive to energy saving;
- conduct of investment policy, elaboration and implementation of crediting system aimed at creation of the conditions which would promote conduct of energy saving measures;

- elaboration and implementation of a system of preferences and tariffs which would promote energy saving;
- elaboration of and taking measures on determination and collection of payments for direct losses and irrational use of fuel-energy resources in the form of a surcharge to existing prices and tariffs in dependence upon excessive consumption of energy as compared with rates, prescribed by a standard;
- elaboration and implementation of economic sanctions' mechanism for spendthrift utilization of fuel and energy;
- elaboration and implementation of a mechanism of granting legal and natural persons any subsidies, allowances, tax-credit and other preferences to promote energy saving measures;
- elaboration and implementation of economic sanctions against producers of energy non-efficient equipment and materials;
- elaboration and implementation of mechanisms of incentive bonus for collectives and individual employees for efficient results of their work in the field of rational utilization and saving of fuel energy resources;
- creation and use of governmental and local out-of-budget funds for energy saving;
- elaboration and implementation of mechanisms for granting tax preferences to enterprises manufacturing energy saving equipment;
- establishment of increased depreciation rates for energy saving fixed assets;
- elaboration and implementation of a mechanism for realization of economic sanctions for untimely conduct of expert's inspection of facilities with respect of fuel and energy utilization matters;
- elaboration and creation of a financial-economic mechanism to promote energy saving through long-term share participation in profits earned owing to energy saving;
- elaboration and creation of a financial-economic mechanism to promote energy saving by virtue of creation of joint ventures;
- elaboration and creation of a financial-economic mechanism to promote energy saving through entering contracts for services in energy saving field;
- elaboration and creation of a financial-economic mechanism to promote energy saving through flexible crediting;
- elaboration and creation of a financial-economic mechanism to promote energy saving through fixed-term crediting;
- elaboration and creation of a financial-economic mechanism to promote energy saving through financing on the part of third parties;
- elaboration and creation of a financial-economic mechanism to promote energy saving by virtue of direct contribution on the part of the State into energy saving measures, and other ways.

Project #12		Installation of turbo-expander utilizing plants at gas-distribution stations
12.1	Customer	Joint Stock company "Ukrigasprom"
12.2	Developer	Joint Stock company "VNIPItransgas" and the State Scientific and Production enterprise "Energozberezhennya" (Energy conservation)
12.3	Brief description	Turbo-expander plants are designed for the electric power production, based on the pressure differentials of gas at gas distribution stations and of water steam at the household and industrial boiler houses. The use of such plants allows to gain additional power, not having any fuel consumed.
12.4	Financial indicators	Total costs of the Project - UAH13.4 mln (\$7.4 mln), including: – capital expenditures for the purchase of the equipment - UAH11.2 mln (\$6.2 mln); – building and assembly works - UAH1.5 mln (\$0.85 mln); – design - UAH0.6 mln (\$0.3 mln). Payback period 3-4 years.
12.5	Energy saving	Yearly energy resources saving, obtained in the result of the Project implementation - 27.5 thousand tce.
12.6	Greenhouse gas emissions reduction	16.65 thousand t CE
12.7	Project life-cycle expected	Design and development - 1 year; construction of the objects, scheduled by the Project - 1 years; exploitation of the objects - 10 - 12 years.

3.9 CONCLUSIONS

The Law of Ukraine «On Energy Conservation» stipulates an economic mechanism of energy saving, aimed at stimulation of rational utilization and saving of fuel and energy resources; it also prescribes imposition of economic sanctions for wasting fuel and energy. One among the constituents of the economic mechanism for energy saving, stated in the above Law, is establishment of deductions from the value of FER, used by an enterprise, and provision of subsidies, allowances, tax-credit and other preferences to a subject of undertaking to stimulate energy saving.

Nevertheless, the principal economic laws of the country «On the Taxation System» and «On Taxation of Enterprises' Incomes» do not prescribe such measures.

Therefore, first and foremost measures have to include a concordance of these laws with respect to creation of an economic mechanism for energy saving promotion.

To implement such mechanism, it could be advised to use proposals of the State Committee on Energy Saving of Ukraine, which proposals assume introduction of amendments and additions to the Laws of Ukraine «On Taxation System», «On Taxation of Enterprises' Incomes» and «On Energy Conservation».

In particular, these amendments are:

- reduction of profits tax of enterprises by 50% for 1 year, where the profits are gained owing to implementation of energy efficient projects;
- reduction of profits tax of enterprises by 50% for 1 year, where the profits are gained owing to implementation of energy efficient equipment and own-produced technologies;
- reduction of profits tax of enterprises by 50% for 1 year, where the profits are gained owing to investment activities in energy saving.

The list of investors into energy efficient projects, energy saving equipment and technologies is planned to be developed and approved by the Cabinet of Ukraine on the yearly basis.

To avoid irrational FER use and with the purpose of observing norms and standards of their consumption, the State Committee for Energy Conservation foresees introduction of deductions from the value of factually utilized fuel-energy resources. With this, it is proposed to refer not to the gross costs the value of factually consumed FER in excess of their rated consumption. According to the proposals and calculations of the State Committee for Energy Conservation, if the deductions for FER, factually consumed by enterprises, are established at the rate of 0.1% for solid fuel, 0.2% for natural gas, liquid fuel, electric and heat power, the annual income to the out-of-budget fund of energy saving is anticipated to be UAH84 mln.

Draft regulatory documents, governing the economic mechanism for energy saving, prescribe to distribute the above deductions as follows:

30% will be assigned to the state out-of-budget fund of energy saving;

30% will be assigned to regional and oblast funds of energy saving;

40% will be left at enterprises for purposeful use of developing and implementing energy efficient projects.

Drafts on amendments and additions to the Law of Ukraine «On Energy Conservation» prescribe imposition of economic sanctions on legal and natural persons for:

transfer of design, technological and project documentation which is not in conformity with requirements of effective standards, rates and norms of energy consumption, and which did not undergo an expertise for energy saving, to an applicant or into production (design enterprises and the consumer of such documentation will pay a fine amounting 25% of the project costs each);

- realization of products which do not meet requirements of effective standards, rates and norms of energy consumption; a manufacturer, seller (an intermediary) and buyer will pay a fine amounting 25% of the value of such realized products each;
- realization within the territory of Ukraine of imported products which do not meet requirements of effective standards, rates and norms of energy consumption; a subject of undertaking will pay a fine amounting 50% of the value of such realized products;
- evasion of a subject of undertaking from submission to the State Inspection on Energy Saving of products which are subject to an expertise on energy saving; such subject will pay a fine amounting 25% of the products' value, manufactured from the date of such evasion;
- realization of products, which are subject to, but were not submitted to obligatory expertise on energy saving, certification or attestation of their production; the subject of undertaking will pay a fine amounting 25% of the value of such realized products.

Adoption of such amendments in the legislation of the country by the Verkhovna Rada would accelerate the creation and implementation of energy efficient equipment and technologies and, respectively, would result in a reduction in greenhouse gas emissions.

The chapter below presents first and foremost energy saving measures separately, on the one hand, in implementation of the state policy in energy saving on account of effectuation of measures of regulatory-legal, organizational, financial-economic and informative-educational nature, and in the other hand – first and foremost technological energy saving measures. Adoption of regulatory and legal acts and standards, included in the number of first and foremost ones, is necessary for development of legislation on energy saving and energy consumption. Implementation of such measures will allow improving energy efficiency on account of creation of FER saving stimuli, improvement of investment climate, enhancement of awareness of managerial staff and population in energy saving matters.

Implementation of organizational and financial-economic measures will allow forming an operating institutional infrastructure for introduction of an economic mechanism for energy saving as on the governmental, so on regional levels. Low-cost organizational-technical measures will be realized within the framework of these measures; they will allow to enhance efficiency of FER utilization.

Informative-educational measures are aimed at the increase of knowledge of the society on energy saving matters on account of a distributive network formation of regional centers on energy efficiency.

Such centers will be obliged to render consultancy services, to effect educational activities, to carry on informative-advertising events with stressing on ecological advantages of efficient use of fuel and energy.

Measures to provide the state policy of energy saving are mutually related and form a single complex. Implementation of these, as compared with technological ones, requires small costs. Efficiency of particular measures of such nature, as a rule, can not be calculated due to their integral influence over energy consumption and to complexity of relationships among them. General recognized assessments of experts determine FER saving owing to implementation of the state policy in energy saving on the level of 1.5-2% of total energy consumption.

First and foremost energy saving measures

1 Regulatory-legal measures

- 1.1 Draft Law of Ukraine «On Introduction of Amendments of and Additions to the Law of Ukraine «On the Taxation System»» (establishment of deductions from the value of factually consumed FER).

