Ministry of Education and Science of Ukraine

National University “Yuri Kondratyuk Poltava Polytechnic”

Educational and Research Institute of Finance, Economy, Management and Law

Department of Economics, Entrepreneurship and Marketing

Department of Finance, Banking and Taxation

# STUDY TUTORIAL

# "UKRAINE'S ENERGY EFFICIENCY POTENTIAL: PROSPECTS FOR COOPERATION WITH THE EU"

**for students of the specialty 076 "Entrepreneurship, trade and exchange activity", 101 "Ecology", 192 "Construction and civil engineering" of the second level of higher education**

**(as part of the Erasmus+ Jean Monnet program " The challenges of energy efficiency: cooperation of Ukraine with the EU" (registration number 599740-EPP-1-2018-1-UA-EPPJMO-MODULE))**


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Explanations and recommendations on the topics of the lecture course (as part of the Erasmus+ Jean Monnet program " The challenges of energy efficiency: cooperation of Ukraine with the EU" are presented (registration number 599740-EPP-1-2018-1-UA-EPPJMO-MODULE)). The manual contains a list of control questions. A thorough list of literature is provided for each topic. The training manual was prepared with the aim of highlighting the problem of limited energy resources in the world, assessing the energy efficiency potential of Ukraine and increasing its level based on European experience. The manual is intended for students of economic, environmental and construction specialties of higher educational institutions, graduate students and teachers, students of business schools, specialists of enterprises.

**CONTENT**

# INTRODUCTION

Jean Monet's educational module of the Erasmus+ program of the European Union on the topic: "The challenges of energy efficiency: cooperation of Ukraine with the EU" is primarily aimed at spreading and systematizing knowledge and skills in the field of energy saving. In particular, the spread of European experience of management actions in the formation of energy-saving policy; development and implementation of a number of energy-saving measures, saving resources in everyday life and production. The educational module systematizes knowledge in the fields of construction, economy, finance, ecology, which are aimed at the rational use of natural resources in all spheres of life.

The study guide " Ukraine's energy efficiency potential: prospects for cooperation with the EU" for students of the specialty 076 "Entrepreneurship, trade and exchange activity", 101 "Ecology", 192 "Construction and civil engineering" of the second level of higher education includes the main prelist of topics devoted to the formation of the conceptual apparatus, structure and levels of energy efficiency potential; carrying out a comparative analysis of energy consumption in Ukraine and the EU; adaptation of the legislative and regulatory framework in the field of energy efficiency of Ukraine to EU standards; analysis of energy efficiency potential of economic activities of Ukraine; researching the energy efficiency potential of enterprises, in particular, the practical implementation of modern European practices; study of the European experience of building energy efficiency potential in everyday life.

The study guide is intended for students of specialties, in particular 076 "Entrepreneurship, trade and exchange activity", 101 "Ecology", 192 "Construction and civil engineering" of the second level of higher education, graduate students and teachers, entrepreneurs, stakeholders and representatives of business structures.

Dissemination of experience in assessing the levels of energy efficiency potential and formation of practical skills for identifying unused potential energy efficiency opportunities and taking them into account when planning energy-saving measures among the target audience of the project, as well as specialists of enterprises, organizations, institutions, local and regional self-government bodies.

This manual contains a summary of lectures, necessary explanations, questions for knowledge control and a list of used literature are also given.

The author's contribution to the manual in percentages: Chichulina K.V. (25%), Byba V.V. (25%), Ph.D., Minyaylenko I.V. (25%), Skryl V.V. (25%).

## TOPIC 1

# CONCEPTS, STRUCTURE AND LEVELS OF ENERGY EFFICIENCY POTENTIAL

**The essence of energy saving and energy efficiency. Determination of energy efficiency potential. Types of energy efficiency potential. Structure of energy efficiency potential. Methods for determining energy efficiency potential.**

Energy is rightly considered the basis of the economy and it satisfies the functioning of all sectors of the economy and makes a significant contribution to the formation of the revenue side of the budget.

Scientific and technological progress in production is inextricably linked with the growth of energy resources and raw materials needed for the production of goods, works and services to the population.

Modern industrial society needs more and more energy. In this regard, energy should develop in the following areas:

– reliable provision of energy resources for the needs of the national economy and the population;

– uninterrupted operation of industries and enterprises of the fuel and energy complex;

– reducing the harmful impact of energy facilities on the environment;

– state guarantee of social protection of the fuel and energy sector [1].

But due to limited quantities and the constant rise in prices for non-renewable energy sources, there is a need for energy conservation and activities in the field of alternative energy. The issue of reducing energy consumption is

also related to the issue of the environment, as the depletion of resources increases the negative, toxic impact on the environment from production. This problem requires from the society decisive and effective actions aimed at solving the problem of energy consumption, ie it is necessary to adhere to energy saving systems and transfer production to energy-saving technologies.

To date, there is no consensus on the essence of the term "energy saving", so it makes sense to consider some of the interpretations of various authors and draw their own conclusions, so the Law of Ukraine "On Energy" defines this concept as activity (organizational, scientific, practical, informational). aimed at the rational use and economical use of primary and transformed energy and natural energy resources in the national economy and is implemented using technical, economic and legal methods [2].

From the point of view of the authors Brych V.Ya., Gevko R.B., Dzyadykevych Yu.V. and Dzhedzhula V.V., determine that "energy saving" has the following main meanings: energy saving as an activity, energy saving as a process, energy saving as a component of management, energy saving as a result, energy saving as a method of management [3, p. 85].

Separately, Gevko B.R. defines "energy saving" as a combination of organizational and economic levers that affect the economic and organizational factors of energy saving. This helps to increase the economic potential and improve the efficiency of the enterprise. Given that there is a need to determine the essence of the organizational and economic mechanism of energy saving in enterprises and justify the criteria and principles of its formation [4, p.103].

"Energy saving" as a set of measures or actions taken to ensure the most efficient use of energy resources, and "energy efficiency" – is the ratio of the actual value of the use of energy resources to the theoretically achieved determines Semenov V.G. [5].

Some authors equate the concepts of "energy saving" and "energy efficiency", but joining the point of view of the authors above, it can be noted

that it would be more correct to differentiate them, as the term "energy saving" is more appropriate in the context of energy conservation. energy efficiency "should determine the state of the system which results in the performance of its functions with minimized energy costs. Note that the concept of "energy efficiency" is broader as it contains not only areas of energy saving, but also indirect costs, which leads to reduced consumption of fuel and energy resources.

However, these definitions are usually interrelated, as "energy saving" is a major factor in improving resource efficiency, and "energy efficiency" is a broader concept, as mentioned above.

So scientists interpret the concept of energy saving differently, but mostly associate the claims with the terms "system" and "systemic", which has certain features. Ways to implement and implement energy saving at an industrial enterprise are the formation of a system of energy saving measures at the enterprise. The energy saving system at the enterprise has the main features: elements; subsystems; system components.

The energy saving mechanism of industrial enterprises is a set of economic, organizational, motivational methods and techniques aimed at economically sound identification and maximum use of energy saving potential in order to minimize unit costs of production and reduce environmental impact on the environment [6, p. 10].

Authors Sichko T.V. and Popadynets N.P. see the reduction of energy consumption at the enterprise the fastest way to increase the profitability of production and, of course, to obtain additional profits without significant capital investment [7, p.55]. Directions of energy saving are focused on saving energy resources (table 1.1).

The company has the opportunity to choose a list of energy saving measures in its work, from those that can bring the most effective result of energy saving, at moderate costs for the company.

Modern energy saving measures are divided into:

- production activities;
- transport measures;
- measures of individual consumption;
- measures of general consumption.

Table 1.1 – Directions of energy saving

| № n/a | Directions and methods of energy saving | Ways |
|---|---|---|
| 1. | Energy saving | lighting, electric drive, electric heating, refrigeration, consumption of household and industrial devices, reduction of losses in the grid, etc. |
| 2. | Fuel economy | reduction of fuel consumption in internal combustion engines, alternative savings, hybrid systems, reduction of losses and increasing the role of electricity and heat production |
| 3. | Gas savings | household consumption, industrial consumption, reducing losses and increasing the role of gas supply systems |
| 4. | Heat saving | reduction of heat loss, increase of efficiency of heat supply systems, etc. |
| 5. | Water saving | water intake, household consumption, industrial consumption, reduction of losses and increasing the role of water supply systems |

Legislation on energy efficiency regulation was launched in 1994. The normative and legal base of the system of energy saving measures at the enterprise is created by the Laws of Ukraine, normative legal acts, methodical documents, national (DSTU) and interstate (GOST) standards of Ukraine, the main ones are:

- Law of Ukraine "On Energy Savings" [2];

- Decree of the President of Ukraine "On the State Agency for Energy Efficiency and Energy Saving of Ukraine" [8];

- Resolution of the Cabinet of Ministers of Ukraine "On approval of the Procedure for the use of funds provided in the state budget for state support of energy saving measures through the mechanism of reducing the cost of loans" [9];

- Law of Ukraine "On Alternative Fuels" [10];

- Law of Ukraine "On Alternative Energy Sources" [11];

- Resolution of the Cabinet of Ministers of Ukraine "On approval of the State Targeted Economic Program for Energy Efficiency and Development of Energy Production from Renewable Energy Sources and Alternative Fuels for 2010-2021" [12].

Author Kasyanova N.V. calls the three main types of energy saving measures, namely:

- organizational measures, or rapid response measures, which are developed and implemented within a year and have a significant effect at low cost;

- technological measures "basic measures" involving the introduction of energy efficiency standards in a particular area, which provides increased efficiency (financial support from banks or leasing companies may be involved);

- investment measures that address the root causes of low energy efficiency but require higher start-up costs [13].

Energy saving potential can be measured by the level of energy consumption.

Energy saving potential (Eneed) is the difference between the actual annual energy consumption according to the reported data (Efact) and consumption under regulatory operating conditions (Enor).

$$\Delta Eneed = Efact - Enor.$$

Energy saving potential is determined during the survey of each energy supply system separately, based on the results of balance calculations.

The size of the realization of energy saving potential for each specific object depends on the implementation of the energy efficiency project, a set of energy saving measures, developed taking into account the technical feasibility and economic feasibility of application.

The energy saving potential allows to estimate the inverse value – the energy efficiency potential of the enterprise, system, object.

Energy efficiency potential is a quantity that indicates (usually as a percentage) the possibility of increasing the efficiency of the system. That is, the greater this potential, the greater, on the one hand, the opportunity to save resources and funds through special measures; on the other hand, this production is technically backward. That is, the level of energy efficiency potential determines the level of efficiency of the management system of any business entity. Perhaps the most meaningful is the definition of the concept.

Energy efficiency potential – the expected result (in %) of reduced costs from the implementation of the planned energy saving measures. Its value depends on the technological state, level of organization and operation of the analyzed production compared to advanced samples (analog samples) [14].

Quantitatively, energy efficiency potential should be assessed by a possible reduction in energy intensity of products, the level of fuel and energy efficiency (FER) and energy costs on FER, and a possible reduction in the fuel and energy component of costs (energy cost of production) in the cost of products and services.

When developing strategies (programs), especially long-term, it is customary to assess the potential of energy efficiency as two components:

- technical (technological);
- structural.

Technical (technological) component of energy efficiency potential:

- increasing the efficiency of production (extraction) of preparation for transportation and consumption of energy resources and, accordingly, reducing the energy intensity of products, providing services through the introduction of new energy efficient technologies and energy saving measures.

Structural component of energy efficiency potential:

- changing the macroeconomic proportions of the economy in order to reduce energy consumption;

- reduction of the share of energy-intensive industries and production of industry and transport due to the development of knowledge-intensive industries, industries with low energy consumption and material consumption.

Instead, structural and technical (technological) factors depend on intersectoral and intra-sectoral shifts in the country's economy.

It should be borne in mind that the energy saving potential will largely depend on the type of economic activity of the surveyed enterprise, business entity [15].

In fact, the potential for energy savings is realized through specific energy saving measures. Therefore, any quantitative value of energy efficiency potential:

- is not an absolute criterion for taking cardinal measures;

- declared at the initial stage of energy audit in order to select areas for further examination, promising, in terms of further development of energy saving measures.

Based on this, we can offer another definition - the potential for energy efficiency (energy saving) can be understood as the maximum loss of fuel, heat, mechanical and electrical energy at the level of installation, cycle, shop, plant, which can be fully or partially returned to the energy cycle. energy saving measures. The definition is not strict, but it does not contain internal contradictions and seems to be quite consistent with the intuitive perception of the problem.

The results of comparing the effectiveness of possible measures to improve energy efficiency can be the basis for a comparative analysis of different techniques for calculating the potential of energy efficiency.

Energy saving measures can be classified according to various criteria: type of resource, belonging to specific energy technology systems, expected cost-effectiveness of FER, etc.

At present, it is advisable to divide the energy efficiency measures recommended for implementation into [16]:

- organizational and low-cost, involving improving the culture of production, maintaining order in the energy sector, strict compliance with nominal operating modes, ensuring the optimal level of loading units, timely commissioning and repair work;

- investment (expenditure) related to the replacement of obsolete production facilities, the introduction of modern energy efficient equipment, modernization of cycles and technologies.

The priority of organizational and technical measures in relation to investment is determined both by the problems of practical implementation of projects and higher indicators of energy efficiency growth. According to various sources, domestic and foreign, up to about 30% of energy efficiency potential is accounted for by low-cost and, above all, organizational measures.

The main problem in determining and assessing the potential of energy efficiency is the choice of the basic value of maximum efficiency, which is a comparison of the actual rate of FER consumption. In the special literature and some regulatory documents you can find various examples of basic indicators that have their pros and cons in solving specific scientific and applied problems.

Evaluation of energy efficiency potential should be carried out taking into account the practical value of the declared potential for the development and further implementation of energy saving measures and technical solutions.

The most natural, visual and logically rigorous is the choice of the base of comparison, based on the analysis of the physical characteristics of energy technology installations and cycles.

There are several main interrelated components of the potential for energy efficiency:

- technical potential – is estimated under the assumption that all equipment is instantly replaced by the best samples that meet the «almost

minimum» unit costs. Technical potential shows only hypothetical possibilities of energy saving without taking into account costs and other restrictions on its implementation;

- economic potential – part of the technical potential, which is economically attractive when using the established criteria for investment decisions;

- market potential – part of the economic potential that is economically feasible to use when applying partial criteria for investment decisions in real market conditions (eg, actual prices for equipment and energy, taxes, etc.);

- information potential – part of the market potential, designed in the form of TES feasibility studies or individual decisions prepared based on the results of collection and analysis of information;

- financial potential – part of the information potential for which a decision has been made to allocate funds for the implementation of measures.

