

РЕГІОНАЛЬНА ЕКОНОМІКА

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ENERGY EFFICIENCY AS A PART
OF ENERGY TRILEMMAЕНЕРГОЕФЕКТИВНІСТЬ ЯК ЧАСТИНА
ЕНЕРГЕТИЧНОЇ ТРИЛЕМИ

Urgency of the research. The study of energy efficiency as part of the energy trilemma is the topical direction of research in the field of ensuring the country's energy security, environmental sustainability and free energy market promotion to stimulate economic development.

Target setting. It is important for Ukraine to ensure higher energy efficiency within the energy trilemma settlement: providing consumers with reliable and affordable energy forms at competitive prices, generating and consuming energy in such a way as to protect the environment and interests of the generations to come.

Actual scientific researches and issues analysis. Some aspects of energy efficiency are considered by V. Barannik, M. Voinarenko, G. Kaletnik, L. Kitsai, A. Sukhodolya and others.

Uninvestigated parts of general matters defining. Necessity of studying the current situation in Ukraine in the sphere of energy efficiency, as well as summarize intermediate results of reforming Ukraine's energy complex in the course of implementing EU - Ukraine Association Agreement in respect of energy and environment. Study of energy efficiency as part of the energy trilemma. Search for solutions of the energy trilemma through securing stable energy efficiency growth.

The research objective. Study the energy efficiency as part of energy trilemma. Study of the analysis of the energy efficiency state in Ukraine in terms of energy security, stimulation of the economic development and formation of a free and fair energy market, provision of environmental sustainability and transition to clean energy.

The statement of basic materials. The article deals with problems and prospects of increasing efficiency of energy use in Ukraine in terms of studying energy efficiency as part of energy trilemma.

Conclusions. The problems are revealed and recommendations are provided on increasing energy efficiency in Ukraine on the basis of treating it as part of energy trilemma.

Keywords: energy trilemma; energy efficiency; energy saving; energy security; incentive tools; environment.

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Urgency of the research. Energy efficiency and husbandry issues have long been a topical problem for a lot of countries. They see the solution of the problem in introducing innovative technologies. Ukraine tries to keep pace with the process.

Актуальність теми дослідження. Вивчення енергоефективності як частини енергетичної трилеми є актуальним напрямом дослідження у сфері забезпечення енергетичної безпеки держави, екологічної стійкості та заохочення вільних ринків енергії для стимулювання економічного розвитку.

Постановка проблеми. Важливим для України є забезпечення підвищення енергоефективності у межах рішення енергетичної трилеми: забезпечення споживачів надійними та доступними енергоносіями, по конкурентним цінам, генеруючи та використовуючи енергію таким чином, щоб захистити навколишнє середовище та інтереси майбутніх поколінь.

Аналіз останніх досліджень і публікацій. Аспекти енергоефективності розглядали у працях: В. Баранник, М. Войнаренко, Г. Калетник, Л. Кицай, А. Суходоля та інші.

Виділення недосліджених частин загальної проблеми. Необхідність в дослідженні поточної ситуації в Україні у сфері енергоефективності, а також підведенні проміжних підсумків реформ в енергетичному комплексі України у ході виконання Угоди про асоціацію України з Європейським Союзом у сферах енергетики та охорони навколишнього середовища. Вивчення енергоефективності як частини енергетичної трилеми. Пошук напрямів рішень енергетичної трилеми шляхом забезпечення стабільного зростання енергоефективності.

Постановка завдання. Дослідження енергоефективності як частини енергетичної трилеми. Вивчення аналітичної інформації про стан енергоефективності в Україні в аспектах енергетичної безпеки, стимулювання економічного розвитку та формування вільного та справедливого енергетичного ринку, забезпечення екологічної стійкості та переходу на чисту енергію.

Викладення основного матеріалу. В статті розглянуті проблеми та перспективи підвищення ефективності використання енергоресурсів в Україні в аспекті вивчення енергоефективності як частини енергетичної трилеми.

Висновки. Виявлені проблеми та рекомендації щодо підвищення енергоефективності в Україні на основі її розгляду як частини енергетичної трилеми.

Ключові слова: енергетична трилема; енергоефективність; енергозбереження; енергетична безпека; інструменти стимулювання; навколишнє середовище.

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What are the reasons of the urgent character of the topic of the efficient resource use? The answer is it was caused by the fact that in the recent decade the energy needs of the planet's population have been growing against acute fluctuations of fuel and energy costs, the reserve depletion and negative impacts of energy consumption on the environment. It is against this background that global energy sustainability provision has gained priority.