- 1.2 Draft Law of Ukraine «On Introduction of Amendments of and Additions to the Law of Ukraine «On Taxation of Enterprises' Incomes» (reduction of tax profits where the profits are earned owing to production, realisation and implementation of energy-efficient equipment).
- 1.3 Draft Law of Ukraine «On Introduction of Amendments of and Additions to the Law of Ukraine «On Energy Conservation» (establishment of deduction percent from the value of factually consumed FER, enforcement of economic sanctions for production, sale and implementation of energy intensive equipment).
- 1.4 Draft Law of Ukraine «On Introduction of Amendments of and Additions to the «Administrative Infraction Code of Ukraine» (establishment of undertaking subjects' responsibility for FER wasting).
- 1.5 Draft Regulations on economic mechanism of energy saving.
- 1.6 Draft Regulations on incentive bonus for collectives and individual employees for FER saving and their responsibility for excessive consumption and irrational utilisation of these.
- 1.7 Draft Regulations on the state out-of-budget fund of energy saving (amendments pertaining to promotion of energy saving).
- 1.8 Draft Resolution of the Cabinet of Ministers of Ukraine «On Payments for FER Consumption in Excess of Prescribed Rates».
- 1.9 Draft Resolution of the Cabinet of Ministers of Ukraine and Regulations on energy inspection.
- 1.10 Draft Law of Ukraine «On Alternative Power Engineering».
- 1.11 Draft Law of Ukraine «On Alternative Types of Liquid and Gaseous Fuel».
- 1.12 Draft complex of standards on energy saving and energy efficiency in sectors of the national economy.
- 1.13 Draft Standards on secondary energy resources.
- 1.14 Draft Standards on alternative and renewable energy sources.
- 1.15 Revision, correction of effective and elaboration of new construction standards and rules, normative-technical documentation on heat engineering, heating, ventilation, air conditioning and others.
- 1.16 Formation of a list of energy saving facilities, devices, materials for production and imports of which preferences will be established.
- 1.17 Draft Regulations on Procedures of state expertise on energy saving.
- 1.18 Elaboration and implementation of sectoral approaches to conduct the state expertise on energy saving.
- 1.19 Elaboration and implementation of sectoral progressive standards for energy saving.
- 1.20 Elaboration of regulatory documents on creation and operation of energy efficient demonstration zones.

2 Organizational measures

- 2.1 Creation of standing system of informative-analytical maintenance of the Comprehensive State Energy Conservation Programme of Ukraine.
- 2.2 Elaboration and implementation of regional programs on energy saving.

- 2.3 Elaboration and implementation of sectoral programs on energy saving.
- 2.4 Certification of energy intensive facilities and implementation of methods for activities efficiency's analysis of enterprises, organizations and regions based on the energy consuming facilities certification and report data on energy saving programs.
- 2.5 Elaboration and implementation of a method for certification of energy intensive products, energy consuming equipment and devices for FER consumption audit. Arrangement of expert-certification service.
- 2.6 Arrangement of performance of the State Programme on production of FER consumption control devices, as well as systems for water, heat and electric power supplies management at industrial enterprises and in the household.

3 Financial-economic measures

- 3.1 Development of regulatory documents and creation of legal conditions for implementing and using the state out-of-budget fund of energy saving.
- 3.2 Creation of regional, oblast and local funds of energy saving and development of regulatory acts on their activities.
- 3.3 Development and implementation of regulatory documents on establishment and collection of payments for direct losses and irrational use of FER.
- 3.4 Creation and use of activities of investment-service energy saving companies of various ownership forms.
- 3.5 Development and implementation of mechanisms of incentives for collectives and individual employees for their achievement of advanced levels of energy efficiency and FER saving.
- 3.6 Elaborating and taking measures on attraction of domestic and foreign investments to development and implementation of energy efficient projects.

4 Informative-educational measures

- 4.1 Creation of inter-department scientific-methodical council at the State Committee of Ukraine for Energy Conservation and at the Ministry of Education to address issues on co-ordination and methodical provision of education in the field of energy saving.
- 4.2 Development and implementation of educational programs for the population of Ukraine in the field of energy saving.
- 4.3 Development and implementation of sectoral and regional educational programs on energy saving.
- 4.4 Creation of central and regional information centres and databases for energy saving.
- 4.5 Creation of regional energy efficiency centres to conduct education, training, re-training and re-qualification of specialists in energy saving, energy audit, energy management, on methodical provision and certification.
- 4.6 Organization of informative-advertising events to popularise energy saving, economic, ecological and social benefits of energy saving.
- 4.7 Leading scientific-practical conferences «Education in the Field of Energy Saving. Experience. Perspectives».
- 4.8 Leading regional conferences and seminars on energy saving issues.

- 4.9 Arranging and conducting exhibitions of vanguard achievements in energy saving.
- 4.10 Introduction of a cycle of telecasts on energy saving problems.
- 4.11 Popularisation of energy saving through broadcasting.
- 4.12 Regular publications of materials on improvement of FER use efficiency in periodicals.

5. Technical and technological cross-sectoral energy saving measures

- 5.1 Implementation of modern energy control, audit and management systems, including installation of metering devices to measure consumption of natural gas, heat power, hot and cold water.
- 5.2 Location of places and liquidation of leakages of gas, steam, water, air and of other energy carriers.
- 5.3 Application of modern methods and means of audit, inspection and expertise of energy consuming facilities.
- 5.4 Creation and implementation of turbo-expanding energy equipment.
- 5.5 Elaboration and implementation of domestic wear-resistant additives for oils for internal combustion engines.
- 5.6 Production of compact energy efficient lamps.
- 5.7 Production of fuel ethanol to use it as an engine fuel.
- 5.8 Transition of automobile transport to compressed natural and oil by-product gas.
- 5.9 Utilisation of secondary energy resources.
- 5.10 Application of modern energy management methods and systems.
- 5.11 Creation and production of pre-insulated pipes, enhancement of heat resistance of pipe insulation.
- 5.12 Application of modern methods and technical facilities to diagnose energy equipment.
- 5.13 Production of co-generating equipment for complex production of electric and heat power at autonomous energy complexes.
- 5.14 Production of heat solar collectors and hot water supply systems for individual and industrial use.
- 5.15 Construction and operation of small and mini-HPP.
- 5.16 Utilisation of excessive coke-oven gas to generate electric power and process steam.
- 5.17 Implementation of controlled electric drives in systems of heat and water supply and ventilation.
- 5.18 Jacketing of external walls for warmth-keeping, insulation improvement of roofs, attics, basements; sealing cracks; additional glazing of living space buildings.

Certainly, a choice of presented energy saving measures, including sectoral ones, depends upon particular economic standing of an enterprise and availability of material and financial means at such enterprise.

Results

1. Existing conditions in the Ukrainian industries, due to obsolete, technical worn-out energy and technological equipment, are characterized by a low level of fuel and energy resources use efficiency. This is evidenced by a rise of energy intensity in Gross Domestic Product and by a rise in specific consumption of fuel by the most technological processes.
2. To reach and maintain a stable growth of country's economy, to decrease its dependence upon fuel imports, to achieve the level of advanced countries in the social sphere, and reduce emissions of hazardous substances and greenhouse gases, the conducting the state policy on energy saving and improvement of fuel and energy use efficiency are the major objectives.
3. Implementation of energy saving policy is hindered by a number of barriers and obstacles, which do not allow to use fully the experience of countries with high energy efficiency. In particular, the Law of Ukraine «On Energy Conservation» is not matched with the Laws «On the Taxation System» and «On Taxation of Enterprises' Incomes» with respect to the energy saving stimulation; the state and local funds of energy saving are not filled in; a mechanism to attract foreign investors to participation in elaboration of energy saving project has a low efficiency.
4. Methodical base for analysis and assessment of elaboration and implementation of energy efficient projects is far from perfection. Because of absence of necessary means and sources of reliable financing, modern methods and means of project analysis, including such its types as technical, commercial, financial, ecological, organizational, social and economic ones, are used insufficiently.
5. Economical crisis, imperfection of legislative basis, insufficiency of financial means and a number of other factors reduce probability of implementation of energy efficient project to the full extent.

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4. MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN FORESTRY

4.1 INTRODUCTION

In a series of measures to reduce greenhouse gas emissions and to store these (first of all – carbon dioxide), special place is occupied by such safe and ecologically expedient measure, as expanded reproduction and increase of biomass productivity of long-term green vegetation, where forests are the first.

Forests cover only 15.6% of Ukrainian territory that is Ukraine is a poorly forested and forest-deficient country. Total area of forest stock is 10.8 million ha, from which 9.4 million ha are forest vegetation.

Other forest lands cover 412.1 thousand ha, including:

- forest nurseries, plantations – 21.4 thousand ha;
- sparse forest – 13.7 thousand ha;
- slash fire, dead plantations – 20.1 thousand ha;
- felling area - 68.8 thousand ha;
- glades, barrens – 189.3 thousand ha;
- forest roads, vistas, firebreak openings – 98.8 thousand ha.

Non-forest lands are represented by the following categories:

- arable lands – 39.3 thousand ha;
- hayfields – 66.7 thousand ha;
- pastures – 35.2 thousand ha;
- perennial plantations – 2.7 thousand ha;
- waters – 124.1 thousand ha;
- swamps – 207.6 thousand ha;
- farms and edifices – 38.3 thousand ha;
- roadways – 18.9 thousand ha;
- sands – 26.6 thousand ha;
- other land – 183.2 thousand ha.

State forest inspection of Ukrainian forests as of 01.01.96 has been carried out on the grounds of Order No. 47-p of the Cabinet of Ukraine of 22.01.96 and the Order No. 11 of the Ministry of Forestry of Ukraine of 01.02.96 pursuant to «Instructions on Procedures for Keeping State Cadastre and Primary Forest Accounting», approved by the Order No. 134 of the Ministry of Forestry of Ukraine of 15.11.95.