It is advisable to consider methodological approaches to assessing the effectiveness of energy saving technologies and measures used in domestic and foreign practices.

Common to all analyzed methodological approaches is a single set of criteria for evaluating investment projects, the characteristics and formulas of which are widely known:

- payback period;
- rate of return;
- net present value of the project;
- internal rate of return;
- yield index.

Here is a brief descriptive and calculated characteristics of the methods.

1. Simplified method of technical and economic calculation of the feasibility of energy saving projects [15].

The essence of this methodology is based on the premise that the implementation of energy saving projects is carried out, as a rule, with the use of a bank loan, which is repaid due to the resulting savings in energy resources. The implementation of projects is complicated by high interest rates. First of all, this is due to the fact that from the moment of obtaining a loan to achieving a reduction in energy costs is a period of investment. The bank's debt is not repaid, but only increased through the accounting of the fee for the use of credit. Only after the end of the investment period can you start repaying the loan with the money received as a result of energy savings.

An additional complication of calculating the feasibility of projects is related to the need to take into account market parameters, such as inflation, which are unpredictable. Therefore, this leads to many calculations with different combinations of expected prices, bank deposit rates, inflation, etc.

2. Methods for assessing the economic efficiency of energy saving measures by O.O. Polycarpov [16].

O.O. Polikarpov developed two methods. The first allows us to assess the effectiveness of short-term investments in energy savings, which are made by enterprises at their own expense. The second method allows to determine the effectiveness of energy saving measures, which are carried out at the expense of borrowed funds, the return of which is due to energy savings.

Let's dwell in more detail on the first method. The author believes that the return on initial investments should be clearly ensured when financing energy saving measures. This condition is necessary but not sufficient. This is due to the fact that there are two alternative ways to use the company's profits. The first is to invest in a new or upgraded project with additional profits from energy savings and the second is to make a profit from placing the same funds on deposit. Both options are equivalent in the case of equality of these profits at the end of the established period. According to the author of the methodology, a

sufficient condition is a full return of funds spent and a profit of at least an alternative.

The author calculates the company's cash resources when placing funds on the deposit account and the company's cash resources after the implementation of energy-saving project at the end of the deadline.

The ratio of these amounts determines the condition of economic feasibility of the energy saving measure. The author calls the period of compensation, which is the restoration of monetary resources to a level that would have taken place without investment in the implementation of energy saving programs. Outside this period, the company benefits from the achieved resource savings. The compensation period should not be long, the author believes that the impact of parameters such as fund fees and depreciation should not be taken into account.

In order to plan short-term investments in energy saving, a deadline should be set for the beginning of the profit for each of the developed measures and the ratio of the amount of funds when placing them on deposit and investing in energy saving should be checked.

This method allows you to compare alternative uses of financial resources of the enterprise, to identify the most effective options for investing in energy saving measures. The author believes that if you refuse to implement such measures at your own expense, it is advisable to consider the use of credit. To assess the energy saving measures taken on borrowed funds, the author proposes to use a recurrent ratio to calculate the financial resources of the enterprise from energy savings. The amount received is compared with the alternative amount that arises after the placement of funds invested in the deposit.

3. Model of financial analysis of projects to improve energy efficiency [15].

This technique is developed on the basis of improvement and successful adaptation of foreign experience. The model operates with the 31st formula for calculating indicators composed of 3 main blocks:

1) investment block;

2) income flow unit;

3) block of economic criteria.

The first block defines the indicators related to investing in the project. It is assumed that part of the investment may be made in foreign currency. The state can partially subsidize the import of energy-efficient equipment and technologies, which will reduce the investment value of the project. The project can be financed not only from own funds, but also through borrowed capital or third party funds, such as the state, which will need to be covered by revenues from the project.

According to the developers of this model, the weighted average price can act as a discount rate in the calculation process, as well as a criterion for the minimum level of return on the project. The price is defined as the average of the prices of the elements of capital resources used to finance the project: interest on loans; the minimum acceptable rate of return for the retained earnings; dividends on shares and bonds.

The second block of the model considers income and current expenditure flows. Current costs are divided into maintenance costs for energy efficient equipment and other current costs. This division is necessary because wages are accrued, which increases current expenses.

Revenues from the project consist of two components:

- the cost of energy stored by it, to this component can be added a reduction in payments for connected capacity in the case of energy savings;

- reduction of fees for environmental pollution.

The net revenue stream forms the difference between the revenue stream and the project costs. An increase in income leads to an increase in the tax base.

If there are economic instruments to stimulate energy saving, the «tax press» on additional income may be weakened.

To estimate the values of the parameters of the third block, the discounted values of the three modifications of the net income flow are used. In this block, the models are estimated as follows. Payback period of the project in its simple traditional form and modified to take into account tax rebates for the purchase of equipment. For three modifications of net income from project implementation, the indicators of discounted net income flow and internal rate of return are estimated.

This model takes into account variables that can be controlled by enterprises, but may affect the values of the final project criteria. The list includes: average annual inflation rates, rising prices of investment goods, current expenditures, wages; average annual growth rates of energy prices; equipment depreciation terms; terms of the loan; wage accrual rates; income tax rates, VAT; rates of tax benefits.

The main advantage of the model, in our opinion, is that it determines the effect of changes in any of these factors or any combination thereof and reveals the upper and lower limits of the internal rate of return on the project with expected ranges of variation of these factors.

Let's highlight the main advantages of this model:

1. The model evaluates modern, market criteria for the effectiveness of investment projects using a cash flow discounting system;

2. The method is universal for taking into account changes in the market environment;

3. High level of informativeness of the received calculations;

4. Comprehensive accounting of factors influencing the implementation of energy saving measures;

5. The method allows you to vary the parameters of the investment project over the years of the life cycle.

Along with the advantages, like any technique, the model has its drawbacks:

- indirect gains and losses from the implementation of the energy saving measure under consideration, the model does not take into account;

- not for each project it is expedient to use as a criterion of investment efficiency a simple or modified payback period based on the results of the project in the first year of the life cycle;

- it is necessary to automate the calculation of return on investment.

The analysis of all the above methods showed that they differ in calculation algorithms, evaluation criteria, features and areas of application.

Analyzing these methods, we conclude that not one of them does not meet all the requirements, which necessitates the creation of foreign and domestic developments in this area methodology for assessing the cost-effectiveness of investment in energy saving technologies that meets all modern requirements.

## Tasks for individual work

1. Analyze approaches to determining energy efficiency potential.

2. Describe the types of energy efficiency potential.

3. Identify the advantages and disadvantages of methodological approaches to assessing the potential of energy efficiency.

## Control questions

1. What are the key features of energy saving and energy efficiency?

2. What areas of energy saving are implemented in Ukraine?

3. What are the structural components of the energy efficiency potential?

4. Are there any features of the application of methodological approaches to assessing the potential of energy efficiency?

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## TOPIC 2

# COMPARATIVE ANALYSIS OF ENERGY CONSUMPTION IN UKRAINE AND THE EU

**EU-Ukraine cooperation in the field of energy. Development of the energy sector in Ukraine and the world. Ukraine's potential for energy saving and energy efficiency. Energy efficiency reform in Ukraine. Energy strategy in Ukraine.**

EU-Ukraine cooperation in the field of energy is aimed at improving energy security, competitiveness and stability, which are necessary to promote economic growth and progress towards integration into the European market.

This cooperation is based on a comprehensive partnership in accordance with the principles of common interests, reciprocity, transparency and predictability in a market economy, the 1994 Energy Charter Treaty, the Memorandum of Understanding between Ukraine and the EU on energy cooperation, the Ukraine-EU Association Agreement, etc. [3].

EU-Ukraine cooperation includes, inter alia, the following areas:

- implementation of energy strategies and policies and development / processing of forecasts and scenarios, as well as improvement of the statistical accounting system in the energy sector;

- creating effective mechanisms for resolving potential crises in the energy sector in a spirit of solidarity;

- modernization and strengthening of the existing energy infrastructure of common interest, in particular energy capacity, integrity, reliability and security of energy networks, gradual integration of Ukraine's electricity system into the European electricity grid;

- developing competitive, transparent and non-discriminatory energy markets based on EU rules and standards through regulatory reforms;

- cooperation within the framework of the Treaty establishing the Energy Community;

- intensification and strengthening of long-term stability and security of energy trade on a mutually beneficial and non-discriminatory basis in accordance with international rules, including the 1994 Energy Charter Treaty, the WTO Agreement and the Ukraine-EU Association Agreement;

- scientific and technical cooperation and exchange of information for the development and improvement of technologies in the field of energy production, transportation, supply and final consumption;

- cooperation within European and international energy standardization structures.

Ukraine has a population of about 42 million and an area about 600 square kilometers ($km^2$). It is the second largest country in Europe, located at the crossroads of the European Union, the Russian Federation (Russia), as well as the Black Sea and Caspian regions. Ukraine has rich mineral resources, including oil, natural gas and coal, as well as great potential for hydropower and biomass. Due to its large population and high energy consumption, it is one of the largest energy markets in Europe. Ukraine also plays a key role in supplying Russian gas to European markets, as most of the world's natural gas transits through it. [1].

In today's world, the development of the energy sector is a factor that largely determines the vector of economic development. The Ukrainian economy is one of the most energy-intensive in Europe. Given the current trend of rising energy prices, there is a growing demand for steel energy-saving solutions in all sectors of the economy.

Ukraine uses various energy sources for its own needs, such as oil, coal, gas, nuclear energy, hydropower, wind, solar energy, etc. Most of the generating

assets and energy networks (thermal, nuclear and hydropower networks) are worn out. and ineffective. Most thermal power plants have exceeded the limit of physical wear and need modernization or replacement, as well as most nuclear power plants.

The energy intensity of Ukraine's GDP is several times higher than in developed European countries. In 2017, this was 0.27 tons of oil equivalent (toe) per $ 1,000 of GDP compared to Italy, Germany, France, Poland, Slovakia and the Czech Republic, where the figure ranged from 0.08 to 0.13. Therefore, the introduction of renewable energy-saving technologies is necessary to strengthen national energy security and is one of the priorities of public policy, as well as an important condition for sustainable development.

Ukraine is one of the most energy-intensive economies in the world and has a huge potential for energy saving and energy efficiency. Ukraine annually consumes about 92 million tons of oil equivalent of energy (tne) and has one of the most energy-intensive economies in the world. If the Ukrainian economy had energy intensity at the global level, it would reduce energy consumption by about 50 million tons [2].

Almost half (44%) of energy produced and imported is lost during its conversion and transportation to the final consumer, which is 12% higher than in the EU. Thus, of the 92 million tons of primary energy supply, about 52 million tons are consumed. The potential for reducing energy consumption during consumption can reach 60%. It is estimated that in only three sectors - housing, budget and energy supply (together about 63% of Ukraine's energy balance) the potential for energy efficiency is equal to savings of about 19 million tons or 8.0 billion euros annually.

Ukraine produces all fossil fuels (in 2018: 14.4 million tons of oil equivalent of coal, 16.5 million tons of natural gas and 2.3 million tons of crude oil), but in quantities insufficient to meet overall energy needs.

However, almost 65% of the total energy demand in Ukraine is covered by domestic production. This high self-sufficiency is explained by the production of nuclear energy, as Ukraine is the seventh largest producer in the world (83 terawatt-hours [TWh] in 2019). More than half of the country's electricity is generated by nuclear energy. Thus, Ukraine and Armenia are the only EU member states that produce energy from nuclear energy.

The effectiveness of economic instruments depends on the selectivity of their choice. The EU positions itself as a world leader in the development, implementation and implementation of stringent environmental policies. Against this background, climate change is a matter of concern in terms of the impact on employment, exports, income distribution and economic growth.

Ukraine remains heavily dependent on oil and gas imports. Variations in the hryvnia exchange rate against the US dollar and the euro, access to export markets, the closure of Russian markets, actions in the Middle East, the impact of weather conditions on agriculture, energy supply and price trends have a significant impact on its domestic economy.

Ukraine cooperates with the European Union through the Eastern Partnership, which aims to promote political unification and economic integration between the European Union and the Eastern Neighborhood (Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine).

Ukraine is a leading energy consumer. In 2018, its main energy supply was 93 million tons of oil equivalent of energy (tne), which corresponds to approximately 90% of Poland's consumption.

The Ukrainian energy mix is relatively diversified, and no fuel is more than 30% of the energy mix. In 2018, the share of coal (the main fuel in the country) fell to 30%, followed by natural gas (28%) and nuclear (24%).

Ukraine depends on imports for about 83% of oil consumption, 33% of natural gas and 50% of coal. In 2018, Ukraine imported 8.5 Mtoe (10.6 billion

m3) of natural gas, 13.8 Mtoe of coal and 10.4 Mtoe of petroleum products. Belarus is the main supplier of refined products to Ukraine.

Ukraine became an observer of the Energy Community Treaty in November 2006 and a full member in September 2010.

Adoption and implementation of energy legislation has begun, namely the legal framework for electricity and gas and requirements in the areas of renewable energy, competition and the environment.

The Cabinet, the main decision-making body, is responsible for coordinating policy and overseeing state-owned energy companies. Energy policy is high on its political agenda, with parliament and the president also involved in decision-making [4].

The seven main national institutions are responsible for energy policy:

1. Ministry of Energy and Environmental Protection (MEEP) is responsible for most energy supply policies, sustainable energy and climate change policies, and for coordinating government energy policy and advising parliament.

2. The Ministry of Finance is responsible for taxation related to the energy sector.

3. The Ministry of Regional Development, Construction and Housing (Ministry of Regional Development) develops policies and programs at the local level.

4. The State Agency for Energy Efficiency and Energy Saving (SAEE), subordinate to the MEEP, is the central government body responsible for promoting and promoting energy efficiency and renewable energy sources and technologies.

5. The National Commission for State Regulation of Energy and Utilities (NCSREU), established by Presidential Decree №715 / 2014 in September 2014, oversees the natural gas and electricity markets, as well as the heat sector. The NCSREU replaced the National Commission for Regulation of State Energy

Markets (NCRSEM) (abolished by Presidential Decree №693/2014 in August 2014) and the National Commission for Regulation of Utilities Markets. The NCRSEM reports to the president and is accountable to parliament.

6. The Antimonopoly Committee is responsible for preventing excessive concentration of market power.

7. The State Nuclear Regulatory Inspectorate is responsible for the operation of nuclear facilities, including uranium mining, radioactive waste storage and decommissioning in Chernobyl.