Forests of Ukraine perform mainly ecological (water-protective, protective, re-creative) functions and are of restricted operation importance. Forests reproduction during the recent decades in Ukraine has been extending. New forests are grown in the volumes, exceeding the ones of their harvest. An increase of forestland takes place mainly owing to forestation of lands which can not be used in agriculture. Coniferous plantations occupy 42% of total area, including pine trees (*Pinus silvestris L.*) – 33%. Hardwood plantations occupy 43%, including oak (*Quercus robur L.*) and beech (*Fagus sylvatica L.*) – 32%.

General stock of Ukrainian forests is evaluated as 1.7 bn. m³. Forests are unevenly spread throughout the territory of the country. The largest forest ranges are concentrated in the North

– in Polissya and Ukrainian Carpathians. Average wood increment in Ukrainian forests is 3.7 m³ for 1 ha. There are only 0.18 ha of forests and 33 m³ of wood for every habitant of the country.

Some 13 million m³ of wood are logged in Ukraine annually, including 45% from main logging, and 70% of these are round timber. Taking into account such acute deficiency of forest resources, waste timber and non-wooden forest products are widely used in Ukraine. In value estimation, these constitute 30% of logged timber.

Current propagation of forests in Ukraine is a result of influence of climatic, geological, soil and, first of all, anthropogenic factors. History of mankind, including its history within the territory of Ukraine, populated since the earliest times, was accompanied with destruction of forests. Historical sources evidence that forest density in Ukraine made 43% then.

Forest management of Ukraine is placed on the state authorities headed by the State Committee on Forestry. Direct forestry activities within the framework of the State Committee on Forestry are effected by 264 specialised forest farms and 5 natural reserves. Primary fields of forest management in Ukraine are:

- increase of forest density of the territory up to its optimal value in all natural zones;
- preservation of biological diversity of forest ecosystems;
- enhancement of forest ecosystem resistibility against adverse factors of the environment: climate changes and growing anthropogenic load, forest fire, blights and hazardous pests;
- rational non-exhausting forest utilisation with the purpose of satisfying, to a certain extent, needs of the domestic market of the country in the timber;
- land and forest melioration and steppe forest growing.

Historically, uneven age structure of forests was formed in our country. As of their age, forest plantations are divided as follows: saplings – 31%, medium-age trees – 45%, under mature trees – 13%, mature ones – 11%. Prevalence of saplings in age structure of Ukrainian forests is a result of large-scale forest reproduction instead of the plantations, felled during the restoration after the World War II. Average age of all forest stands is 51 years. Average age of coniferous trees is 49, hardwoods – 56 and softwoods – 38 years.

Forest density of various natural zones of Ukraine differs considerably and is not optimal one. It means that such forest density does not bring the most favourable influence over climate, soil, surface run-off formation, and forests do not meet the national economy's needs.

Scientific researches had proven that optimal timber density for Ukraine is 20%.

To achieve the level of optimal forest density, the territory of Ukraine under forest cover has to be increased to 11.95 million ha, with timber stock of 2.15 bln m³. To approach the task, we have to create not less than 2.55 million ha of forest plantations at new land plots.

With this, it should be taken into account the fact that while forests of Polissya and Carpathians have operation importance in addition to ecological one, forests of the Forest-Steppe, Steppe and Crimea zones have mainly water-protective, protective, sanitary-hygiene, invigorative and other ecological functions.

In other words, the increment of forest density of Ukrainian territory to an optimal value will allow not only to increase national resources of timber, but to stabilise ecological conditions of the region and to make essential contribution to diminish results of greenhouse effects.

Elaboration and implementation of forest policy of Ukraine is based on consideration of real timber provision of the country and principal changes in its economy, and provides reasonable equilibrium between forest ecosystem protection and continuous, non-exhausting, multipurpose forest utilisation.

In 1996, having sequestered 75,958 kilotons of carbon dioxide from the atmosphere, forests of Ukraine have deposited 20,716 kilotons of carbon. Logging has reduced the stock of carbon, deposited in forest plantations, by 3,225 kilotons or, as reduced, by 11,825 kilotons of carbon dioxide, and forest fires – by 146 kilotons of carbon dioxide.

Due to Chernobyl's NPP accident, 67.1 thousand ha of lands were excluded from agricultural use as of 01.01.96, including 57 thousand ha of land within thirty-kilometres alienation zone [6]. If within 1986-1995 over 3 thousand ha of agricultural lands and territories of farms were forested in a natural way, this process almost was not found in 1996. Further natural reproduction of forests is hindered by a competition on the part of meadow-grassland gramineous coenoses, which were formed during the above period, as well as due to heavy turfing of soils [7]. That is, depositing of carbon within said category of land in 1996 was effected mainly as a result of carbon absorption by «soil-grass» complex.

As a whole, such category of land deposited 134 kilotons of carbon or 491 kilotons of carbon dioxide in 1996.

Summarising the year, we may say that forest plantations of Ukraine had deposited 17,585 kilotons of carbon from the atmosphere or 64,478 kilotons of carbon dioxide. This fact once more convincingly evidences that forest plantations in conditions of Ukraine are among the ecologically (environment-protective and invigorative functions) and economically (long-term and increasing effect of capital investments into forests creations; forests as a source of timber) profitable mitigation measures.

4.2 MEASURES TO INCREASE FORESTLAND AREA TO SEQUESTER CARBON

Priority task of forestry is building-up of forest-raw materials and nature-protective potentials of the forest stock through formation of new forests mainly on land plots, unadaptable for agriculture production, through agroforest meliorative plantations, as well as through increase of productivity and enhancement of protective functions of forests.

With the purpose of diminishing erosion processes impact over any cultivated areas and increasing soils fertility, a large-scale reproduction of forests will be effected on account of involvement of new land into it.

Below the first and foremost measures to reduce greenhouse gas emissions are stated.

4.2.1 Creation of Protective Forest Plantations

Protective forest growing is of great importance for Ukraine as for a poorly-forested, agricultural and industrial country. As a whole, over 14.9 million ha of cultivated area, or 35.2% of their total area, are under impact of water and air erosion. Mostly eroded soils are in Donetsk (70.6%), Lugansk (61.6%) and Odessa (55.8%) regions. Almost 50 percent of productive lands are eroded in Kirovograd, Mykolayiv and Kharkiv regions. Annual increment of eroded lands in the country is 80-90 thousand ha.

To diminish the impact of erosion processes over any cultivated areas and to improve soil fertility, an expanded reproduction of forest and forest shelterbelts is effected on account of involvement of new lands into it. During the recent 30 years, 747.4 thousand ha of anti-erosion plantations were planted on lands which can not be used in agriculture; besides, 440 thousand ha of forest shelterbelts were planted, protecting over 13 million ha of arable lands, some 1.4 million ha of anti-erosion plantations, 150 thousand ha of which were planted along the banks of small rivers and water reservoirs.

At the same time, intensity of erosion processes remains a considerable phenomenon and the problem of land protection with forest melioration method is not resolved to the end yet.

Position of Ukraine with respect to this important matter is unambiguous – acceleration of

works on protective forest growing, creation of complete systems of protective forest plantations.

Draft National Program on Land Protection for 1997 - 2010 foresees creation of 375.2 thousand ha of protective forest plantations on the lands which are not used by agricultural enterprises, with allowance of UAH354.65m from the State Budget (λ).

Table 4-1. Forest protection plantations to be created on steep banks, sands, river and reservoirs' banks, thousand ha

Administrative region (oblast)	Years							
	1997	1998	1999	2000	Total	2001-2005	2006-2010	Total
Crimea Autonomous Republic	0.568	0.568	0.57	0.58	2.286	2.84	3.34	8.466
Vinnitsya	0.586	0.716	0.767	0.867	2.936	4.925	6.335	14.196
Volynska	0.507	0.707	0.758	0.858	2.83	4.58	6.24	13.65
Dnipropetrovsk	1.215	1.165	1.118	1.018	4.516	8.36	10.34	23.216
Donetsk	1.137	0.637	0.438	0.438	2.65	8.69	10.69	22.03
Zhytomyr	0.898	0.498	0.35	0.10	1.846	6.10	6.60	14.546
Zakarpatska	0.053	0.053	0.064	0.034	0.204	0.27	0.50	0.974
Zaporizhzhya	1.838	1.578	1.589	1.289	6.294	9.695	10.195	26.184
Ivano-Frankivsk	0.068	0.068	0.068	0.068	0.272	1.84	1.88	3.992
Kyiv	0.62	0.80	0.621	0.721	2.762	2.545	2.465	7.772
Kirovograd	1.064	0.874	0.245	0.145	2.328	5.725	7.425	15.478
Lugansk	1.12	1.22	1.221	1.221	4.782	7.505	10.505	22.792
Lviv	0.282	0.312	0.334	0.334	1.262	3.21	2.68	7.152
Mykolayiv	1.717	1.757	1.817	1.917	7.208	8.585	41.49	57.283
Odesa	2.15	1.75	1.455	1.555	6.91	15.795	24.615	47.32
Poltava	0.31	0.26	0.211	0.161	0.942	2.705	2.805	6.452
Rivne	0.663	0.113	0.064	0.064	0.904	8.38	7.52	16.804
Sumy	0.22	0.12	0.125	0.075	0.54	1.335	1.375	3.25
Ternopil	0.277	0.277	0.277	0.327	1.158	4.138	5.818	11.114
Kharkiv	0.25	0.19	0.151	0.051	0.642	4.135	5.155	9.932
Kherson	0.917	0.917	0.917	0.897	3.648	3.135	3.36	10.143
Khmelnysk	0.487	0.387	0.42	0.38	1.674	2.73	2.65	7.054
Cherkasy	0.468	0.518	0.519	0.519	2.024	3.285	6.675	11.984
Chernivtsi	0.095	0.095	0.106	0.126	0.422	0.797	1.127	2.346
Chernigiv	0.645	0.645	0.667	0.667	2.624	3.615	4.795	11.034
Total in Ukraine	18.155	16.225	14.872	14.412	63.664	124.92	186.58	375.65
Funding, UAH mln	16.19	14.26	12.89	12.43	55.77	118.44	180.44	354.65

Implementation of the above outlined scopes will allow to diminish wind and water erosion considerably, to decrease washouts of fertile humus horizon into water reservoirs and the silting of the latter.