The National Commission for Regulation of Electricity Regulations or the Regulator (until 2011 it was called the National Electricity Regulatory Commission) regulates both energy and utilities. He is responsible for the economic regulation of the market and for its transparent, predictable, non-discriminatory and efficient functioning. In November 2016, Ukraine adopted the Law on the National Commission for Energy Regulation and Competitiveness to fulfill its obligations in accordance with the requirements of the Energy Agreement. The law aims to establish the legal status of the National Commission for Regulation of Economic Competition and regulatory powers, as well as to ensure its economic and financial independence for effective regulation of the energy market.

In today's world, the vast majority of activities of all social and economic actors (population, business, public sector) need energy. According to the forecast of the International Energy Agency (International Energy Agency: World Energy Outlook 2017), by 2040 energy consumption will increase by another 30% due to a significant increase in energy consumption in developing countries. At the same time, the European Union will remain the leading center for the implementation of energy efficiency. The Millennium Declaration was adopted at the UN Summit in September 2000, setting global development goals for the next 15 years, to which 189 countries have committed themselves.

The goals included reducing extreme poverty, reducing child mortality, combating epidemic diseases such as AIDS, and ensuring environmental sustainability and expanding global cooperation for development. As of 2015, significant progress has been made in implementing the targets, and some indicators have been achieved ahead of schedule. In September 2015, the UN Summit on Sustainable Development approved new benchmarks for 2030 - 17 global «sustainable development goals» and 169 tasks.

The supply of energy is primarily due to non-renewable energy sources, most of which are concentrated in several geographical areas. This makes the global energy system vulnerable to short-term shocks (such as conflicts in energy-supplying countries), but even more so in the long run due to possible imbalances between supply and demand. Therefore, the International Energy Agency believes that energy efficiency is «a critical tool for reducing the pressure on the energy supply system».

In addition, the negative environmental consequences of increased energy consumption are obvious. According to many experts, energy efficiency is not only one of the most efficient, but also one of the cheapest ways to reduce greenhouse gas emissions, and thus preserve the environment, improve health and quality of life. More energy-saving energy will directly or indirectly contribute to most of the UN's 2030 Sustainable Development Goals, which Ukraine has committed itself to.

Energy efficiency reform is one of Ukraine's priority reforms, which was, in particular, envisaged by the Coalition Agreement in 2014. In addition, Ukraine has committed itself to implementing it in accordance with EU Directives by joining the Energy Community and signing an Association Agreement with the EU. Improving energy efficiency is a necessary element for increasing the country's energy independence and reducing the energy intensity of the economy. Currently, Ukraine's energy intensity in purchasing power parity is three times higher than in most European countries. Over the last three

years, significant progress has been made in implementing the reform (especially in the residential sector): important laws, bylaws, the final stage of the process of launching the Energy Efficiency Fund, etc. have been adopted.

Energy efficiency reforms are actively supported by the international community, including the European Commission, the World Bank, the German Government and other partners, which provide both technical assistance and co-finance the implementation of specific energy efficiency projects.

According to the current National Action Plan on Energy Efficiency, Ukraine has committed to achieve a 9% (or 6.5 million tons) reduction in energy consumption by 2020 compared to 2005-2009. The set goal was achieved in 2013, however, the main factor was not the implementation of energy efficiency measures, but the economic downturn in the country (from 2008 to 2016, Ukraine's real GDP fell by 19.5%) and loss of control over part of the territory conducting anti-terrorist operation).

According to European experience, the general prerequisites (excluding specific instruments by direction) for large-scale implementation of energy efficiency are:

- Ensuring commercial accounting of energy consumption;

- Existence of effective models of relations, and clear definition of the rights and obligations of subjects in the energy market;

- Ensuring payment discipline for consumed energy resources (primarily by the population for utilities);

- Existence of an efficient energy audit market and energy management system;

- Promotion of energy efficiency (communication campaign).

In August 2017, the government adopted a new Energy Strategy of Ukraine (ESU) until 2035. It replaced the Energy Strategy until 2030, which was already outdated at the time of its adoption in July 2013.

The forecast indicators contained in the document show the trajectory of development of energy and related industries.

Reducing the energy intensity of the economy, as well as diversifying sources and ways of energy supply, increasing domestic production will help increase economic, energy and environmental security, which will optimize the energy balance and create a solid foundation for a sustainable energy future. The use of domestic scientific, technical and technological achievements with the maximum involvement of the local component will also contribute to the innovative development of the economy, scientific and educational potential, increase employment, reduce dependence on imported resources, etc [4].

Liberalized competitive energy markets are a prerequisite for sustainable development of the energy sector. Ukraine's Energy Strategy (ESU) ensures full implementation of commitments to reduce carbon dioxide ($CO_2$), nitrogen oxides ($NO_x$) (nitrogen oxides and nitrogen dioxide) and dust emissions from large combustion plants, and to introduce an emissions trading system (ETS) by 2035 year. At the same time, coal will continue to stimulate electricity production until 2035. Although major modernization of coal-fired power plants is planned to begin after 2025, their electrical efficiency will increase to a modest 36.8% by 2035.

The implementation of the ESU is divided into three stages:

The first stage (2018 - 2020) aims to create liberalized, competitive energy markets and minimize the state's conclusion on their work.

The second stage (2021 - 2025) is the development of energy infrastructure and its integration with the European system and attracting the necessary investments in the energy sector. The key tasks of the second stage are: creation of mechanisms for attracting investments in the energy sector for modernization of generating capacities; attracting investments in renewable energy; development of distributed generation; introduction of Smart Grids; development of infrastructure for electric vehicles.

The third stage (2026 - 2035) concerns sustainable development: fulfillment of commitments to reduce greenhouse gas emissions; quickly renewable energy sources; and ensuring energy security by further increasing gas production, including unconventional gas and offshore drilling, once gas supply has been reached in the second phase.

To increase energy efficiency in consumption, it is planned to introduce standards for building a "passive house" (with almost zero energy consumption for heating), as well as achieving emission reduction targets in accordance with the National Emission Reduction Plan for large combustion plants and introduction of greenhouse gas emission allowance trading in Ukraine [5].

Much attention in the strategy is paid to improving energy efficiency. The key objectives of the energy efficiency strategy are:

- reduction of energy intensity of the Ukrainian economy from the current 0.28 tons AD / thousand USD US to 0.13 (per PPP) by 2035;

- implementation of energy management systems in state and municipal buildings, as well as in enterprises;

- stimulating energy saving at the level of consumers, the formation of energy efficiency awareness among citizens;

- stimulating energy efficiency by implementing the monetization of subsidies to the final consumer, minimizing the amount of subsidies in the future;

- ensuring accounting for the generation and use of all forms of energy and energy resources (electricity and heat, natural gas, etc.);

- improving the energy efficiency of the housing sector by creating tools for state technical and financial support;

- introduction of mechanisms to promote energy efficiency in the housing sector (energy audit, financial instruments, etc.); support for energy efficiency initiatives in buildings; implementation of demonstration and pilot projects.

The strategy envisages investments in infrastructure development mainly at the expense of attracted investments - the share of investments from the state budget should not exceed 5 - 10%. The Ministry of Energy and Coal Industry should be the key body in the implementation of the strategy, while the Ministry of Regional Development is primarily responsible for heat and energy efficiency of buildings.

Despite the difficult political situation, the quality of Ukraine's energy data is improving every year.

In its Energy Strategy for Ukraine until 2035, the Ministry of Energy and Coal Industry envisages several changes in the TPP from 2015 to 2035: reduction of consumption of coal (from 27 Mtoe to 12 Mtoe) and oil products (from 10.5 Mtoe to 7 Mtoe); and increase in consumption of natural gas (26 Mtoe to 29 Mtoe), nuclear (23 Mtoe to 24 Mtoe), solar and wind (0.1 Mtoe to 10 Mtoe), biomass (2 Mtoe to 11 Mtoe) and hydropower (from 0.5 Mtoe to 1 Mtoe).

The government expected biomass to replace 3 billion m3 of natural gas in district heating, as parliament passed legislative amendments in March 2017 guaranteeing biomass heat producers 90% of the average tariff for heat produced from natural gas. Despite the successful deployment of several renewable heat projects with the assistance of international financial organizations (including the construction of a state-of-the-art biothermal thermal power plant in Kamianets-Podilskyi under the World Bank's Energy Efficiency Project), overall progress in biomass is much lower. expected 3 billion cubic meters. m of natural gas [6].

Among the most well-known projects implemented in recent years is the injection of pulverized coal (PKI) in the metallurgical industry, which replaces coal with natural gas. This technology was successfully implemented at ArcelorMittal Kryvyi Rih and MTZ Metinvest Azovstal in 2016, and it has been implemented at all major steel plants for the past five years. Another interesting

fuel switching project at ArcelorMittal Kryvyi Rih is replacing biomass (sunflower seed husk) with natural gas in lime production, which is an important factor for iron and steel production.

Ukraine has a significant amount of environmental legislation, including large norms, norms and standards for the efficient use of energy resources, energy conservation and renewable energy. Among its approximately 50 national standards are those related to energy efficiency, including the definition of methods; construction and analysis of energy balance; regulation of specific fuel consumption and losses; energy labeling of household electrical equipment; energy audit and management; and energy efficiency standards for certain types of equipment. These standards will have to be consistently harmonized with EU standards in accordance with the Energy Community Treaty.

## Tasks for individual work

1. Analyze the energy sector in Ukraine and the EU.
2. Analyze Ukraine's potential for energy saving and energy efficiency.
3. Carry out a SWOT-analysis of the modern energy efficiency system in Ukraine.

## Control questions

1. Formulate the main advantages of Ukraine's cooperation with the EU in the field of energy.
2. What is the essence of Ukraine's existing potential in the field of energy saving and energy efficiency.
3. What energy efficiency reforms have been carried out in Ukraine?
4. Name the main directions of the Energy Strategy in Ukraine.

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## TOPIC 3

# POTENTIAL OF ENERGY EFFICIENCY OF KINDS OF ECONOMIC ACTIVITY OF UKRAINE

**Features of determining the sectoral potential of energy efficiency. Technical and technological factor of energy efficiency potential. Structural factor of energy efficiency potential. Intersectoral potential of energy efficiency. Measures to increase energy efficiency potential.**

Ukraine's economic security in modern conditions depends on the implementation of energy saving measures in priority sectors of the economy. Problems of rational use of energy resources are common to all enterprises and sectors of Ukraine, as there is a significant energy intensity of production. Therefore, it is advisable to develop targeted sectoral development programs, which would be based on logically formed strategies for increasing energy efficiency of the economy and the implementation of innovative measures. Currently, the main factor in reducing energy dependence in all types of economic activity (TEA) is the formation of an effective mechanism for managing energy saving potential.

The introduction of energy-saving technologies in the economic activity of enterprises is one of the important steps in solving many economic, social and environmental problems – climate change, air pollution, depletion of minerals, resources and more.

Improving energy saving in Ukraine will be accompanied by a reduction in energy consumption, conservation of fuel and energy resources, reduction of carbon dioxide emissions, as well as trends in optimizing energy prices for enterprises.

According to the Energy Strategy of Ukraine for the period up to 2030 [3], the total energy saving potential due to the structural transformation of the economy and technological changes will be 318.36 million toe. Accordingly, the energy intensity of GDP in 2030 is projected to decrease by 2 times compared to the current level.

Each state tries to adhere to the guidelines in order to achieve the Sustainable Development Goals (SDG). The basis for the implementation of the SDG is to achieve energy security of the state through:

– accelerated development of traditional domestic energy sources (coal, oil, gas) to reduce dependence on imports;

– reduction of energy consumption and increase of energy efficiency, development of energy saving technologies;

– development of environmentally friendly energy technologies, alternative energy;

– ensuring the stability of the development of the national energy sector with a reasonable combination of market relations with state regulation, including long-term planning for the development of its industries;

– creation and systematic maintenance of appropriate amounts of strategic reserves of fuel and energy resources in case of various crises and force majeure [1].

Ukraine has the potential for energy savings, which is not inferior to developed countries, but Ukraine still suffers huge losses in various industries, due to the lag of the economy from the world.

It is difficult to overestimate the importance of solving energy saving problems for both the country's environment and the economy, which proves the need to continue research in this area to improve the energy system as a driving force to improve the economic and environmental situation in the country and the world.

Results of the sustainable development goal 7 "Affordable and Clean Energy", 9 "Industry, Innovation and Infrastructure", 11 "Sustainable Development of Cities and Communities" at Ukrainian enterprises in ensuring the effective implementation of energy saving technologies related to solving economic, social and environmental challenges (Fig. 3.1).

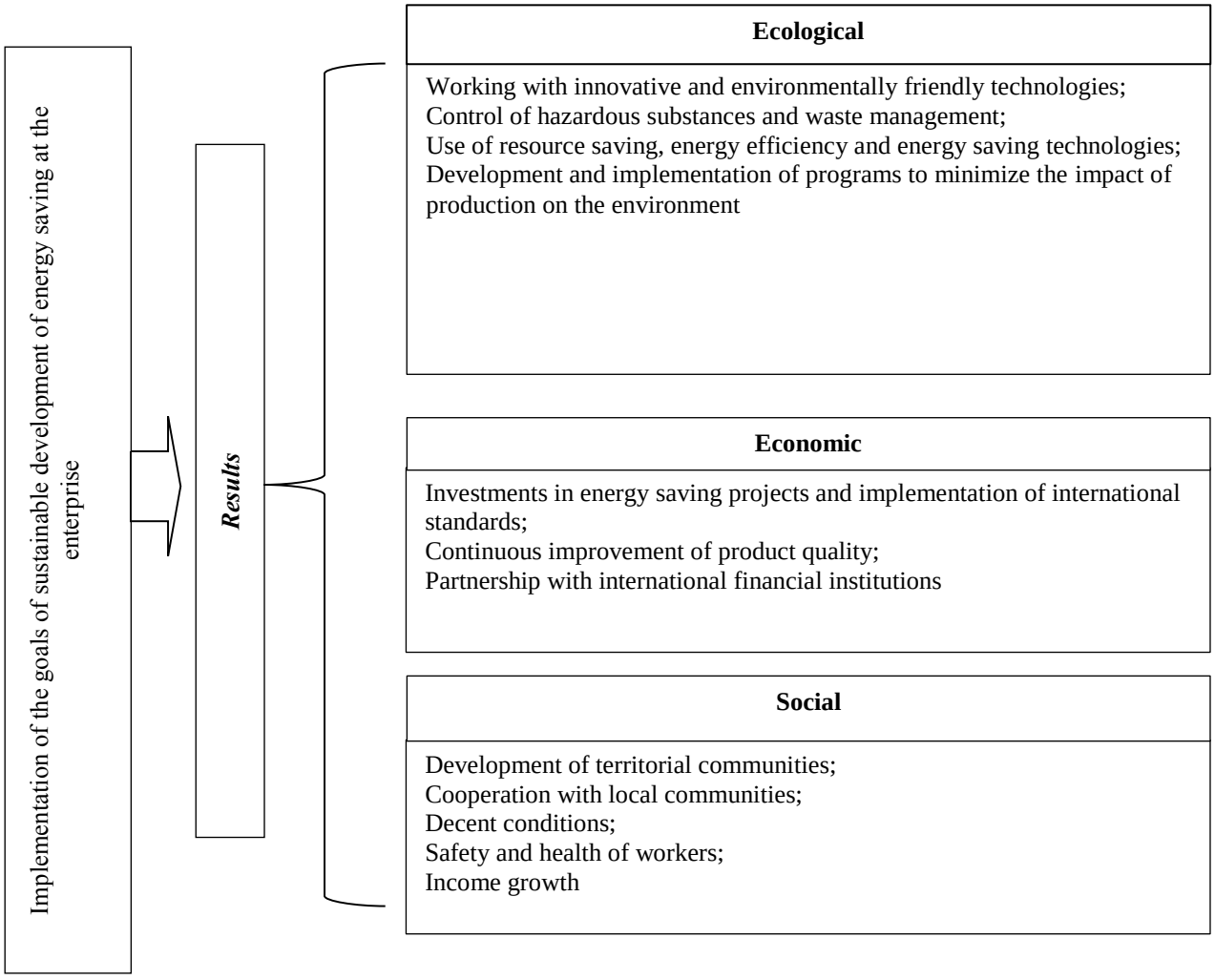


Figure 3.1 – Results of achieving sustainable development goals at Ukrainian enterprises

The high energy intensity of industries (Fig. 3.2) is due to a number of factors, among which the most influential are:

- a significant share of fuel and energy resources in the overall structure of production costs;

- high degree of physical wear and tear of fixed assets, including production equipment (65-70%);

- lack of information about energy saving programs and technologies;

- relatively little experience in financing such projects and, as a result, their inactive implementation [5].

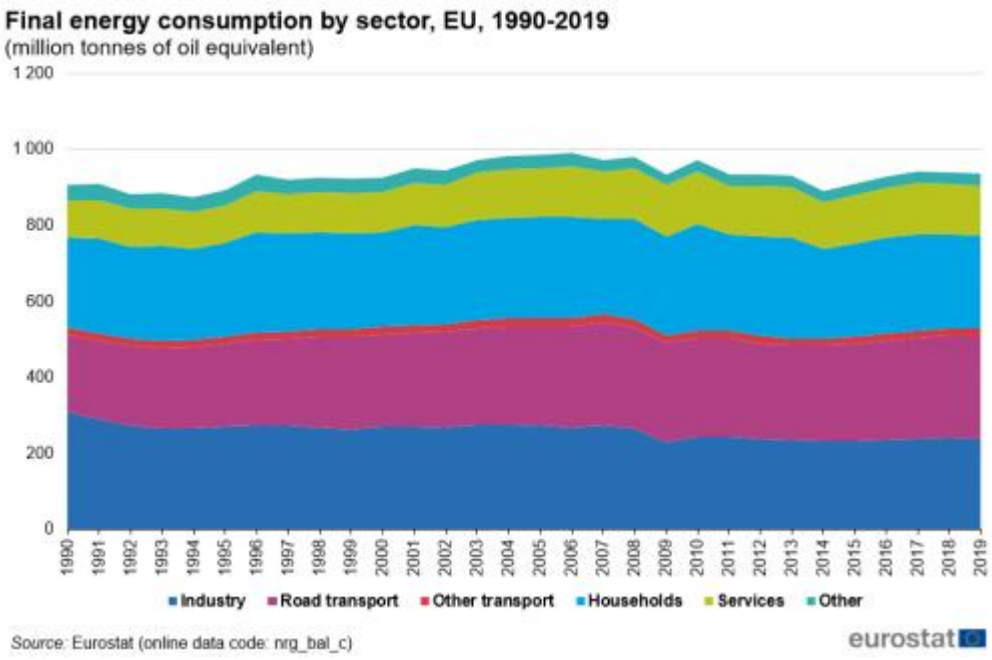


Figure 3.2 – Energy efficiency and energy consumption in industry – European Environment Agency

Representatives of large industrial companies of Ukraine are already paying great attention to energy consumption, energy saving and energy efficiency. The leading companies of Ukraine, representing the metallurgical sector, mining and machine-building industries, have made a significant step forward. In order to identify the potential for energy saving in different regions of Ukraine, a special index (Ukrainian Energy Index) (UEI) was developed and

calculated, which allows to compare energy efficiency in the regions of Ukraine taking into account the structure of the national economy [2].

The most energy-intensive sectors of the economy are:

- metallurgical, machine-building, chemical and petrochemical industries (where the energy saving potential, according to experts of this market, is 62-64%) (Fig. 3.3);

- housing and communal services (35-38%);

- services sector (5%);

- agriculture (3-5%).

There is also the potential for energy savings in the transport sector and in the food industry [2, 4].

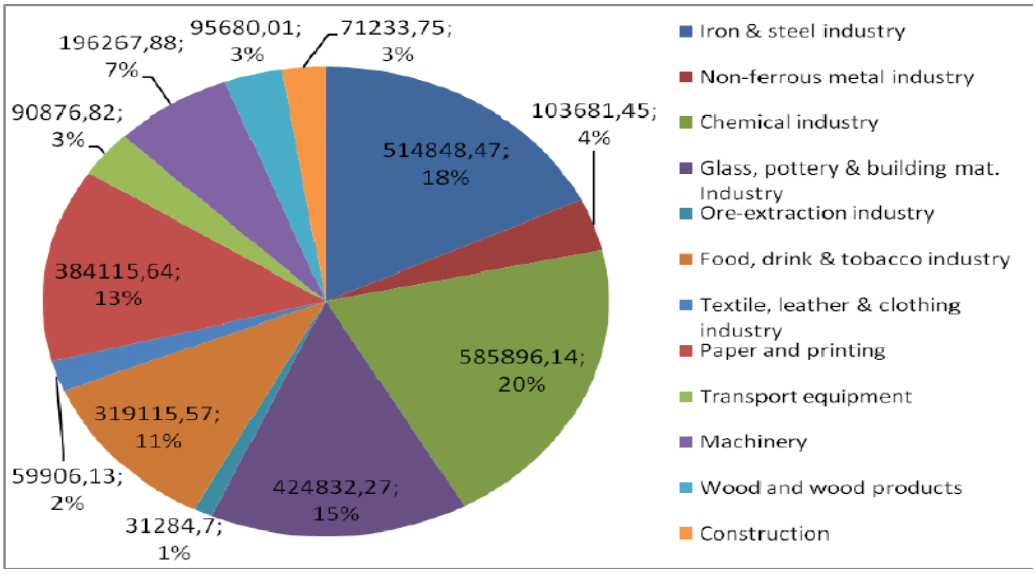


Figure 3.3 – Final energy consumption of the industry in EU-27 in different industry

Among energy resources, natural gas is the most consumed. Ukraine's natural gas consumption in 2020 amounted to 30.9 billion cubic meters, which is 3% more than in the same period of 2019. This was reported by the press service of the state company "GTS Operator of Ukraine": "... consumption of natural

gas in Ukraine in 2020 amounted to 30.9 billion cubic meters. This is 3%, or 1 billion cubic meters, more than the same period in 2019. "According to the GTS Operator, Among the trends of 2020 that affected the results in Ukraine, we can highlight the increase in gas use by generating companies in electricity production (+ 164% compared to 2019) and chemical companies (+ 49%) (Fig. 3.4).

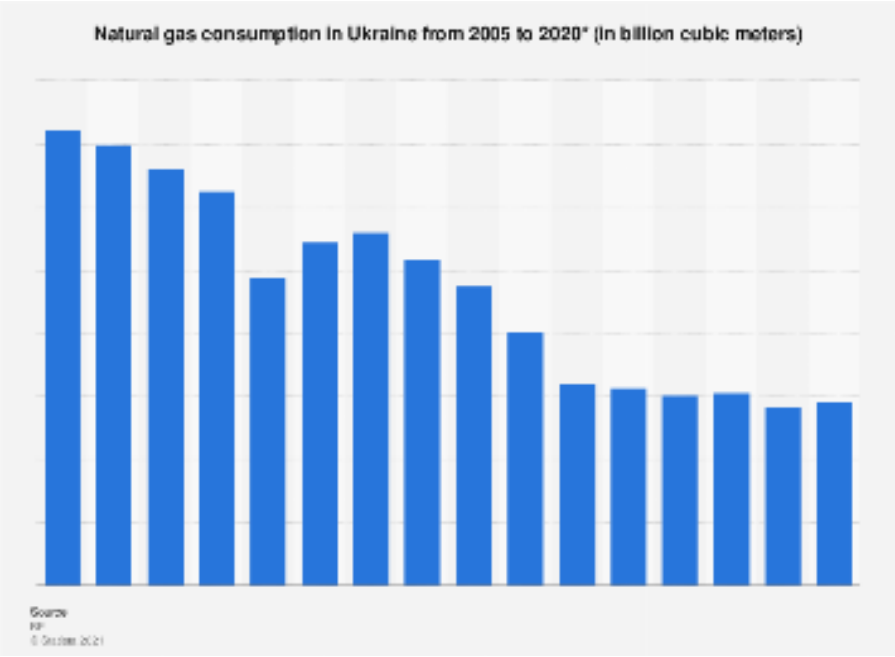


Figure 3.4 – Gas consumption in Ukraine for 2005-2020

In 2020, global gas demand fell by about 2.5% (100 billion cubic meters), the biggest decrease in history, according to the International Energy Agency. Given this decline, demand for gas for electricity generation remained stable due to changes in the fuel structure, while the entire supply chain showed high flexibility in adapting to fluctuations in demand. The globalization of gas trade has progressed with increasing liquidity, while prices have reached historic lows and have been highly volatile. The COVID-19 crisis and the overcrowded market have halted investment, while gas market reforms and clean gas policy initiatives have gained momentum in major consumer markets.

In Europe, gas consumption also decreased (by 16 billion cubic meters or 3.3% compared to the previous year), mainly due to the warm winter of the 2019-2020 season and spring lockdowns, which significantly affected all business processes in Europe and the pace of industrial production. The second quarter saw the sharpest decline in gas consumption (by 11.8% compared to the 2nd quarter of 2019). The largest reductions in gas consumption were in Western Europe (where the most severe and prolonged lockdowns were introduced), while consumption in some Eastern European countries (where lockdowns were temporary and short-lived) even increased. Natural gas consumption in Ukraine increased by 3.7% in 2020, compared to 2019 (from 29.9 billion cubic meters to 31.0 billion cubic meters). In 2020, the population consumed 8.2 billion cubic meters. m of gas, which is 1.3 billion cubic meters. m (13.7%) less than in 2019, due to lower demand for natural gas, which depends on temperature indicators. Gas consumption by DH companies for other consumers and electricity production reached 5.1 billion cubic meters. m, which is 2.3 billion cubic meters. m (+82%) more than in 2019 due to low natural gas prices and active use of natural gas for electricity production. In 2020, gas consumption by the industrial sector also increased by 1.0 billion cubic meters. m (+ 12%) to 9.1 billion cubic meters.

The most large-scale and effective direction of energy saving is the introduction and realization of the sectoral potential of energy efficiency in the following areas (Fig. 3.5):

– introduction of new energy-saving technologies and equipment;

– improvement of existing technologies and equipment;

– reduction of energy losses;

– improving product quality, improving and reducing losses of raw materials;

– replacement and selection of the most efficient energy sources [8].

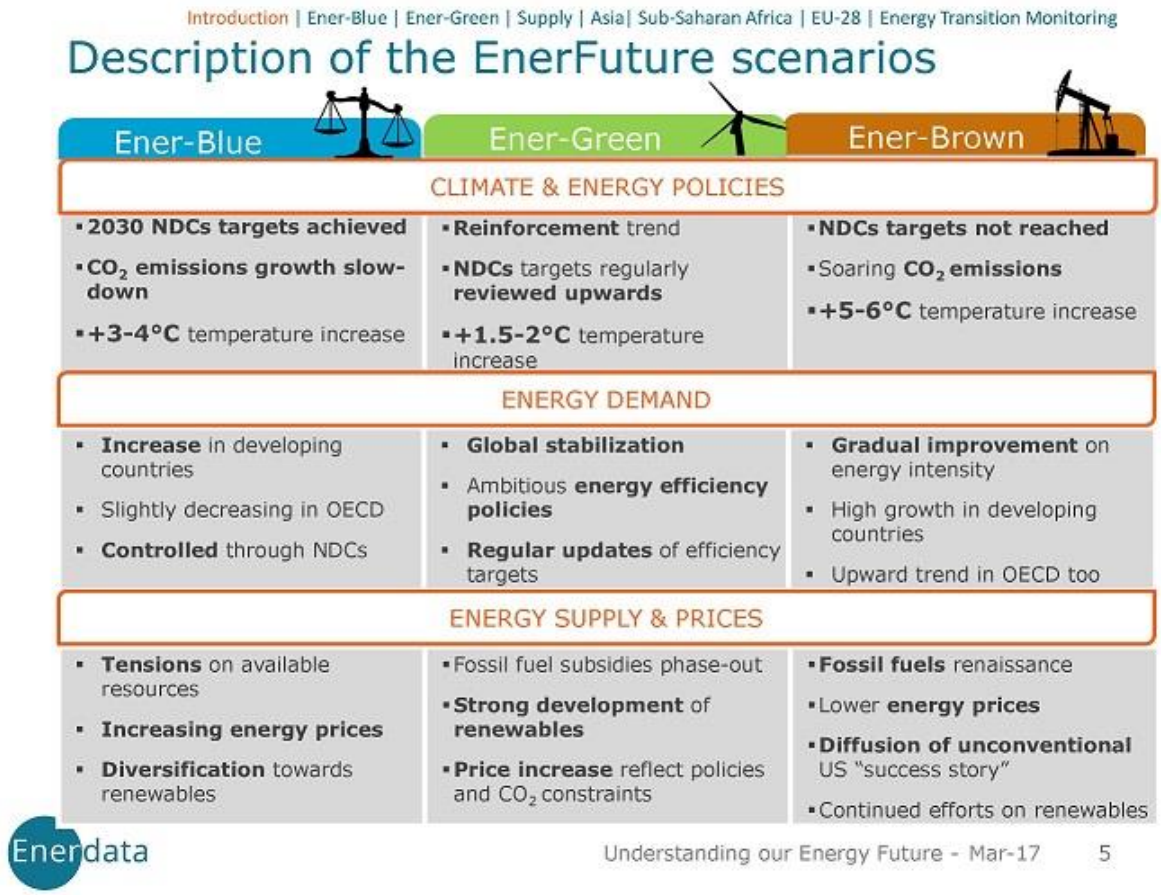


Figure 3.5 – Energy saving measures in Ukraine and EU countries

When assessing the level of efficiency of energy saving measures, the values identified on the basis of the study of progressive foreign experience, industry averages, indicators of leading enterprises in the field of energy saving, indicators defined as strategic guidelines of the enterprise are used. In general, the system of efficiency of energy saving measures is characterized by its complexity and diversity of phenomena and requires the study of a large number of indicators. Therefore, it is advisable to assess using a set of indicators based on such characteristics as stability, maneuverability, flexibility, reliability, efficiency, controllability [7].