Draft of the Program foresees to exclude from agricultural operation and to preserve land with the area of some 2.4 million ha. Preservation of lands will be made with consideration of soil conditions and structures of the lands (heavy washed out and partially medium-washed soils; soils contaminated with radionuclides).

The land, subject to conservation will undergo:

- grassland formation within the area of 1.8 million ha;
- forestation within the area of some 0.6 ha.

Before 2010, it is planned to create:

- protective forest plantations on eroded agricultural lands – 538.3 million ha with use of UAH333.77mln (Table 3-2);

- forest plantations on agricultural lands, contaminated with radionuclides – 35.6 thousand ha (3).

Table 4-2. Forest protection plantations to be created on eroded lands, thousand ha

Administrative region (oblast)	Years							
	1997	1998	1999	2000	Total	2001-2005	2006-2010	Total
1	2	3	4	5	6	7	8	9
Crimea Autonomous Republic	0.01	0.02	0.03	0.04	0.10	0.80	0.90	1.80
Vinnitsya	0.05	0.05	0.1	0.1	0.3	1.8	1.9	4.0
Volynska	-	-	-	0.1	0.1	2.0	19.2	21.3
Dnipropetrovsk	0.1	0.2	0.3	0.4	1.0	10.4	75.0	86.4
Donetsk	0.2	0.8	1.0	1.0	3.0	3.0	8.8	14.8
Zhytomyr	-	-	-	-	-	2.8	53.0	55.8
Zakarpatska	-	-	-	0.03	0.03	0.17	-	0.20
Zaporizhzhya	0.2	0.5	0.5	0.8	2.0	1.8	3.8	7.6
Ivano-Frankivsk	0.02	0.02	0.03	0.03	0.1	1.8	2.0	3.9
Kyiv	-	-	-	-	-	2.1	22.0	23.1
Kirovograd	1.3	1.7	2.5	3.6	9.1	5.2	10.1	24.4
Lugansk	0.2	0.2	0.2	0.2	0.8	1.6	2.3	4.7
Lviv	-	-	-	-	-	-	-	-
Mykolayiv	0.2	0.2	0.2	0.2	0.8	7.0	7.2	15.0
Odesa	0.2	0.6	1.0	1.0	2.8	6.5	10.0	19.3
Poltava	0.1	0.2	0.3	0.4	1.0	6.0	92.1	99.1
Rivne	-	0.6	0.7	1.1	2.4	7.4	41.7	51.5
Sumy	0.2	0.3	0.3	0.4	1.2	1.0	1.1	3.3
Ternopil	-	-	-	-	-	-	-	-
Kharkiv	0.3	0.4	0.5	0.8	2.0	5.0	23.3	30.3
Kherson	0.01	0.01	0.02	0.04	0.08	3.48	3.88	7.44
Khmelnysk	-	0.15	0.17	0.26	0.58	1.0	1.42	3.0
Cherkasy	0.12	0.14	0.14	0.14	0.54	6.0	26.0	32.54
Chernivtsi	0.01	0.02	0.02	0.01	0.06	0.15	0.1	0.31
Chernigiv	0.1	0.14	0.13	0.13	0.5	11.8	16.2	28.5
Total in Ukraine	3.32	6.25	8.14	10.78	28.49	87.80	422.0	538.29
Funding, UAH mln	2.06	3.87	5.05	6.68	17.66	54.44	261.64	333.74

4.2.2 Creation of Forest Shelterbelts

Experience in a protective forest-growing decisively evidences economic the profitability and efficiency of forest meliorative plantations in the struggle against water and wind erosion of the soil. One hectare of forest shelterbelt, in conditions of Ukraine, protects 25-30 ha of arable lands, while productivity of land is increased for up to 15% as compared with shelterless fields. Forest belts and protective plantations are ecological niches for fauna and serves as biological passages for animal migration. A system of forest plantations forms a forest-agrarian landscape, which is an unique factor for optimisation of hydroclimatic constituents, where not only the microclimate of inter-belt components, but the climate conditions of the whole region are changed.

It is worthy to note, that unlike other kinds of forest plantations, forest shelterbelts are mostly formed on the lands, suitable for cultivation. Increase of the yield, which will CE harvested from the protected fields, and effects of arable land protection against wind and water erosion, are sufficient reasons to use arable lands for plantation of forest shelterbelts.

Draft of the National Program on Land Protection foresees creation of forest shelterbelts on the area of 174.3 thousand hectares before 2010, provided that UAH107.87 mln will be assigned from the State Budget (₴).

Table 4-3. Forest shelterbelts creation, thousand ha

Administrative region (oblast)	Years							
	1997	1998	1999	2000	Total	2001-2005	2006-2010	Total
1	2	3	4	5	6	7	8	9
Crimea Autonomous Republic	0.35	0.35	0.365	0.365	1.43	2.135	2.135	5.7
Vynnytsya	0.15	0.25	0.3	0.4	1.1	3.6	5.0	9.7
Volynska	0.03	0.03	0.04	0.05	0.15	0.58	0.8	1.53
Dnipropetrovsk	0.15	0.15	0.15	0.18	0.63	7.5	9.75	17.88
Donetsk	0.1	0.1	0.1	0.1	0.4	4.5	5.55	10.45
Zhytomyr	-	-	-	-	-	0.2	0.5	0.7
Zakarpatska	-	-	-	-	-	-	0.23	0.23
Zaporizhzhya	0.5	0.5	0.5	0.5	2.0	5.0	9.6	16.6
Ivano-Frankivsk	0.02	0.02	0.02	0.02	0.08	0.2	0.4	0.68
Kyiv	0.015	0.015	0.015	0.015	0.06	1.2	1.5	2.76
Kirovograd	0.10	0.10	0.10	0.10	0.4	1.5	2.9	4.8
Lugansk	0.2	0.2	0.2	0.2	0.8	2.0	2.6	5.4
Lviv	-	-	-	-	-	0.14	0.14	0.28
Mykolayiv	0.2	0.2	0.2	0.2	0.8	10.0	10.0	20.8
Odesa	0.19	0.19	0.19	0.195	0.765	10.0	12.0	22.765
Poltava	0.03	0.03	0.03	0.03	0.12	4.0	4.9	9.02
Rivne	-	-	-	-	-	0.7	1.0	1.7
Sumy	0.08	0.08	0.08	0.08	0.32	0.94	1.0	2.26
Ternopil	-	-	-	-	-	0.2	0.3	0.5
Kharkiv	0.3	0.3	0.3	0.3	1.2	5.0	6.66	12.86
Kherson	0.45	0.45	0.475	0.52	1.895	9.02	9.5	20.415
Khmelnysk	0.04	0.04	0.04	0.04	0.16	0.32	0.38	0.86
Cherkasy	0.08	0.08	0.08	0.088	0.328	2.0	3.64	5.968
Chernivtsi	-	-	-	-	-	0.02	-	0.02
Chernigiv	0.015	0.015	0.015	0.017	0.062	0.145	0.215	0.422
Total in Ukraine	3.0	3.1	3.2	3.4	12.7	70.9	90.7	174.3
Funding, UAH mln	1.86	1.92	1.92	2.11	7.87	44.00	56.00	107.87

4.2.3 Afforestation of Lands, Contaminated as a Result of Chornobyl' NPP Accident

Forests of Polissya, where Chornobyl' accident happened, constitute 40% of all forests in Ukraine. Almost 300 thousand hectares of forests were excluded from their use, while the latter was restricted for the remainder of Polissya forests to a certain extent. Forest, as one among the most radiosensitive natural objects, had undergone and is suffering now from adverse impact of radioactive contamination [13].

The territory which happen to CE the epicentre of the accident, by territory's natural-climatic properties, may CE referred to the zone of mixed forests of Ukrainian Polissya; the zone has 750 km extension from the East to West and 150-180 km extension from the North to South. Characteristic features of natural conditions of the region, where Chornobyl' accident has its impact, are low surface relief with vast slumpy river valleys, high horizon of subsoil water, positive moisture balance, and sod-podzol and slumpy soils.

Forests are represented mainly with high and medium productive pine plantations, which are plentiful of food, medicinal and fodder resources, as well as of forest fauna. Utilisation of

these natural resources is forbidden strictly for over eleven years already, since the most part of Ukrainian Polissya is contaminated with radionuclides (RN).

The accident had inflicted tremendous losses to the forestry. We need some new, unknown to world practice, technologies of forest growing and forest utilisation, some large-scale measures to protect those, who work in the forests, against radiation, and a quantity of other technologies and scientific development [14].

Within framework of this Program, it is supposed to effect forestation of lands, unsuitable for agricultural production due to heavy contamination of these with radionuclides. Area of radio-contaminated land only outside the abandonment zone (so called «30-km zone») is 35.6 thousand hectares; distribution of such lands by regions is shown in Column 5 (**Error! Number cannot be represented in specified format.**).

Forestry specialists tried to resolve the problem of the contaminated lands forestation as long ago as the first years after the accident, when radiation survey of the territories, located within approximately 100-130 km radius from the blasted reactor (a part of Zhytomyr, Chernigiv and Kyiv regions), had been carried out. It has been found out then that further utilisation of these lands by their previous intention was impossible. The necessity of forestation of such lands is dictated by weighty factors.

Table 4-4. Agricultural lands contaminated with Caesium-137, thousand ha

Administrative Region (oblast)	Contamination level, Ci/km ²					Abandonment zone
	0.1-1	1-5	5-15	more	Total	
1	2	3	4	5	6	7
Vinnitsya	850.0	85.7	0.4	-	936.1	
Volynska	228.4	15.4	0.2	-	244.0	
Zhytomyr	1116.8	270.3	62.0	20.2	1469.3	0.7
Ivano-Frankivsk	71.3	19.1	1.0	-	91.4	
Kyiv	1272.4	213.3	28.2	14.9	1528.8	54.2
Rivne	172.1	145.7	11.5	-	329.3	
Sumy	301.3	12.2	0.3	-	313.8	
Ternopil	219.3	12.5	-	-	231.8	
Cherkasy	1172.8	146.6	6.5	-	1325.9	
Chernivtsi	74.5	22.7	0.3	-	97.5	
Chernigiv	1759.2	68.6	5.4	0.5	1833.7	
Total in Ukraine	7238.1	1012.1	115.8	35.6	8401.6	54.9

First of all, the lands are overgrown with ill weeds and are the source of secondary radioactive contamination of the environment when fire happens, and are a source of additional radiation for the people who live nearby. Just creation of forests here will have favourable influence over the stabilisation of radioactive conditions of the territories, located nearby the blasted reactor. Of course, future forestland will accumulate a considerable amount of radionuclides. It may be seen from scientific investigations of Ukrainian Scientific-Research Institute on Forestry and Agroforest Melioration (UkrSRIFAM). Further migration of Caesium-137 radionuclides will be within the zone of maximal placement of sucking roots (roots up to 2 mm in diameter) of primary forest-forming trees. But, at the same time, taking into account the growing period of mature forest in Polissya zone (primary forest-forming tree is pine with maturity period of 80-100 year), it is assumed that a certain part of radioactive substance will decay and the timber will be fit for utilisation.

However, a number of complicate problems exist to be resolved before this important ecological and social step is made. One of the most complicated problems is the absence of scientifically grounded technology of forest growing under radio-contamination conditions. Nevertheless, forestation of these areas was launched in 1989 by enterprises of the State

Committee on Forestry of Ukraine. They used then common technologies of forest growing and common mechanisms for forest planting. But such machinery was not designed to provide protection of its operators against radiation; therefore it is not suitable for said large-scale works on forest planting now.

Science still did not find schemes of arboreal and shrubby species that would be suitable for creation of forest plantations on radio-contaminated lands. Any plantations, formed on radio-contaminated land, have to be resistant in biological respect, that is, these have to be unexacting to chopping, tree surgery and be resistant against pests, blights, forest fire. Soil preparation for future forest plantations has to be made in accordance with a special technology, which would allow to minimise amount of care after young plantations (weeding, hoeing).

With such density of Cesium-137 radio-contamination – over 15 Cu/km² – within land plots, excluded from agricultural rotation, death of forest trees is impossible [15]. Quite other matter is with the people who will be employed in forest growing. They have to be protected against over-radiation. With this purpose in mind, it is necessary to carry out detailed cartographic radio-survey, to create a map of radiation conditions of the land plots to be forested.

To forest 35.6 thousand ha of land, contaminated with radionuclides in excess of 15 Cu/km², it is planned to assign UAH46.26m from the state budget (**Error! Number cannot be represented in specified format.**).

Table 4-5. Afforestation of the agricultural lands contaminated with radionuclides, thousand ha

Adminisatrative region	Years							
	1997	1998	1999	2000	Total	2001-2005	2006-2010	Years
1	2	3	4	5	6	7	8	9
Zhytomir	0.2	0.6	0.8	1.4	3.0	7.2	10.0	20.2
Kyiv	0.4	0.4	0.6	0.6	2.0	5.9	7.0	14.9
Chernigiv	0.1	0.1	0.1	0.1	0.4	0.1	-	0.5
Total in Ukraine	0.7	1.1	1.5	2.1	5.4	13.2	17.0	35.6
Funding, mln UAH	0.91	1.43	1.95	2.73	7.02	17.16	22.10	46.28
Abandonment zone	0.05	0.05	0.2	0.4	0.7	5.0	7.0	12.7
Funding, mln UAH	0.07	0.07	0.26	0.52	0.92	6.5	9.1	16.52
Total in Ukraine	0.75	0.15	1.7	2.5	6.1	18.2	24.0	48.3
Total funding, mln UAH	0.98	1.50	2.21	3.25	7.94	23.66	31.20	62.80

From 54.9 thousand ha of agricultural lands, located within the alienation zone and excluded from agricultural cultivation now, it is planned to form forest plantation on 12.7 thousand ha before 2010, using UAH16.52 mln from the state budget.

First of all, planting has to be made on the lands with the lowest contamination density.

Prior to completion of scientific-research works on creation of a new technology of forest growing (2-3 years), land areas of 1,000 - 1,100 ha may be planted annually. It is the most expedient to propose implementation of measures, foreseen for forestation, to forestry enterprises, located nearby such contaminated areas: to Dymer, Ivankiv, Polissya state forestry enterprises of Kyiv region, to Lugyny, Korosten', Ovruch state forestry enterprises and Ovruch-Narodychi special forestry state enterprise of Zhytomyr region, to Chernigiv state forestry enterprise of Chernigiv region.

Young seedlings for such activities may be purchased from Stary Petrivtsi Forest-Planting Research Station. Price of these is somewhat higher that that of common seedling, since they grow their seedling of common pine with improved genetic features. 6 thousand of seedlings are needed to forest 1 hectare.

Land plots, needing forestation because of radio-contamination, are much more in area, but not all of these are excluded from agricultural usage as yet.

4.2.4 Productivity Increase of Forest Plantations' Biomass

Productivity increase of forest plantations' biomass means an increase of stock of timber in tree-trunks, branches, roots, leaves and needles, as well as growing wood species, brushes and forest floor. Bearing in mind a long-term increase of carbon dioxide storage, we shall outline in this section certain measures intended to stimulate an increase in their volume of the most long-living part of the forest biomass – the timber.

Forest stand productivity depends upon the kind of forest-forming trees, natural-climatic zone and conditions of growing place, as well as upon taxation indices of the plantation (age, average height, diameter, stoutness). A scientifically grounded forestry system considers the increase of such indices as one among its main goals. It is orientated towards a differentiated approach to each particular kind of plantations. Scientific grounds of forestry are in preservation of trends for placement and restoration of basic forest-forming trees and forest formations, in bringing forest stands productivity in correspondence with capacities of forest-vegetation conditions, in creation of optimal age structure and overall structure of a plantation in dependence upon its intention [9].

Depending on what is preferred: amount of carbon sequestered or duration of its storage in phytomass, as structure of plantations under formation, so growing duty of these have to be determined. Forest trees, distinguished with high initial increment of forest stands (softwood), are distinguished with short age as a rule.

Carbon-storing plantations, and first of all those which are formed artificially, had to differ from the plantations of raw-material intention in initial density, desirable composition and care technology; being joined, these features would provide not only carbon storage, but resistibility of ecosystems as well [10].

If we want to combine amount of carbon deposition with carbon accumulation, then the most prospective trees for such combination are oak and pine in conditions of Ukraine.

The highest ability to deposit carbon is characteristic of young trees in age before 40.

Medium-age plantations' ability to absorb carbon is decreased 5-6 times, as compared with younger ones. Ability of under-mature and mature forest stands to absorb carbon is still lower [11], but these age groups of plantations accumulate maximally possible scope (for their kind of forest) of biomass. That is, these are the largest (as of scope) sinks of carbon as compared with other age categories of plantations [12].

Development and wide implementation of achievements of forest selection into practice of forestry is one among the most important factors to improve carbon-sequestering abilities of forests. The science, using principles of genetics, artificial selection and hybridisation, allows obtaining forms and varieties of trees with improved carbon-sequestering abilities under maximal indices as of their longevity and resistibility against unfavourable factors, pests and blasts.