In the system of efficiency of energy saving measures, the indicators are divided into stimulants that have a direct impact on strengthening the level of energy security of enterprises in the industry and disincentives that have a

reverse effect on the level of security. This means that the higher the level of disincentive or the higher the rate of its growth, the lower the level of sectoral economic security.

The main measures to increase the efficient use of energy saving potential in the following priority areas should be identified, in particular [6]:

In metallurgy – the replacement of open-hearth smelting technology with converter smelting technology. This will reduce 1.65 million toe. per year, that is more than 1.4 billion $m^3$ of natural gas. It is advisable to introduce the technology of blast furnace smelting with injection of hot reducing gases on cold process oxygen and pulverized coal mixture, which will save more than 2.6 billion $m^3$ of natural gas and increase the productivity of the blast furnace by 25%.

In the gas industry – introduction of gas pumping units with centrifugal superchargers with modernized impeller design in the gas transmission system. The introduction of this technology on the existing GPA will significantly reduce the annual costs of natural gas for the needs of the gas transmission company, while the efficiency of the superchargers will increase by 10%. In the building materials industry - the transition from the wet method of cement production to semi-dry and dry production methods. This will reduce energy consumption by about 0.5 million toe. per year, which will be 25% of the annual consumption of fuel and energy resources for cement production.

It is advisable to set up existing plants in this industry for the production of hollow bricks. The production of this type of brick with 40% void will save about 100 million m3 of natural gas. This is 25% of annual consumption.

Based on the data in the Energy Strategy for 2030 [3], it should be noted that the use of new technologies will not only reduce natural gas costs, but also save electricity, especially in ferrous metallurgy and heat in the food industry, ferrous metallurgy, chemical and petrochemical industries.

Synergetic intersectoral potential of energy efficiency has higher efficiency – 2-4 times compared to the industry.

The main intersectoral energy saving measures are the following:

– use of modern effective systems of accounting and control over energy costs;

– use of secondary energy resources;

– introduction of automated energy management systems;

– use of economic systems and electric lighting devices;

– introduction of modern systems and means of power electronics;

– improvement of heat supply systems;

– use of modern technologies for burning low-quality solid fuels;

– improving the structure of the fleet of electrical appliances in industries, etc.

According to the forecast of development of priority sectors of Ukraine's economy in 2030, the share of the most energy-intensive in the structure of output is expected to be reduced, namely electricity by 2.5%, metallurgy by 5.45%, fuel industry by 1.8%, chemical and petrochemical industries by 1.4% with a simultaneous increase in the shares of mechanical engineering, building materials industry, food industry, agriculture.

Implementation of the developed energy efficient innovation measures will increase the efficiency of energy saving potential, maintain the competitive position of enterprises, ensure economic and energy security of Ukraine.

Implementation of energy saving measures at the enterprise can be divided into several types according to the scope of operation: energy saving measures in production; in transport; energy saving measures of individual and general consumption [4]. To obtain an energy-saving effect, it is advisable to modernize the energy-saving system and improve existing technological processes.

Intersectoral technological energy saving in accordance with the Energy Strategy of Ukraine 2030 has significant potential (table 3.1) [6].

Table 3.1 – Intersectoral technological potential of energy saving in Ukraine

| Measures to save energy resources | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|
| 1.Use of modern means of accounting and control over energy costs, million toe | 1,41 | 1,66 | 1,81 | 2,03 |
| 2.Development and implementation of ACS by energy consumption, million toe | 0,31 | 0,39 | 0,41 | 0,43 |
| 3.Use of economic systems and electric lighting devices, million toe | 1,55 | 1,83 | 1,89 | 2,00 |
| 4.Introduction of power electronics, million toe | 6,42 | 7,61 | 7,81 | 8,38 |
| 5.Improving the structure of the fleet of electric motors in industries, million toe | 1,12 | 1,3 | 1,33 | 1,41 |
| 6.Use of modern technologies for burning low-quality coal, million toe | 0,71 | 0,8 | 0,82 | 0,97 |
| 7.Improvement of heat supply systems, million toe | 1,68 | 2,8 | 3,19 | 3,32 |
| 8.Increasing the level of use of secondary energy resources, million toe | 2,64 | 2,93 | 3,05 | 3,59 |
| Economically feasible intersectoral energy saving - total, million toe | 15.84 | 19,32 | 20,31 | 22,13 |

According to the Institute of General Energy of the National Academy of Sciences of Ukraine, the country's energy saving potential is estimated at 42-48%. The main savings of energy resources can be achieved according to experts in industry - 38%, in the utilities sector - almost 30% and directly in the fuel and energy sector - 17%. Based on this, it is safe to say that the priority for Ukraine in the coming years will be energy conservation and economical use of

natural resources, the solution of which will achieve the goals of sustainable development.

## Tasks for individual work

1. Describe the effective mechanism for the formation and use of energy efficiency potential.

2. Analyze the energy efficiency potential of Ukraine in key sectors of the economy.

3. To form a program to increase the energy efficiency potential of the most energy-intensive industries in Ukraine.

## Control questions

1. What is the essence of the technical and technological factor influencing the potential of energy efficiency?

2. How is the intersectoral potential of energy efficiency formed and assessed?

3. Describe the main energy saving measures implemented by EU countries.

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## TOPIC 4

# RESEARCH OF THE POTENTIAL OF ENERGY EFFICIENCY OF ENTERPRISES: PRACTICAL REALIZATION OF MODERN EUROPEAN PRACTICES

**The concept and structure of energy intensity in Ukraine and the world. Measures to increase energy efficiency in Ukraine and EU countries. Practical implementation of modern energy saving practices in the world.**

In the economy there is the concept of "energy intensity of GDP". This is the ratio of total energy consumption to GDP.

According to the International Energy Agency (IEA), in 2020 Ukraine's energy intensity was 2.7 times higher than in Poland and 3.3 times higher than in Germany.

This means that by producing the same product, a Ukrainian company spends three times more energy than a Polish one.

When Ukrainian producers do not invest in energy-efficient technologies, this has at least three negative consequences.

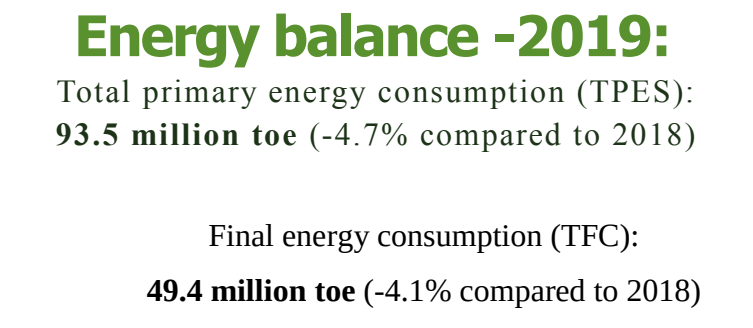


Figure 4.1 – Ukraine's energy balance in 2019

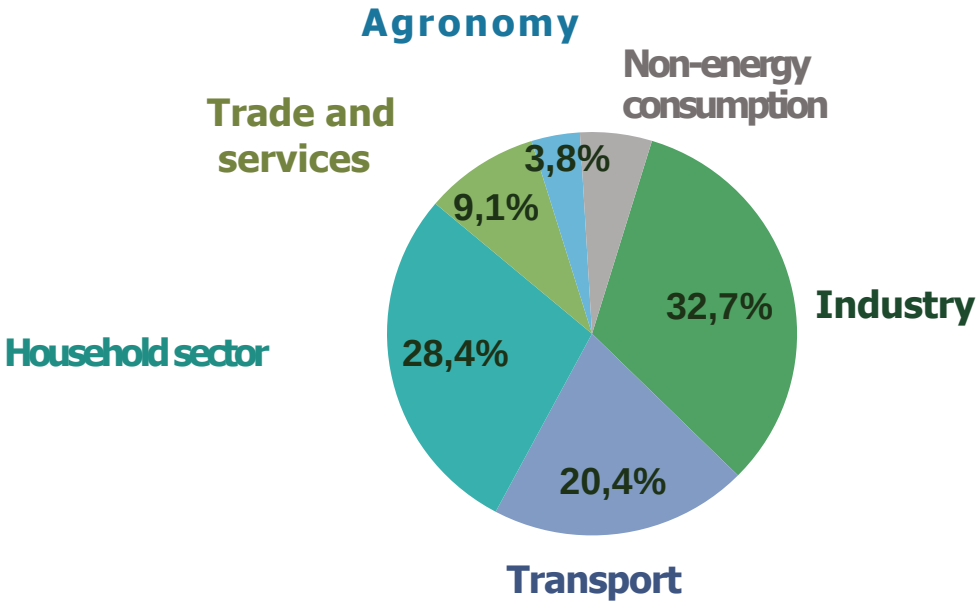


Figure 4.2 – The structure of final energy consumption in 2019 in Ukraine

Businesses are becoming uncompetitive. An industry that does not invest in energy efficiency today will not be able to sell its product on world markets tomorrow.

The higher the cost of production, the higher will be the final price of the goods for the buyer. Thus, Ukrainian companies are becoming less competitive in foreign markets, so they lose markets to more efficient producers.

The state has to import energy. High energy intensity of enterprises leads to excessive energy consumption throughout the country. As its own energy production is not enough to meet the country's needs, Ukraine has to import it.

At the end of 2018, Ukraine imported 36% of all energy it needed. In today's geopolitical environment, dependence on imported energy resources means political and economic danger.

According to the State Statistics Service, industry consumes 32% of the country's energy. At the same time, the industry has a 40 percent potential for energy efficiency. That is, productions could consume 40% less energy per unit of output if they upgraded equipment and took care of energy saving.

As a result of greenhouse gas emissions from the combustion of gas, coal and other fossil fuels, the planet is warming. The introduction of efficient clean technologies in production will reduce energy consumption, which reduces CO2 emissions and counteracts climate change.

Unlike the household and budget sectors, the industry does not have any systemic program to support energy efficiency by the state.

Figure 4.3 shows the energy intensity of GDP by country. Thus, in the EU, Canada and the United States in the late twentieth century, an active government policy on energy conservation, which allowed them to save more than 40% of fuel and energy resources [1].

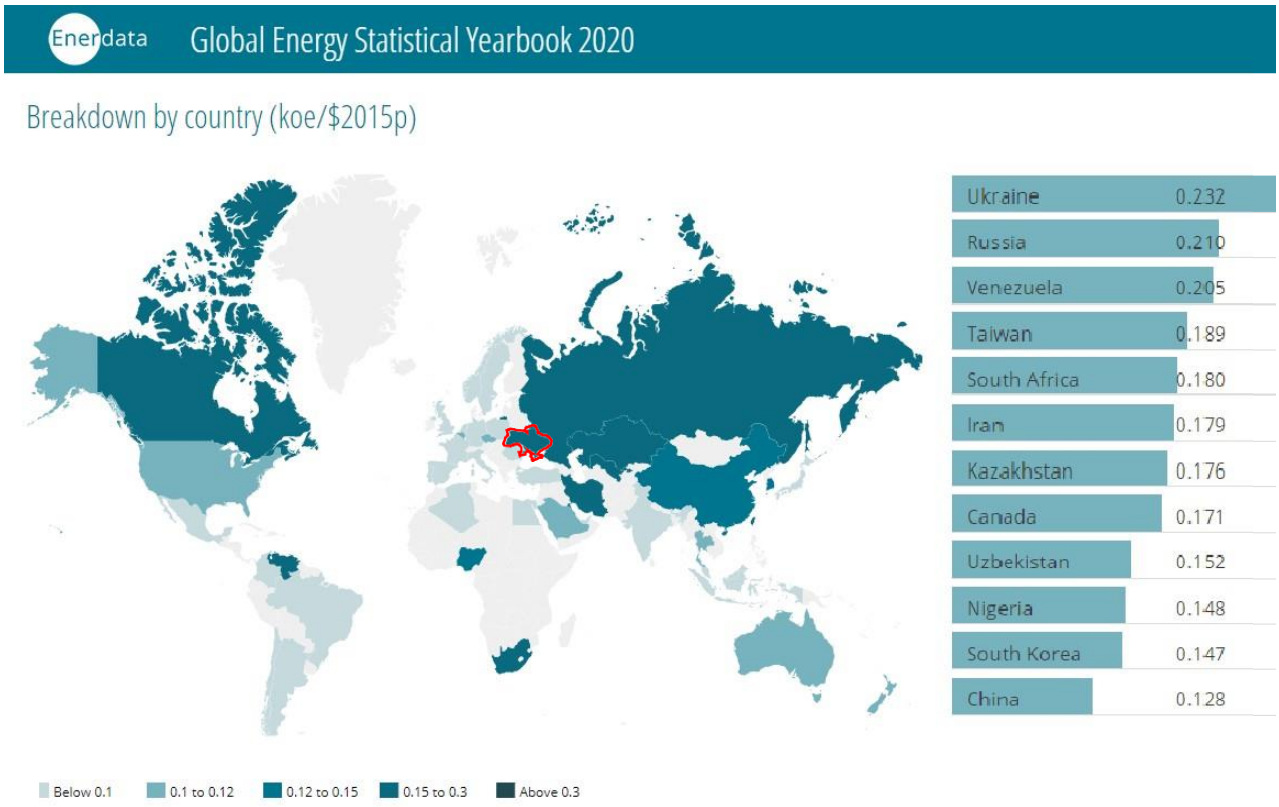


Figure 4.3 – World energy intensity of GDP in 2020

In 1992, the US Department of Energy developed a comprehensive document Energy Act, which covers the main problems of energy conservation and ways to solve them [2]. In developed countries, the main element of an

effective mechanism for managing energy saving potential is administrative management. It covers: labeling, certification, standardization, standardization, prohibition of the use of certain equipment and technologies. In order to achieve the goal of energy saving in the leading countries of the world successfully use a number of economic tools, namely:

- differentiation of the tax burden;
- budgetary and extra-budgetary financing of energy saving measures;
- preferential lending;
- government Procurement;
- differentiation of tariffs and prices for energy resources and energy efficient products;
- financial instruments and transfer of property rights [2].

Measures designed to stimulate energy efficiency in industry have become very popular in developed countries. These include [3]:

- introduction of mandatory energy audits, which is a necessary condition for the allocation of state subsidies, subsidies or other types of assistance for the implementation of energy saving measures;
- introduction of mandatory submission of reports on the implementation of plans of organizational and technical measures to reduce the consumption of energy resources in production;
- introduction of energy consumption standards for certain types of technical equipment and technological processes;
- creation of a favorable price regime and provision of state subsidies for joint financing of the introduction of energy-saving technologies and equipment.

At present, the state policy in the field of stimulating energy saving of industrial enterprises of the world's leading countries is mostly selective. Increasingly, measures to improve the efficiency of energy use are carried out within a separately selected energy-intensive industry, group of enterprises, or even focused on the technical re-equipment of a particular technological

process. This approach allows you to maximize the economic effect of allocating funds from the state budget or extra-budgetary specialized funds. These measures are implemented within the framework of the state framework programs for energy saving.

In the UK, the most effective energy saving program in the industry is the Energy Savings Opportunity Scheme [4]. It is implemented with the support of the United States Department of Energy and Climate Change in the United Kingdom of Great Britain and Northern Ireland. This program provides advice to business leaders on effective management decisions on energy conservation and expires in 2030. 4400-6600 industrial enterprises join this program annually. Starting from 2015, the expected economic effect from its implementation should average $ 5.3 billion annually. USA. In fig. 4.4 shows the dynamics of reducing energy use in the industrial sector of the United Kingdom.

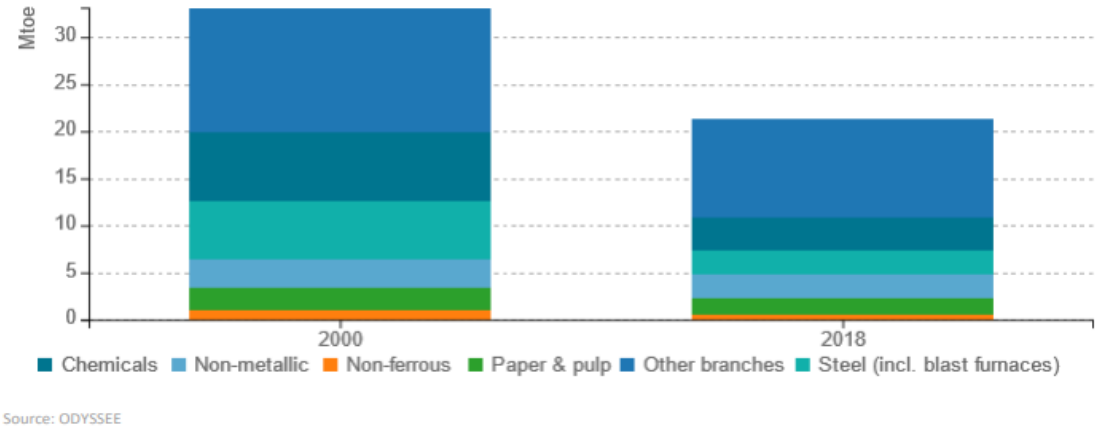


Figure 4.4 – Energy end-use by UK industries

Final energy consumption in industry decreased by 11.8 Mtne in 2018 compared to 2000. The analysis of decomposition explains this equally by the change in the structure of the industry (-14.2 Mtne) - for example, the loss of some types of energy-intensive production abroad - and energy. savings as a result of energy efficiency (-10.5 Mtne). The decrease in energy consumption

caused by these two factors was partially offset by other reasons, including an increase in some industrial activity during this period.

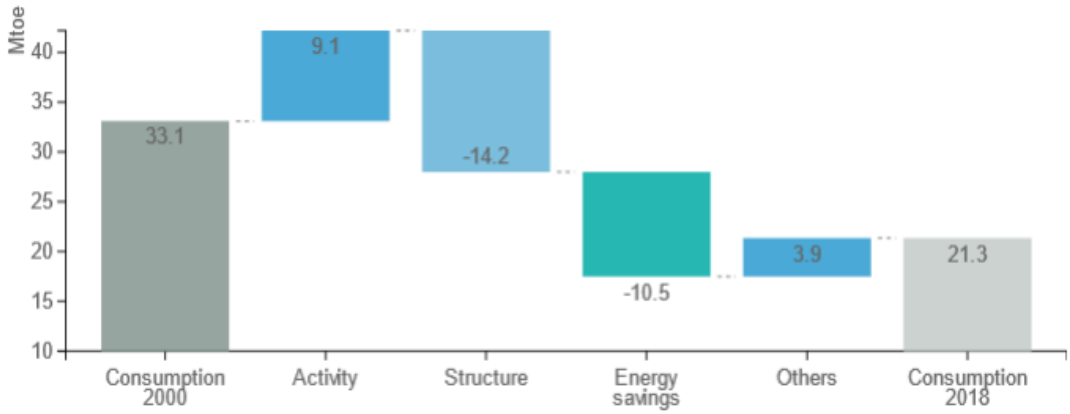


Figure 4.5 – The main factors changing energy use in British industry

Policies to improve energy efficiency in UK industry include a combination of market-based instruments, tax incentives and cooperation measures. Measures aimed at energy efficiency and carbon emissions in industry include the Energy Saving Opportunity Scheme (ESOS, see Overview), Climate Change Agreements (CCAs), Climate Change Charges (CCLs) and Increased Capital Standards (ECAs), as well as UK ETS.

Achieving the UK's goal of deep decarbonisation of industry by 2050 will require an innovation policy that goes beyond energy efficiency (eg carbon capture, use and storage (CCUS)). In table 4.1. an example of policies and measures implemented in the industrial sector of the United Kingdom.

At the end of the twentieth century, the EU, Canada and the United States pursued an active state policy on energy saving. This has enabled them to save more than 40% of fuel and energy resources over the last 40 years. In 1992, the US Department of Energy developed a comprehensive document, the Energy Act, which covers the main problems of energy conservation and ways to solve them [5].

Table 4.1 – An example of policies and measures implemented in the UK industrial sector

| measures | description | Expected savings, impact assessment |
|---|---|---|
| Climate change fee | The climate change levy (CCL) is a tax on energy use in industry, trade and the public sector. Proceeds from the levy are returned to the business by reducing employers' contributions to national insurance (NIC) and additional support for energy efficiency schemes and low-carbon technologies. | high |
| Climate change agreements | Climate change agreements ( CCAs ) allow for a partial exemption from the climate change levy for businesses in certain energy-intensive sectors. The tax rebate is granted to those sectors that agree with ambitious targets for improving their energy efficiency or reducing CO2 emissions under their GHGs. | high |
| Competition of green distilleries | The competition of green distilleries will provide funding for the development of technologies that allow the use of low-carbon fuel in the distillery. | low |
| UK Emissions Trading Scheme | At the end of 2021, the UK will move from using the EU ETS to operating in its own carbon market. | high |
| Liabilities of energy companies: brokerage services | Suppliers of energy company obligations can sell "lots" to energy companies in exchange for an ECO subsidy, what are the rules and who can trade. | |

In the developed countries of the world the main element of the effective mechanism of management of energy saving is administrative management. It covers: labeling, certification, standardization, standardization, prohibition of the use of certain equipment and technologies. In order to achieve the goal of energy saving in the leading countries of the world successfully use a number of economic tools, namely:

– differentiation of the tax burden;

– budgetary and extra-budgetary financing of energy saving measures; 23 - preferential lending and public procurement;

– differentiation of tariffs and prices for energy resources and energy efficient products;

– financial instruments and transfer of property rights [5].

The US Department of Energy is successfully implementing a set of programs that include energy audits, special training for energy managers in industrial enterprises and the use of economic incentives to comply with ISO standards. The implementation of these measures at a large enterprise saves $ 1.2 million. USA. In the world's leading countries, the effectiveness of energy saving management is achieved through the use of the Schuhart-Deming cycle, which allows to dynamically improve the energy management system [5]. Using the experience of EU countries and advanced countries in the field of efficient use of energy resources can significantly reduce the energy intensity of products.

The state program for energy saving in Germany Energy Efficiency - Made in Germany (Energy Efficiency in Industry, Building Service Technology and Transport) is aimed at providing government subsidies for technical re-equipment of certain energy-intensive production cycles [6]. For example, subsidies are provided for the purchase of equipment for heat recovery from injection molding processes in the amount of 54.8 thousand dollars. US per production line, and the result is energy savings of $ 3.45. US for each production operation (payback period does not exceed 4 years).

Denmark is one of the leading countries in the field of energy sector reform and development of new green technologies, renewable energy sources and energy efficiency. Today, the main elements of Danish energy policy can be represented in Fig. 4.6. Yes, Denmark has an energy-efficient industry and the lowest energy intensity of GDP.

The Danish policy to encourage companies to take energy efficiency measures is as follows.

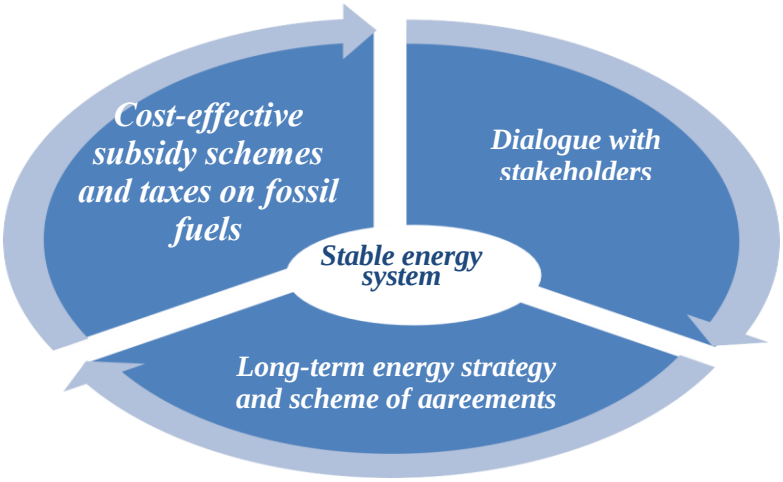


Figure 4.6 – The main elements of Danish energy policy

**SCHEME OF VOLUNTARY AGREEMENTS**

In 1996, a package of "green" tax, which consisted of 3 elements:

– Taxes on CO2, SO2 emissions (carbon tax and sulfur dioxide);

– Possibility to receive a tax benefit for enterprises that enter into agreements with EAD;

– Possibility to receive a subsidy for energy saving projects.

**2 main motivations for enterprises:**

– to compensate for the payment of CO2 / SO2 tax (for those who concluded the agreement the tax was 3 DKK / ton, the usual regime - 100 DKK / ton);

– receiving a state subsidy of 30% of the amount of investment in energy efficiency projects.

*Number of agreements: 370 (2000), 280 (2008) and 100 (2013) total number of concluded agreements 750.*

Table 4.2 – Encouraging businesses to take energy efficiency measures in Denmark

| Participants in the scheme of voluntary agreements | Functions |
|---|---|
| Danish Energy Agency | Agreements with enterprises, contact with tax authorities, delegation of tasks to accrediting organizations and accredited companies |
| Enterprises | Agreements with EAD, Implementation of energy management system in accordance with ISO 50001 |
| Tax authorities | Establish benefits for enterprises in accordance with the information of the EAD |
| A k p e e s tuyuchy organizat ion | Monitoring of accredited companies, close ties with EAD |
| A k p e di tonnes of Old Company | Control the implementation of energy management systems by enterprises in accordance with ISO 50001, close ties with EAD |
| Technical experts | Support of accredited companies to certification by the standard ISO 50001 |
| Special experts | Assistance in accreditation of companies by accrediting organizations |

Mechanism for concluding voluntary agreements between EAD and Danish industry

The Voluntary Agreement obliged enterprises (or groups of enterprises):

1. Apply certified energy management systems in accordance with ISO 50001 (until 2011 - DS2403).

2. Implement ALL energy efficiency projects (with a payback period of no more than 4 years).

3. Provide information on energy consumption on an ongoing basis.

The results of the implementation of the scheme of voluntary agreements:

– Implemented energy management systems at enterprises in 2006-2011.

– Reduction of carbon dioxide emissions by 240,000 tons per year;

– Energy management systems have been implemented at enterprises since 2011 until today 8% reduction in energy consumption;

– Reduction of carbon dioxide emissions by 330,000 tons per year.

Table 4.3 – Participants in the scheme of voluntary agreements

| Participants in the scheme of voluntary agreements | Functions |
|---|---|
| Danish Energy Agency | Agreements with enterprises, contact with tax authorities, delegation of tasks to accrediting organizations and accredited companies |
| Industry | Agreements with EAD, Implementation of energy management system in accordance with ISO 50001 |
| Tax authorities | Establish benefits for enterprises in accordance with the information of the EAD |
| Accrediting organizations | Monitoring of accredited companies, close ties with EAD |
| Accredited companies | Control the implementation of energy management systems by enterprises in accordance with ISO 50001, close ties with EAD |
| Technical experts | Support of accredited companies in ISO 50001 certification |
| Special experts | Assistance in accreditation of companies by accrediting organizations |

*To calculate energy savings from the application of the scheme of agreements EAD receives data on energy consumption from enterprises:*

*- Energy consumption / ton of industrial products (kWh / ton)*

*- Heat consumption / ton of industrial products (kWh / ton)*

Thus, the Danish scheme of voluntary agreements proved its effectiveness, namely:

– Acted as an effective tool for the implementation of energy efficiency measures in enterprises and the implementation of an energy management system that works continuously, which increases the attractiveness for investors

– Has provided an opportunity to reduce energy consumption by 10-15% only through the introduction of energy management in the enterprise and to control energy costs and reduce energy consumption of production

– Receive subsidies for the implementation of energy efficiency projects

– Reduce environmental impact / reduce carbon dioxide emissions.

The Top-1000 Enterprises Energy-Saving Program, which has been implemented by the Chinese government since 2006, has proven to be extremely effective. Using the levers of strict public administration in the field of energy saving enterprises 9 most energy-intensive industries, which account for 47% of total energy consumption, China has achieved a reduction in energy consumption by 150 million toe. or savings of $ 34.2 billion. USA [7].

Thus, the implementation of an effective state policy in the field of energy saving has allowed the countries of Western Europe, North America and East Asia to achieve a significant economic effect. Since the 1970s, energy consumption by these countries has decreased significantly, and their GDP has increased 1.5-2 times. Today, foreign scientists and politicians of these countries see the possibility of further development of energy saving in strengthening integration processes in the field of energy supply of economies, generalization and optimization of experience in managing energy efficiency systems, as well as continuing technical re-equipment of energy-intensive industries.