In forests of Ukraine, over 26 thousand ha of genetic refugiums of main forest-forming species were separated; these are located in all natural-climatic zones of Ukraine, including:

- pine – 5,886.5 ha (4,332.8 ha in Polissya, 1,382.2 ha in Forest-Steppe, 171.5 ha in Steppe);
- oak – 6,789.1 ha (2,526.3 ha in Polissya, 3,935.8 ha in Forest-Steppe, 269.0 ha in Steppe, 58.0 ha in Carpathians).
- About 3 thousand ha of plus plantations were separated in genetic refugiums, including:

- pine – 763.7 ha (450 ha in Polissya, 313.7 ha in Forest-Steppe);
- oak – 1588.6 ha (from which 330.3 ha in Polissya, 1,24.7 ha in Forest-Steppe, 30.3 ha in Steppe, 3.3 ha in highlands of Carpathians).

Over 4 thousand ha of plus trees of main forest-forming species were separated in forests of Ukraine, including:

- pine – 975 items (636 items in Polissya, 299 items in Forest-Steppe, 29 items in Steppe and 11 items in highlands of Carpathians);
- oak – 1214 items (294 items in Polissya, 459 items in Forest-Steppe, 323 items in Steppe and 138 items in highlands of Carpathians).
- Over 1,350 ha of clone seed plantations of main forest-forming species were formed on the base of mentioned above objects, including:
- pine – some 594 ha (438.1 ha of I order and 43.8 ha of II order in Polissya, 98.5 ha of I order and 12.1 ha of II order in Forest-Steppe, 1.5 ha of I order in Carpathians);
- oak – 492.8 ha (76.9 ha in Polissya, 382.0 ha in Forest-Steppe, 28.6 ha – in Steppe, 5.3 ha in highlands of Carpathians).

24 varieties of forest trees were recorded into the State Registry of Ukraine.

Existing forest-seeding base has potentials to provide forestry enterprise and other enterprises with seed pieces, seeds and planting stock to the annual amount of:

- up to 2 million of seedlings of poplars of good quality;
- up to 2 tons of acorns (in years of plenty), and about 600 thousand of seedlings;
- over 1,250 kg of pine, from which over 80 million of seedlings with improved genetic properties can be grown.

Thus, planting and seeding stock is quite enough for implementation of the mentioned above Programme.

Growth and development of forest plantations can be greatly influenced with improvement of forest soil fertility. Fertilisation is one among the factors, which improve fertility of forest soils.

The most efficient agents among mineral fertilisers in this case are nitrogen and compound ones (the latter include three basic constituents – nitrogen, phosphor and potassium). These fertilisers demonstrate the highest favourable effect when applied in combination with lime. Organic fertilisers, as more deficit ones, are applied only on very poor sandy soils, in mining places, in forest-park farming. Turf, composts, green manuring fertilisers, sawdust and other fertilisers are the most widely used among the organic ones. Such fertilisers are especially efficient in compound with mineral additives.

Maximal response of forest plantations to mineral fertilisers is observed 2-3 years after the application, while period of their effect is 5-7 years.

The most yield (as of timber increment) under fertilisation is given by forest varieties – high-stout sapling and medium-age forest stands, But age of plantations does not diminish favourable influence of fertilisers; use of these is efficient as for under-mature, so for mature plantations.

Improvement of forest soil productivity may be achieved by pure forestry facilities as well. A growing importance in this respect is acquired by biological melioration: introduction of tree-bush vegetation and lupine into the body of a plantation. Enrichment of forest plantation body with soil-improving varieties has to be effected with consideration of climatic factors and level of their conformity with growing conditions of tree and bush vegetation. Forestry measures have to be matched with biological and ecological peculiarities of the plants.

Productivity increment of forest soils can be greatly influenced by leafy varieties. Expedient components of forest plantations on poor in nutritive substances soils are robinia, elder, *Amorpha fruticosa L.*, *Caragana arborescens Lam.*, hazel, birch-tree and others. The fall of their leaves and root system of these varieties in the body of monocultures improve physical-chemical properties of soils, enriching these with nitrogen, potassium, phosphorus and other nutritive substances.

Among grass plants, lupine has a considerable influence over soil productivity growth. As long-term experience of lupine application in forestry shows, such measure has the most effect on poor soils (Ukrainian Polissya).

Increase of forest biomass is possible also through measures aimed at reconstruction of existing plantations, which measures allow to alter in desired direction the natural composition and structure of plantations, bringing these in conformity with growing place conditions.

Primary objects of reconstruction are low-value saplings of natural and artificial origin, drying and heavily affected with pests and blights forest stands, bushes, low-value, low-productive biologically non-resistible plantations.

Among reconstruction methods of low-productive and low-value plantations, in dependence of their forestry parameters, the following ones are mostly used:

- clean cutting of plantations with following creation of high-productive plantations in their stead;
- introduction of basic forest trees into passages (strips) which are cut in low-value saplings;
- creation of forest varieties under the cover of thinned plantations;
- conduct of measures which are conducive to natural reproduction of basic varieties;
- cutting of low-value plantation overstorey under availability of necessary quantity of viable growth of major forest-forming varieties;
- introduction of necessary varieties in low-stout plantations and saplings of natural origin. [16]

Correct choice of reconstruction method and varieties' matching in accordance with forest-plant conditions create a necessary potential for increase of carbon-depositing features of the plantations.

4.2.5 Forest Protection Improvement

During the recent time as in Ukraine, so in the whole Europe, events of mass forests drying are observed. Any existing scientific concepts do not provide comprehensive explanation of modern sanitary conditions of the forests, of reduction of their resistibility against unfavourable conditions. However, it is indisputable that the leading place among these is occupied with adverse impact of industrial production and intense economic activities of man. Such adverse process are characteristic of European region and of Ukraine as well, the latter being characterised with high concentration of industrial production and high population density.

Continuous observations over forest plantations are kept in the system of the State Committee on Forestry of Ukraine with the purpose of gathering information on conditions of forest resources, dynamics of forest stock, affectation of forests with anthropogenic, biotic and abiotic factors. The observation system is based on the principles of ecological monitoring; the latter includes surface observations and remote probing.

Creation of the system of ecological monitoring of Ukrainian forests was started in 1989 within the framework of International Joint Programme on Assessment and Monitoring of Air Pollution Impact over Forests («FORESTS»), initiated by the Executive Authority of Convention on Global Pollution of Atmosphere at United Nations European Economic Commission. Forests in 14 of 25 administrative regions are covered with such monitoring today.

A priority field of the specialised forest-protective agency of the State Committee on Forestry is elaboration and implementation of biological facilities and methods of struggle against pests. Such facilities are non-hazardous for the people and environment and may be applied in heavy populated regions of Ukraine, where application of chemicals to kill pests is prohibited. A biotechnological laboratory is formed in the branch; such laboratory deals with search and production of biological viral preparations to struggle against major pests of the forests. Demand for certain of these preparations is satisfied already today.

Problem of forest protection against fire is one of the most complicated to be resolved by employees of forestry of Ukraine, especially in its eastern and southern regions, where artificial plantations of coniferous varieties have been formed owing to large-scale works on forest-growing during the latest 40 years. High density of population and steep rise of their visiting forestland significantly increase the fire danger in forests.

Finding and quenching forest fires are made by a specialised agency, comprising surface and aviation units. Airborne forest protection is effected by Ukrainian State Base of Aviation Protection of Forests, consisting of 23 aviation units and fire-fighting paratroops groups, acting from helicopters and aircraft.

The problem for forest protection against fires and pests remains acute still. About two thousand of forest fire cases occurred within the area of over 0.5 thousand ha in 1997. Area of pests' and blights' activity made 396 thousand ha. Forest protective jobs are performed in the most acute cases only. Conduct of any large-scale measures is hindered with the lack of budgetary means. Due to the same reason, acquisition of fire-fighting technical facilities and facilities to struggle against forest pests and blights constitutes only 20% of the demand during the recent years.

Annual assignment of UAH24.5 mln in average from the State Budget for guarding and protecting forests against fires, pests and blights will allow to improve significantly the sanitary conditions of the forests, to decrease the number of fire cases, to provide for timely detection and liquidation of these, to avoid transition of forest fires into these in the second growth.

4.3 MECHANISMS AND CONDITIONS TO IMPLEMENT THE MEASURES

4.3.1 Organisational Provisions

Increase of forests productivity, extension of their reproduction and creation of new plantations is a function of state authorities on forestry, which authorities have relevant manpower and where personnel training and qualification improving are arranged.

Specialised state forestry authorities, headed by the State Committee on Forestry, are charged with state management of all forests in the country. Direct forestry activities are performed by 264 specialised forestry enterprises. The task of such forestry enterprise is to provide for improvement of forests productivity, protection and reproduction, enhancement of their beneficial features, satisfaction of society's demand for forest resources on the grounds of their scientifically substantiated rational utilisation. Elaboration and implementation of own forest policy is based on consideration of real forest wealth of the country and principal changes which take place in the economy, and provides reasonable equilibrium between

forest ecosystems' protection and continuous, non-exhausting, multipurpose utilisation of these.