One of the most economical EU countries is Austria. Its industry produces about 24% of gross national product, while consuming almost 30% of electricity. It should be noted that the country's industry consists mainly of medium and small enterprises that have state support. The state, through a special bank, allocates federal subsidies to finance municipal environmental investments and consulting projects. Allocated funds are distributed to enterprises for environmental protection and energy saving (25%), for equipment for thermal power plants up to 20% and for insulation of old buildings from 25% to 30% [8].

In developed countries, different approaches are used to manage the funds of energy sector enterprises. In particular, in Sweden, the government encourages the use of renewable energy sources by exempting companies from the energy tax for a period of 5 years, providing subsidies for insulation of old

houses and facilitating obtaining permits for the construction of wind farms. At the same time, the state uses administrative management methods, applying taxes, subsidies, subsidies, trading quotas and electrical certificates. Swedish energy with the help of heat pumps with a capacity of up to 40 kW provides central heating and cooling of apartment buildings. The raw material is the potential of the Earth and water. Heat pumps are energy efficient and do not pollute the environment. Today, more than 500,000 heat pumps are operated in Sweden. It should be noted that in 2015, the Swedish government passed a resolution that the country should abandon fossil fuels. For this purpose, the state has allocated significant funds, namely: 390 million kroons per year for the period 2017 - 2019 for the introduction of solar energy; 50 million kroons and 10 million kroons for "smart grids" are provided for the study of energy-saving technologies. Significant funds are also planned for the modernization of residential buildings and improving their energy efficiency (1 billion kroons). In order to develop "green" transport, funds were allocated for subsidies and investments [8].

Norway also pays great attention to the efficiency of energy-intensive industries (production of aluminum, ferroalloys) and reducing the use of electricity for domestic heating, creating investment support programs for special demonstration and pilot projects. For many years, there have been educational programs to improve the skills of implementing energy efficiency programs and technology development in organizations responsible for the operation of buildings.

Since the 1980s, the most important direction in US government policy has been energy. Large companies were provided with preferential terms and tariff deductions for oil transportation. The government has exempted oil companies from a temporary income tax. In order to encourage the implementation of energy saving measures in industry, the state has allocated investment subsidies, direct or indirect interest surcharges, 25 depreciation

discounts, etc. The effect of the implementation of energy saving measures in industry was 10-15%, in transport 10-20%, and in the residential and commercial sectors - 40-50% [8]. It should be noted that in 2014, the President of the United States proposed a "Comprehensive Energy Strategy", which provides for the development of renewable energy sources. It is planned to triple the production of electricity from renewable energy sources. Greenhouse gas emissions from US power plants in 2030 will be reduced by 32%. The EnergyStar program, developed by the Environmental Protection Agency and the Department of Energy, has been in place in the United States since 1992. Connecticut has a successful program that supports energy-efficient businesses. For business owners who increase the energy efficiency of their enterprise, energy distribution companies provide a significant discount, as well as interest-free credit for the introduction of new energy-saving technologies [10]. U.S. energy policy is conducted in accordance with the Energy Laws (2005-2007), which provide for tax benefits and loan guarantees for various types of energy production, energy conservation work in their homes, and the introduction of innovative technologies that provide reduction of greenhouse gas emissions, development of biofuels and renewable energy sources [11].

One of the important tasks of the US Department of Energy is to implement the national energy policy and solve a number of urgent energy problems facing the state, namely: the impact of high energy prices, environmental protection, increasing domestic energy supplies, increasing energy conservation and energy efficiency, increasing the use of renewable and alternative energy sources, development of energy infrastructure and energy security. Today, the United States is intensively developing alternative energy sources, as their implementation allows to save fossil energy resources. The largest producer of renewable energy in the United States are alternative hydroelectric power plants [12]. In terms of hydropower generation, the country ranks fourth in the world after China, Canada and Brazil. The leaders in wind

energy are the states of Texas, Iowa and California. The world's largest solar panels are located in the Mojave Desert, and Northern California has the largest production of geothermal energy, making the United States a world leader in the use of alternative energy sources.

The United States is successfully working to introduce alternative fuels from biomass, as liquid fuels are an important component of the energy balance of many developed countries that do not have enough of their own energy resources. The use of liquid fuels from biomass not only increases the country's energy security, but also improves the environmental situation. The most common in the world energy market are biodiesel and bioethanol, which are obtained from fats of vegetable and animal origin. They can help reduce US spending on foreign oil and increase energy security. For example, the industrial production of bioethanol in 2005 alone provided the country with $ 3.5 billion in tax revenues to local, regional and federal authorities [13]. It should be noted that in the United States much attention is paid to energy efficiency. Energy efficient technologies are used, which are provided with financial incentives and tax benefits. In particular, by 2016, 30% tax benefits were extended to companies that produce equipment for photovoltaic and thermal power plants, as well as put into operation new low-power air turbines [14].

The International Energy Agency has concluded that the US government in energy policy should work to reduce dependence on fossil fuels and greenhouse gases, accelerate the implementation of clean energy projects, and work more closely on energy policy between Congress, the administration and the government. between the executive and legislative branches [13].

## Task for individual work

1. Carry out a comparative analysis of modern world energy saving practices.

2. To present the main programs of state support for energy efficiency by the state in Ukraine and the EU.

3. Systematize the world experience of forming voluntary agreements.

## Control questions

1. Define the concept of "Energy intensity of GDP".

2. What is the essence of voluntary agreements?

3. Identify areas for effective state policy in the field of energy saving in Ukraine and the EU.

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## TOPIC 5

# EUROPEAN EXPERIENCE OF FORMING ENERGY EFFICIENCY POTENTIAL IN LIFE

**Existing measures to improve energy efficiency. Experience in improving the energy efficiency of EU countries. Steps to energy efficiency of Ukrainian society.**

Countries around the world are increasingly turning to energy conservation and energy efficiency as the most effective ways to reduce energy consumption, save costs and create more self-sufficient energy sectors. Energy saving is one of the most effective ways to increase the reliability of energy supply and reduce emissions of greenhouse gases and other pollutants.

Energy efficiency should be given more attention and more attention. Energy efficiency is at the heart of the EU's energy policy, setting ambitious targets for energy efficiency in the coming years.

The practical importance of energy conservation and energy efficiency policies in the developed world was realized in the wake of the 1973-1974 oil crises, when oil prices for the main energy resource increased several times over several months. It is since the mid-1970s that most developed countries have been implementing energy efficiency policies and programs. Successful implementation of such policies and programs is ensured through the widespread implementation of energy efficiency methods and practices. They help to overcome information, institutional, political, regulatory and market barriers and create an environment in which industrial enterprises are able to implement energy-efficient technologies, methods and practices. Experience with energy efficiency policies shows that, in order to achieve the best results, energy efficiency must be integrated into other economic and social policies,

from industrial development to transport, housing and communal services and the environment. spheres of state activity. As an example, almost all national and regional energy efficiency strategies are directly linked to climate change policies.

In general, there are three types of measures to improve energy efficiency, namely: coercive, incentive and educational.

**Coercive measures include** statutory regulations and initiatives (first and foremost, EU directives are examples of such measures).

**Incentives include a number** of mechanisms to influence producers and consumers of energy resources. Among such mechanisms are: instruments of financial incentives, methods of information PR support.

**Educational methods** are mostly aimed at energy consumers and aimed at forming a new culture of energy consumption, which is based on the conservation of nature and the conscious choice of energy-saving technologies. At the same time, energy producers also implement "green" solutions that facilitate consumer choice.

**Experience in improving the energy efficiency of EU countries.**

Today, there are more than 230 procedures and activities in the field of energy efficiency in the EU Member States, including a wide range of documents and tools, including:

– Guidelines for consumers - on energy efficient goods, environmentally friendly construction, energy efficient behavior, etc.

– Household energy surveys / household energy efficiency calculators.

– Energy efficiency awareness campaigns for different target groups: households, drivers, commercial and public buildings, small and medium enterprises, industry.

– Consulting on energy for households / energy audit in industry and trade.

**Energy Efficiency Initiative Germany.**

In Germany, ambitious goals have been set at the state level to save energy and increase energy efficiency. In particular, by 2020 the total consumption of primary energy compared to 2008 should decrease by 20%. Energy consumption per unit of value added in the country has been brought to its lowest level since its reunification in 1990. In 2016, the total GDP in Germany amounted to 3643.4 billion dollars. The US despite the fact that during the financial crisis in 2008, value added in industry decreased by 15% with a further resumption of growth since 2010. From 2000 to 2016, there was a decrease in energy intensity of GDP by almost 29% with GDP growth at 21% for the same period, thanks to the successful implementation of the National Action Plan on Energy Efficiency. Germany's energy concept sets a common goal to increase energy efficiency – to reduce primary energy consumption by 20% by 2020 (by 50% by 2050).

Germany managed to get such a result due to a number of areas. Thus, today in Germany there are a number of training programs for children and young people in the field of energy efficiency, energy saving and environmental protection. Including:

**Berliner Klima Schulen** – Competition for all schoolchildren in Berlin, funded by the Berlin Senate for Science Education and Research, the Senate for Health, Environment and Consumer Protection, the General Association of German Insurance (GDV) and the World Wide Fund for Nature (WWF).

What can we do in our daily lives for climate and energy saving? What technologies can help us in the future? Through creative ideas and activities, children answer these questions, recognizing their important role in climate protection. The competition is a great success among Berlin schools, last year more than 2,000 students took an active part in various schools and age groups. This competition is a great opportunity for high school students at an early age to take part in climate protection.

**Die Freie Universitat Berlin** offers a program developed in collaboration with the Berlin Energy Agency, consisting of interactive lectures, seminars and round tables on key energy and climate change issues.

The program trains not only students but also teachers, in order to further exchange information between professionals and colleagues. Participation in the events is free. Students get the first knowledge about where heat and electricity are produced and how they appear in their homes. The implementation of such programs contributes to the formation of a new worldview in the efficient use of energy resources and the education of a new generation with respect for natural resources and the environment.

Die Renewables Academy AG (RENAC) offers seminars and trainings for technicians and engineers based on energy efficiency and energy saving.

In addition to the technical aspects, the seminars also provide information on economic evaluation, financing and project management. To fill the modern labor market with qualified personnel, RENAC covers training in the fields of energy efficiency, energy saving and renewable energy sources, providing professionals with professional skills.

Thrifty and efficient use of energy should become part of everyday life and a habit, become part of the morals of society. Because, as we know, only morality that is profitable and effective is viable. In the same way, man should be proud of what is given to him by nature and God - energy from natural sources, that nothing is lost in vain in the economy. That it saves a lot of heat and light and does not depend on centralized systems. And most importantly, it preserves the nature of the country, preserving it for their children and future generations.

The greatest contribution to energy conservation and reduction of CO2 emissions is expected through the initiative to create "energy efficiency training networks" (LEEN). Since the launch of the LEEN initiative, 50 energy efficiency networks have been set up, covering more than 500 companies. The

federal government and the association of companies have set the task of "LEEN 100 plus" to create more than 100 training networks on energy efficiency by 2018.

Under the auspices of the German Energy Agency (dena), a focal point has been set up to act as a contact point for initiative participants and potential initiators. The focal point also registers and verifies new energy efficiency training networks, organizes coordination processes between the partners funding the initiative, and coordinates public relations activities. Businesses can access information on the website about subsidized measures, funding amounts and application rules. Depending on the activities carried out and the implementation of programs, applications for funding of relevant projects up to 1.5 million euros are accepted.

The Federal Government has prepared a work program to further consolidate efforts: the National Action Plan for Energy Efficiency. In accordance with the objectives of the Plan, funding programs, legal advice and information centers on energy efficient technologies have been developed at the Federal level to support municipalities, enterprises and private households in their work aimed at improving energy efficiency.

Great importance is attached in Germany to the implementation of energy efficiency projects at the land level. Developed by the German Energy Agency DENA, the concept of "Das kommunale Energie- und Klimaschutzmanagement" ("Municipal Energy and Climate Change Management") promotes not only the introduction of energy-saving technologies in specific cities and communities, but also regular monitoring of energy consumption and implementation. other projects in order to find optimal solutions to improve energy efficiency.

**Energy audits for private households (Germany).**

– Funded by the Federal Ministry of Economy and Energy / conducted by the National Consumers Association;

– Energy saving consulting in local branches of the consumer association or online;

– Home inspections by energy consultants - for a small fee, for low-income families - free of charge;

– Information on energy saving measures, incentives, ongoing inspections;

**Incentive schemes for energy-saving schools "Fifty / Fifty" (Germany)**

Currently, 3,500 schools are involved

– Involved schools receive 50% of the achieved savings for use at their own discretion;

– Target groups include students, teachers and technical staff

– The main attention is paid to the behavior of changes and settings / quality maintenance of technical systems;

– Support of professional organization;

– Trainings, rental of measuring equipment, etc .;

– On average, the savings are 80 MW (thermal energy), 8 thousand kW / year (electricity), 25 tons CO2 / a and 5 thousand euros per school.

**Klimaaktiv Program (Austria).**

Conducted by the Austrian Energy Agency under the supervision of the Ministry of the Environment.

– Provides direct grant support, information and advice

– Pays attention to: (I) energy efficiency in buildings, (II) mobility, (III) communities, (IV) renewable energy sources

– 22 subroutines

– Training of climate specialists

– 1500 events, 2.5 million contacts with consumers per year.

The Austrian Mobility Management Action Program aims to reduce CO 2 emissions, promote clean and energy-efficient mobility and stimulate new innovative business opportunities and green jobs.

The Paris Climate Act entered into force on November 4, 2016. In the transport sector in particular, we need a concerted effort to achieve the transition to green mobility, not least in Austria, as shown by the Umweltbundesamt: 45% of Austrian non-ETS greenhouse gases. Greenhouse Gas Emissions Trading Scheme) and 32% of energy use is related to transport, which is more than 90% dependent on fossil fuels.

The transport of the future requires the separation of fossil energy use and the transition of mobility to an environmentally friendly, sustainable and efficient transport system:

- with the minimum possible emissions
- with less dependence on fossil fuel imports due to decarbonization
- with renewable energy sources and higher energy efficiency.

This transition to mobility will be important for achieving the 2020 climate goals, the new climate and energy goals for 20-30 and the long-term perspective for 2050. Austria should reduce its greenhouse gas emissions by 16% by 2020 and by 36% by 2030 compared to 2005. Decarbonisation requires a reduction in greenhouse gas emissions from transport of up to 80% (compared to 1990) by 2050, in line with the EU Roadmap for a Low-Carbon Economy and the EU White Paper on Transport. Thus, transport will have to make a significant contribution to achieving energy and climate goals. Addressing both long-term goals of technological development and investment is just as important as implementing today.

To facilitate the transition to environmentally friendly mobility, the Federal Ministry for Sustainable Development and Tourism (BMNT) is already taking the necessary measures: strategic plans such as master plans for cycling and walking, a joint action program of the Ministries of Environment and

Transport to support electric mobility and a financial support scheme klimaaktiv mobil program, embedded in a broader climate protection initiative.

The klimaaktiv mobil program provides financial support to Austrian companies, fleet operators and developers, as well as urban and municipal entities, municipalities and regions, as well as relevant participants in tourism, school and youth initiatives. This program facilitates the transition from clean mobility to electric vehicles, cycling, intelligent mobility management and innovative mobile services. The klimaaktiv mobil portfolio includes a financial support program, consulting and information programs, partnerships, and training and certification initiatives.

Successful results of klimaaktiv mobil:

– 21,000 environmentally friendly mobile projects initiated / implemented by approximately 17,700 enterprises in 1,500 cities, municipalities and regions 1,300 tourism and entertainment organizations and 500 schools;

– annual savings: 350,000 tons of CO 2;

– Financial support for mobility projects worth € 167.5 million from BMK through klimaaktiv mobil, the Climate and Energy Fund and the Austrian Environmental Support Scheme, including € 17.9 million from EU funds (EAFRD), leading to an increase in 1.2 billion euros in investments;

– provided about 10,700 so-called green jobs;

– financial support for about 47,800 alternative vehicles, including 44,900 electric vehicles;

– financial support for about 340 cycling projects, including the promotion of cycling in the federal states and cities;

– training of 1879 competent partners of klimaaktiv mobil, such as instructors in environmental driving, cycling technicians, trainers in youth mobility, as well as certification of 45 driving schools klimaaktiv mobil;

– support for know-how for 60,000 children and 3,500 teachers in 300 schools, thus saving 800,000 car journeys;

– about 100 youth mobility projects implemented mobility projects involving more than 15,000 young people.

**Company "Nieuw driving" (Netherlands).**

Consumer education on energy efficient driving style

– Practical advice for drivers of cars, trucks and buses

– Trainings on the basis of driving schools and other organizations

– Tools for mobility planning and costing

– Mobile application "Fuelless" ("fuelless")

– Emission reductions of 1 million tons of CO2 have been achieved.

**Energy efficiency of Irish households.**

The goal is to increase EE by 33% by 2020

• Sustainable Energy Agency of Ireland (SEAI)

- Independent body provided by law, responsible for RES and EE;

- Funding from national and EU funds.

• Dublin Energy Agency, CODEMA

- Non-profit joint-stock company;

- Funding by Dublin local authorities and projects funded by the EU and Ireland.

In fig. 5.1 lists the environmental / research centers in Ireland.

Also, today there are four types of school workshops for students:

- "Guzler" for students 5-7 years

- Energy challenges - for students 8 -12 years

- Daily energy - for students 13 - 15 years

- Climate champions - for students 16 - 17 years.

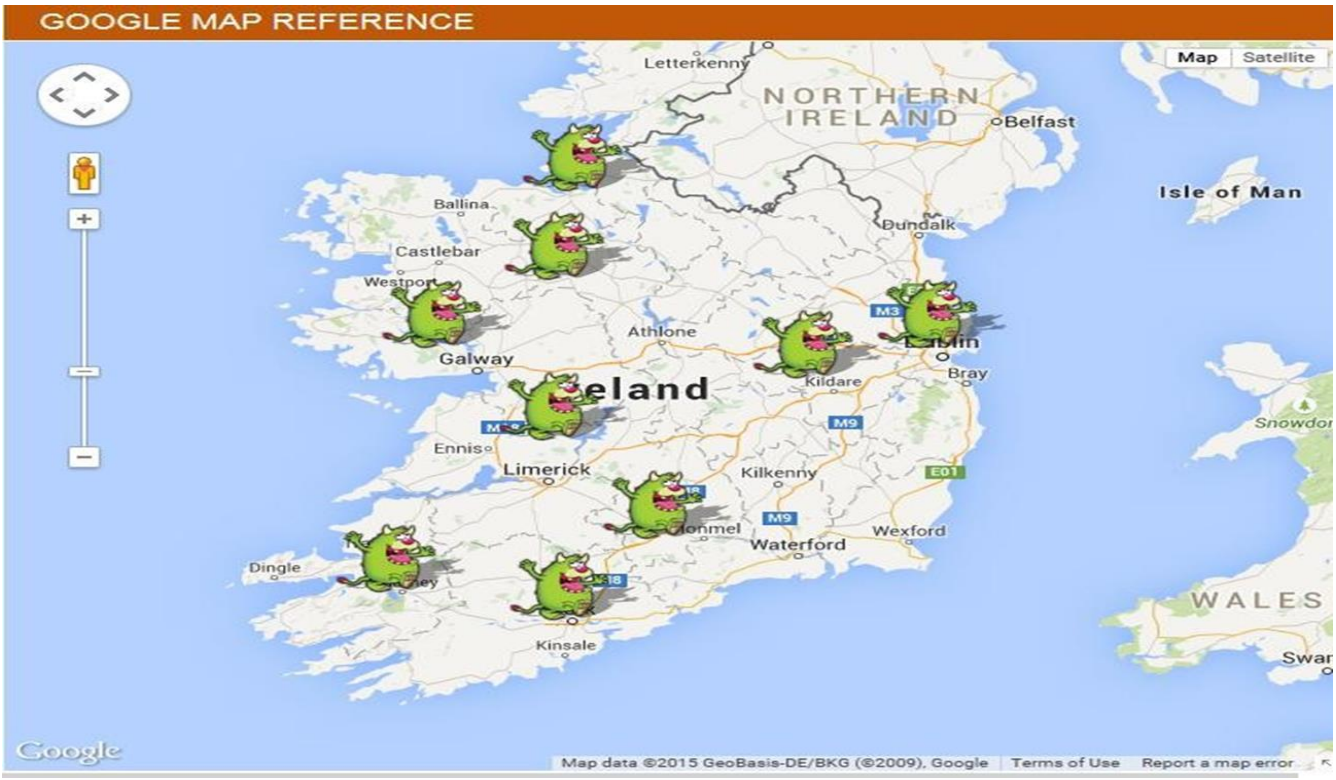


Figure 5.1 – Environmental / research centers in Ireland

The "One Good Idea" Project is implemented every year.

• 750 students take part in the competition of “one good idea” projects annually

• The competition is open to all schools in Ireland

• Students develop an information project

• Support from AIB Bank



As for Poland, it should be noted that it has been implementing an energy saving system since 1991. There are several aspects of this country's energy saving policy. First of all, it should be noted that the Polish authorities have harmonized national legislation with EU regulations. There are almost no contradictions between national and local regulations. Institutional and organizational support of energy saving policy is being successfully formed. The country has established effective and purposeful work of state and local authorities, financial and commercial structures, economic entities on energy saving measures in the housing sector, efficient use of local resources and electricity, implementation of solar energy, biogas production, waste disposal, heat and electricity energy from burning straw and other plant waste.

Residents of Polish houses were organized into certain associations, such as analogues of Ukrainian condominiums. As prices remained quite high, these organizational structures that managed the house began to take bank loans to renovate the house in order to save energy. In Poland, this process began in 1998. Thanks to loans, residents insulated roofs and basements, installed meters and regulators of heat consumption, replaced windows. In this way, they increased the energy efficiency of their homes. Today, all Polish houses have already gone through this process.

In Poland, the creation of associations similar to Ukrainian condominiums was forced. Participation in such an association is mandatory for all co-owners, and this structure does not require legal registration for its existence. Every year, Polish co-owners must approve the level of contributions for the maintenance of the house, from this money and works condominiums. From the bank's point of view, condominiums are a good borrower. For example, in Western Europe, the amount of loans issued to all condominiums over the past 15 years is estimated at about 2 billion euros. All loans were repaid.

Poland has a positive experience of mixed financing of energy projects (EU funds, international donor funds, environmental foundations, budget), where the system of tax benefits is effectively used.

The government is trying to use government levers to expand the range of creditors for such energy-saving measures, which require significant funds and which are designed for the long term. In Poland, there is a special utility fund, the funds of which are accumulated through fees from the population and are used to implement low-cost energy saving projects, improve the quality of heating, maintenance.

Energy consumption in the country is carried out on a contractual basis. This avoids the bureaucratic red tape associated with the permitting system, prevents monopolization of the sphere, improves the quality of services through competition, reduces prices, and simplifies auditing.

The creation of powerful state-owned companies has intensified the investment process in the Polish energy sector. However, the problem of upgrading generating capacity and power grids remains relevant. Measures are being taken to systematically decommission obsolete and uneconomical facilities. In particular, Polska Grupa Energetyczna (PGE) has commissioned a new 858 MW power unit at Belchatow TPP. However, the introduction of new modern facilities is not enough and needs to be significantly expanded with the involvement of appropriate investments.

All leading Polish energy companies have significant investment budgets. Thus, by 2025, PGE plans to invest in the creation of new and modernization of existing capacity in generation and network economy EUR30 billion, Tauron – EUR12 billion by 2020 and Energa – EUR5 billion. In total, the total investment in the industry is estimated at about 100 billion PLN (about EUR24 billion) by 2020. During this period, the total generating capacity is expected to increase to 41.5 GW, ie increase it by 27%. By 2020, at least 4-5 GW of obsolete economically inefficient generating capacity must be decommissioned.

One of the sources of financing is the European financial structures European Investment Bank and the EBRD. In particular, a ten-year loan of $ 300 million was provided for the implementation of the project of modernization and expansion of distribution networks (the total amount of the project exceeds $ 770 million).

Today, more than 90% of generating capacity in the country is accounted for by coal-fired power units. With large coal reserves, the country intends to continue to use this resource, which contradicts European energy policy aimed at reducing carbon emissions.

Last year, the European Commission extended the permit for the issuance of free CO2 emission quotas to existing Polish coal-fired power units at least until 2019. However, the issue of extending this provision to the projected facilities has not been resolved. As a result, PGE today stopped developing about 30 projects for the construction of new coal-fired power units.

Previously, it was planned to compensate for decommissioning coal-fired units by building new nuclear power plants, which by 2025 were to cover up to 25% of the country's electricity needs, but after the accident at Japan's Fukushima last year, these plans were postponed. However, PGE together with Tauron, KGHM announced the possible creation of a consortium for the construction of the first Polish NPP with a capacity of 3 GW, while the

complexity and high cost of this project (EUR12.1 billion) may delay the implementation process.

Poland is developing projects to build powerful wind farms on the Baltic coast, but according to experts, the share of this source in the country's energy balance in the next 20 years will not exceed 10%.

Thus, all the above makes it possible to identify steps that will increase the energy efficiency of housing of Ukrainian citizens and significantly increase their energy awareness.

**1. Mandatory accounting** – installation of meters for gas (savings up to 70%), water (savings up to 70%), electricity. "It is impossible to control what cannot be measured." In this way, you will pay for household consumption not "according to regulations", but for the resource actually consumed. Most families consume less resources than they pay on receipts. Monitor your intake. If you notice that consumption has increased sharply compared to the previous period – look for possible malfunctions in the system, the causes of overspending. To achieve greater savings, it is also recommended to install a heat regulator or automatic weather controller in an apartment or private house. Such devices allow you to adjust the amount of heat supplied depending on weather conditions and pay less. It is also possible to install a multi-zone electricity meter, when appropriate (the consumer pays 30% less for electricity consumed at night, with dual-zone metering and 60% less - with three-zone.).

**2. Replacement of old and low-efficiency equipment with modern and economical ones**: replacement of incandescent lamps with LED lighting (continuous LED life of at least 50,000 hours, equivalent to 11 years of operation with 12 hours of work per day – this is two orders of magnitude longer than conventional incandescent lamps), use of motion sensors for street lamps or lamps in entrances, use of ventilation system with recuperation, installation of household appliances with a low level of energy consumption (marked "A" or "A +"). Devices of this class have an efficiency of more than

90% and consume 30-50% less electricity than devices of class "B". The payback period of more expensive energy-saving appliances is on average 2-3 years.

**3. Complex thermal modernization** – replacement of windows and doors with energy-saving ones (with double-chamber energy-saving double-glazed windows and heat transfer resistance higher than the standard 0.6; this will reduce excessive heat loss by up to 40% and increase the temperature in apartments by more than 2 ° C, payback period 3-7 years), thermal insulation roof (payback of about 7 years, cost reduction of up to 30%, exterior walls and plinth (savings of up to 40%, payback period of up to 10 years), basement (if the basement is not heated, insulation will maintain a positive temperature of 5-10 ° C). Important: the insulation of the facade should be carried out only completely! Patchwork (apartment-by-apartment) insulation (applies to apartment buildings) destroys the integrity of the structure of the house. This reduces its service life. Comprehensive thermal modernization will save energy almost twice.

**4. Modernization of heating systems** – installation of an individual heating point (ITP, payback period 1-3 years), thermal insulation of pipelines (payback period about 1 year), if necessary flushing of the heating system (scale up to 1 mm thick reduces the level of heat transfer by about 15%), installation of high efficiency boiler more than 85%), the use of thermostats.

**5. Use of renewable energy sources** – installation of solar panels and power plants, heat pumps, solar collectors (vacuum and flat), installation of wind turbines (more for private buildings). Such systems require large investments at first, but make it possible to use natural and environmentally friendly sources for energy. They are in great demand in areas far from public networks and communications. An additional bonus from the state is the ability to connect to the "green tariff" provided that consumption is less than generation. Green tariff is a special tariff at which the state buys electricity from

private individuals generated by solar and wind power plants. The maximum power of a private power plant should not exceed 30 kW.

**6. Energy saving behavior** – the most affordable method of saving: turn off lights, appliances, faucets, do not close the heaters with curtains and foreign objects, ventilate the room, use light and warm colors in the interior, take a shower instead of a bathroom, install a heat reflective screen behind the radiator (increase room temperature) 2-3 degrees) use aerator nozzles on the taps.

## Tasks for individual work

1. Form a number of priority measures to improve energy efficiency.
2. Analyze the existing experience of energy efficiency of EU countries.
3. Draw up a program to maximize the energy efficiency of housing of Ukrainian citizens and ways to increase their energy awareness.

## Control questions

1. Analyze the essence of coercive, stimulating and educational measures?
2. Energy efficient housing in Ukraine: features and prospects?
3. Name the most common EU programs in the field of energy efficiency?

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TUTORIAL

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