At the same time, methods of forest management and forestry keeping are changed in accordance with development of the society. Once the principle of continuous and non-exhausting utilisation is established, the stage of intense forest utilisation commences, the latter being orientated towards maximally quick reproduction of felled forest stock.

It is necessary to improve organisational structure of the authorities, effectuating state supervision over guard, protection, utilisation and reproduction of the forests, to guarantee legal provisions for these. In particular, it is necessary to form regional authorities of forest management and relevant entities at places.

It is necessary to restore service of inter-district agroforest meliorators in the system of Ministry of Agriculture and to form relevant service in other ministries and authorities, enterprises of which have forestland in permanent use and are dealing with forest growing.

4.3.2 Financial Provisions

Formation of forest shelterbelts, creation and upkeep of natural-reservation fund facilities is planned to be made on account of the State Budget in accordance with its «Environment Protection» section.

Scopes of financing, needed to implement the planned measures, and possible sources of such financing are given in **Error! Number cannot be represented in specified format.**

Data of **Error! Number cannot be represented in specified format.** were calculated on the basis of factual costs (in 1996 prices), which were formed in the forestry of Ukraine under existing progressive technologies and prime costs of forest management and forest cultivation works. The same cost indices were used for elaboration of the National Programme on Land Protection for 1997-2010.

The following cost levels were taken as the reference:

- to create 1 hectare of protective forest plantations (with consideration of planting and measures, required by technology measures to care after the plantations under creation until these reach the age when crowns close their ranks) – UAH1,000;
- to create 1 hectare of forest shelterbelts (with consideration of their planting and necessary measures to care after them) – UAH620;
- to create 1 hectare of forest plantations on radio-contaminated agricultural land plots (with consideration of their planting and necessary measures to care after them) – UAH1,300.

Creation of protective forest plantations and forest shelterbelts on agricultural lands is planned as on account of the State Budget means, so on account of local budgets' means, means of land owners and land users in the proportion, prescribed by the Draft National Programme on Land Protection for 1997 - 2010.

Creation of forest plantations on lands of the State Forest Fund and on radio-contaminated agricultural lands is planned (as it is prescribed by legislation in force and the Draft National Programme on Minimisation of Chornobyl' Accident Consequences) on account of relevant items of the State Budget of Ukraine.

Scopes of forest plantations to be created in the State Forest Fund are in correspondence with forest restoration scopes after clean forest harvesting (or after main utilisation, reconstruction, sanitary and the other cutting). Quantitative indices of these are established by scientifically substantiated cutting area, which has to be approved by the State Committee on Forestry and Ministry of Ecological Safety of Ukraine.

Scope of costs to implement measures on guard and protection of forests against fires, pests and blights are taken from average yearly levels of relevant expenses of forestry enterprises of the State Committee on Forestry of Ukraine and are to be effected on account of the State Budget of Ukraine.

Taking into account economic conditions of the country, implementation of the above targets needs a work in the field of additional involvement of local budgets' means, means of land owners and land users, as well as involvement of international financial support through governmental structures.

If 1,136.05 thousand ha of new forest plantations are created by 2010, the forest density level of Ukraine will approach to 17.5%.

Table 4-6. Volumes and costs of climate mitigation measures in the forestry of Ukraine

Developer, Source of funding	Units	Years							
		1997	1998	1999	2000	Total	2001- 2005	2006-2010	Total
1	2	3	4	5	6	7	8	9	10
1. Afforestation of agricultural lands									
1.1. Forest protection plantations to be created on steep banks, sands, river and reservoirs' banks, thousand ha									
The State Committee on Forestry of Ukraine	thousands ha	12.98	11.05	9.66	9.20	42.89	106.0	168.8	317.69
	mIn UAH	12.98	11.05	9.66	9.20	42.89	106.0	169.0	317.89
including:									
State Budget	mIn UAH	12.98	11.05	9.66	9.20	42.89	-	-	42.89
Local Budget	mIn UAH	-	-	-	-	-	106.0	169.0	275.0
Ministry of Transport of Ukraine (land owners' money)	thousands ha	4.67	4.68	4.71	4.71	18.77	15.60	15.63	50.00
	mIn UAH	2.90	2.90	2.92	2.92	11.64	9.67	9.69	31.00
Ministry of Defence of Ukraine (land owners' money)	thousands ha	0.5	0.5	0.5	0.5	2.0	3.32	2.15	7.47
	mIn UAH	0.31	0.31	0.31	0.31	1.24	2.77	1.75	5.76
Total	thousands ha	18.15	16.23	14.87	14.41	63.66	124.92	186.58	375.16
	mIn UAH	16.19	14.26	12.89	12.43	55.77	118.44	180.44	354.65
1.2. Forest protection plantations to be created on eroded agricultural lands, thousand ha									
The State Committee on Forestry of Ukraine	thousands ha	3.32	6.25	8.14	10.78	28.49	87.80	442.0	538.29
	mIn UAH	2.06	3.87	5.05	6.68	17.66	54.44	261.64	333.74
including:									
State Budget	mIn UAH	2.06	3.87	5.05	6.68	17.66	54.44	169.46	241.56
Local Budget	mIn UAH	-	-	-	-	-	-	92.18	92.18
1.3. Forest shelterbelts creation, thousand ha									
The State Committee on Forestry of Ukraine	thousands ha	3.0	3.1	3.2	3.4	12.7	70.9	90.7	174.3
	mIn UAH	1.86	1.92	1.98	2.11	7.87	44.00	56.0	107.87
including:									
State Budget	mIn UAH	1.86	1.92	1.98	2.11	7.87	32.38	41.0	81.25
Local Budget	mIn UAH	-	-	-	-	-	11.62	15.0	26.62

1	2	3	4	5	6	7	8	9	10
<i>1.4. Afforestation of agricultural lands contaminated with radionuclides, thousands ha</i>									
The State Committee on Forestry of Ukraine	thousands ha	0.7	1.1	1.5	2.1	5.4	13.2	17.0	35.6
	mIn UAH	0.91	1.43	1.95	2.73	7.02	17.16	22.10	46.28
Timber processing enterprise «Chornobyl» (state budget)	thousands ha	0.05	0.05	0.2	0.4	0.7	5.0	7.0	12.7
	mIn UAH	0.07	0.07	0.26	0.52	0.92	6.5	9.1	16.52
Total	thousands ha	0.75	1.15	1.7	2.5	6.1	18.2	24.0	48.3
	mIn UAH	0.98	1.50	2.21	3.25	7.94	23.66	31.20	62.80
Sum (Section1)	thousands ha	25.22	26.73	27.91	31.09	110.95	301.82	723.28	1136.05
	mIn UAH	21.09	21.55	22.13	24.47	89.24	240.54	529.28	859.06
<i>2. Creation of forests on the lands of the State Forestry Fund</i>									
The State Committee on Forestry of Ukraine	thousands ha	28.5	28.5	28.5	28.5	114.0	142.5	142.5	399.0
	mIn UAH	17.7	17.7	17.7	17.7	70.8	88.4	88.4	247.6
Timber processing enterprise «Chornobyl» (state budget)	thousands ha	0.55	0.55	0.55	0.55	2.2	2.75	2.75	7.7
		0.71	0.71	0.71	0.71	2.84	3.57	3.57	9.98
Total	thousands ha	29.05	29.05	29.05	29.05	116.2	145.25	145.25	406.7
	mIn UAH	18.41	18.41	18.41	18.41	73.64	91.97	91.97	257.58
<i>Total</i>									
The State Committee on Forestry of Ukraine	mIn UAH	16.2	16.2	16.2	16.2	64.8	81.0	81.0	226.8
Timber processing enterprise «Chornobyl» (state budget)	mIn UAH	0.4	0.4	0.4	0.4	1.6	2.0	2.0	5.6
Other Ministries and Departments (land owners' money)	mIn UAH	7.9	7.9	7.9	7.9	31.6	39.5	39.5	110.6
TOTAL		24.5	24.5	24.5	24.5	98.0	122.5	122.5	343.0
Sum (sections 1,2,3)	mIn UAH	64.0	64.46	65.04	67.38	260.88	455.01	743.75	1459.64
including:									
State Budget	mIn UAH	52.89	53.35	53.91	56.25	216.40	285.45	416.63	918.48
Local Budget	mIn UAH	-	-	-	-	-	117.62	276.18	393.80
Money of land owners and users	mIn UAH	11.11	11.11	11.13	11.13	44.48	51.94	50.94	147.36

4.3.3 Legislative Provisions

Forest Code of Ukraine has been passed by the Parliament in 1994. The Code established legislative norms pursuant to which all forests are now in state ownership. It is explained, first of all, by long periods of forest growing, by prevalence of ecological importance of the forests over their significance as raw materials, by the necessity of preservation and planned replenishing of forest wealth to benefits of not only today's, but future generations as well, and by insufficient today's legal and ecological culture of forest utilization, which was formed during the recent years on the principles of consumptive approach as to the forest, so to the nature as the whole.

Forest Code of Ukraine meets the set tasks on provision of forest relationship regulation in contemporary socio-economic conditions and is aimed at preservation, improvement of quantitative composition and rational utilization of forests in the name of all-nation interests.

Forestry management of the country is based on the State Programme on Development of Forest-Farming and Forest-Industrial Complexes of Ukraine for the period up to 2015, which Programme is approved and brought to the State Committee on Forestry of Ukraine for execution by the Resolution No. 14959/10 of the Cabinet of Ukraine of 02.08.93. The Programme foresees extended reproduction, protection and rational utilisation of the forests.

Measures to resolve principal problems of forestry of Ukraine were elaborated by the State Committee and were included as separate sections into «State Programme on Liquidation of Chernobyl' Accident Consequences», «National Programme on Agroindustrial Production Development and Countryside Rebirth for 1997-2010», «National Programme on Preservation of Biological Diversity of Ukraine up to 2015», «National Programme on Land Protection for 1996-2005», «State Programme on Utilisation of Production and Consumption Wastes». Sections, pertaining to the forestry, were included into the State Programmes on socio-economic developments of Carpathians, Prydniprovyia, Polissya, Podillya, Ukrainian Prychornomorya (the Black Sea-side) regions, as well as into «Programme on Protection and Rational Use of Dnieper Water Resources» (Table 4-7).

To provide for implementation of measures on extension of the protective forest-growing in Ukraine, it is necessary:

1. To adopt National Programme on Land Protection to its full extent;
2. To adopt Land Code of Ukraine;
3. To pass Governmental resolution on large-scale reproduction of forest resources (with alienation of low-productive and non-productive lands for forestation over the area above 1 million ha);
4. To establish State Order for creation of systems of protective forest plantations and forest shelterbelts within the lands of agricultural enterprises;
5. To transfer lands to be forested to the nature protection fund, which is in exclusive ownership of the state;
6. To increase budgetary financing of the jobs on creation of forest plantations and enhancement of material-technical base of the enterprises intended to perform these;
7. To create agroforest melioration service at agricultural enterprises.

Table 4-7. List of the national and state programs, dealing with forestry activity

<i>Program</i>	<i>A customer on a state scale</i>	<i>Current condition</i>
<i>1</i>	<i>3</i>	<i>4</i>
The Program on the Development of Forestry and the Forest Industry in Ukraine for the Period up to 2015	The State Committee on Forestry of Ukraine, Ministry of Agriculture	Approved by the resolution of the Cabinet of Ministers of Ukraine on 02.08.93.
National Programme on Minimisation of Chornobyl' Accident Consequences	Ministry of Emergency Affairs	Developed, approved, under approval at the Berkhovna Rada of
The National Program on the Development of Agricultural production in Ukraine for 1996-2005	Ministry of Agriculture of Ukraine	Developed
The National Program on Land Protection for 1996-2005	State Committee on Land-use of Ukraine	Developed, approved
The National Program on Preservation of Biological Diversity of Ukraine up to 2015	Ministry for Environmental Protection and Nuclear Safety	Under development

4.3.4 Scientific Provisions

The most part of forestry methods, traditional for Ukraine, are to be improved in accordance with the principles of eco-system management. To achieve this, it is necessary to carry on preliminary a considerable scope of scientific -research work with the purpose of gathering additional information, analysing situation, assessing the fecundity of existing and new methods of planning and economy in various regions of Ukraine.

It is necessary to expand fundamental and applied researches in the field of biomass productivity increase and enhancement of carbon-depositing ability of forest ecosystems, carried on the base of Ukrainian Scientific-Research Institute on Forestry and Agroforest Melioration, named by G.M. Vysots'ky (UkrSRIFAM), Ukrainian Scientific-Research Institute on Highland Forestry (UkrSRIhifor) and in the network of their experimental stations.

UkrSRIFAM is a leading scientific centre on forestry science and scientific school in Ukraine.

UkrSRIhifor is established as a chief authority of the country on elaboration of scientific-technical matters of forestry in highland conditions.

Scientific-research network of said Institutes covers all forest growing zones of Ukraine and includes certain unique facilities of forest science; first of such facilities were created for over 150 years ago. UkrSRIFAM was officially recognised in former USSR as a leading scientific organisation on matters of steppe forestry and agroforest melioration.

Network of scientific-research institutions of the State Committee on Forestry consists of two scientific-research institutes UkrSRIFAM, UkrSRIhifor, Steppe affiliate of UkrSRIFAM, 9 forest scientific-experimental stations (Lugans'k, Vinnytsya, Krasnotrostanets', Crimea, Mariupol', Prydesnyans'ka, Polissya, Stary Petrivtsy, Carpathians), experimental parkland «Veseli Bokoven'ky» and Danyliv experimental state forest farm.

Forest studies, especially those directly related to forest growing and selection, are of a long-term nature. Financing of forest studies, because of their importance for our forest-deficient country and specificity of the studies, are always made on account of the State Budget.

Forest-growing scientists of Ukraine have unique scientific and productive experience in steppe forest-growing, agroforest melioration, creation of forest plantations on shifting sand.

For the purpose of scientific provision of implementation of the Project, it is expedient to place an order for elaboration of the strategy to resolve a number of problems, needing scientific resolution, at specialised scientific-research institutions – UkrSRIFAM and UkrSRIhifor.

Among these problems, the following have to be especially stressed:

1. Elaboration of a concept on forestry keeping in Ukraine in accordance with drainage basins.
2. Elaboration of new principles of forest-growing which would provide exhaustless, stable and balanced multipurpose forest utilisation under modern conditions.
3. Elaboration of new instructions on forest management (in co-operation with «Ukrderzhlisproekt»).
4. Elaboration of scientific-practical grounds for creation of protective forest plantations' system, as basic constituents of ecological corridors in poor-forested regions of Ukraine, based on territorial principles.
5. Analysis, improvement of existing and elaboration of new technologies of forestry keeping, which are maximally conducive to the increase of forest ecosystems productivity.
6. Assessment of forests' resistibility on the level of a region, natural-economic region, country by the change trends of varietal composition of the forests.
7. Elaboration of a modality for diagnosing and complex zoning of damages to Ukrainian forests, caused by technogenic pollution, which modality will be the base for forestry keeping.
8. Elaboration of scientific and organisational grounds for ecological monitoring of Ukrainian forests.
9. Analysis of mass drying of Ukrainian forests, substantiation of the measures to improve their resistibility.
10. Elaboration of a system for forest-pathology examination and elaboration of technologies for application of new, ecology-friendly preparations to protect forests against pests and blights.
11. Elaboration of first and foremost measures on prevention of forest fires in pine plantations.
12. Elaboration of new principles of forest selection and seedage to enhance carbon-depositing capacity of forest ecosystems on the base of population methods.
13. Long-term forecasting of the role of Ukrainian forests in the global process of atmospheric carbon content regulation and in climate changes.

4.4 CONCLUSIONS

- I. Forests of Ukraine are one of the major accumulators of atmospheric carbon dioxide; thus, they have absorbed from the atmosphere and deposited in timber biomass 64.5 thousand kilotons of CO₂ in 1996.
- II. It is necessary to create a scientifically grounded system of national forestry, which would fully meet the goals of increase of carbon-depositing potentials of Ukrainian forests, which system would be oriented towards:
 - A. increase of forests productivity;
 - B. increase of woodiness level of the country's territory up to an optimum;
 - C. enhancement of forest plantations resistibility against adverse factors of the environment;
 - D. preservation and restoration of biological diversity of forest ecosystems as one of the principal constituents of their ability to self-regulation;
 - E. provision of efficient protection against fires, pests and blights.
- III. Further development of forest shelterbelts' growing and of agroforest melioration, which, apart from its primary tasks, is a weighty factor to increase long-term deposition of atmospheric carbon dioxide by timber vegetation.

- IV. As a result of creation of protective forest plantations on non-usable agricultural lands, on eroded and radio-contaminated lands, an increase in productivity and ecological stability of agrolandscapes will take place, ecological-economic efficiency of arable farming, stability of land utilisation and living conditions of the population will be improved.
- V. Implementation of proposed measures in the forestry sector of Ukraine will allow:
- a) to create additionally:
 - A. 375 thousand ha of protective forest plantations along gullies, washes, on sands, along banks of rivers and water reservoirs;
 - B. 538 thousand ha of protective forest plantations on eroded lands;
 - C. 174 thousand ha of forest shelterbelts;
 - D. 48.3 thousand ha of forest plantations on unusable in agriculture, radio-contaminated lands;
 - b) to increase overall productivity of timber biomass of forest plantations;
 - â) to improve protection of forests against fires, pests and blights.
- VI. Financing of planned measures is conciliated with existing ones and is orientated towards the elaborated projects of national and state programmes in agrarian and nature-protection fields. Such financing also takes into account the means, prescribed by relevant items of the State Budget of Ukraine for forestry, nature protection measure, scientific developments and for implementation of programmes, passed on the governmental level.
- Total value of planned measures for 14-year period (1997-2010) is (in 1996 prices) UAH1.46bn. From these:
- A. 63% are on account of the State Budget;
 - B. 27% - on account of local budgets;
 - C. 10% - means of land owners and users.

Implementation of assumed measures will allow to increase woodiness of Ukraine from 15.6% to 17.5%, that is for 1,136.5 thousand ha of new forest plantations, which, apart from the recommended measures on increase of biological productivity of existing plantations, will allow to deposit some 2.5 thousand kilotons of atmospheric carbon a year additionally.