Target setting. Possible ways of energy sustainability provision are: energy security provision, free energy market promotion to stimulate economic development and environmental sustainability. The countries of the world have advanced a global dialogue in their attempt to solve the energy trilemma: to provide consumers with reliable and affordable energy carriers at competitive prices, generating and using energy in such a way as to protect the environment and interests of the generations to come. Energy efficiency and saving are treated by progressive countries as national priorities and a strategic means of increasing the national economies' competitiveness.

Such authoritative organizations as United Nations Economic Commission for Europe,

International Energy Agency pay much attention to forming the energy policy, analyzing trends, price drivers and service markets in the energy sector. A great number of energy security increase projects are supported by the European Commission, USAID programs, Tacis, Thermie programs, etc.

Actual scientific researches and issues analysis. Problems of efficient use of energy resources are dealt with in a number of publications by Ukrainian scientists (O. Tsapko-Poddubnaya, G. Kaletnik, L. Kitsay etc.). Works by V. Barannik, M. Voinarenko, S. Kudrya, A. Sukhodolya and others study the problems of energy security provision, environmental sustainability, use of renewable energy sources.

Uninvestigated parts of general matters defining. In spite of the popularity of the research of energy efficiency increase in Ukraine, a considerable number of issues remain understudied. Due to it, the necessity arises to study the current situation in the field of efficient energy use within the three systems of growth (economic, social and environmental) and summarize intermediate results of reforming Ukraine's energy complex in the course of implementing EU - Ukraine Association Agreement in respect of energy and environment.

The research objective. The objective of the research is to provide a wide range of readers – scientists and the public including European ones - with the analysis of the energy efficiency state in Ukraine and intermediate results achieved by the country in the course of implementing EU – Ukraine Association Agreement and EU Directives.

The civil society's increased awareness allows more complete visions of Ukraine implementing international reforms in the power industry, efficient use of donor funds allocated within international projects and strengthening the public positions in the political dialogue with the government on major directions of Ukraine's development.

Considering the above, it is necessary to study energy efficiency as part of the energy trilemma highlighting the following directions: energy efficiency as the way to energy security; energy efficiency as a stimulus to economy and a prerequisite for creating a free and fair energy market; energy efficiency as a means of providing environmental sustainability and the end goal of transition to clean energy.

The statement of basic materials. For Ukraine with its particular geographic position, rich natural resources, extensive infrastructure of transit gas pipelines, the task of providing the energy security has gained priority. High dependence of the energy industry on imports, low diversification of supply sources, prevalence of energy consuming industries and "energy poverty" of the population about 60% of whom are subsidized by the government cause the necessity of the system approach to reforming the energy industry on the basis of balanced consideration of the majority of stakeholders. The concomitant problem of environmental improvements in industrial regions with high level of pollutions greatly affecting the population and the climate is also crucial for Ukraine.

It should be noted that increase of the efficient energy use requires realization of the energy saving potential which results in decreased expenses on its acquisition. Assessment of efficient energy use macro parameters is given in Tab. 1.

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Table 1

Assessment of efficient energy use in Ukraine

year	Energy consumption to supply ratio, unit fraction	Imported to produced energy ratio, unit fraction	Energy intensity from average primary energy supply, toe/\$1000	Energy intensity from final energy consumption, toe/\$1000
2011	0.60	0.68	0.334	0.200
2012	0.60	0.55	0.322	0.192
2013	0.60	0.46	0.305	0.183
2014	0.58	0.45	0.298	0.173
2015	0.56	0.51	0.281	0.159

Source: created on the basis of [1]

In 2015 Ukraine’s total final energy consumption made 56% of the primary energy supply. Their considerable decrease was caused by:

- 1) deterioration of the geopolitical situation in the country due to which statistics on the Autonomous Republic of Crimea and part of Donetsk and Lugansk regions are not considered;
- 2) crisis processes in the country’s economy;.
- 3) changes in the primary energy market infrastructure.

By 2015 the imported to produced energy ratio had been changing for several years towards the decrease of imports. However, the analysis of indices of 2016 and four months of 2017 enables the conclusion that, in spite of positive macroeconomic changes (growth of GDP, production, construction and exports), gas import to Ukraine has increased by 64.7 % as compared with the same period in 2016, and import of oil products and coal has increased by 50.4 % and 66.2 % respectively [2]. In other words, the downward trend of dependence on imports has reached its limits; the country’s energy security level has even decreased for the last 18 months.

The review of the data of Ukraine’s State Statistics Service on major energy sources has revealed that percentage of renewable energy sources in the total energy balance remains slight – up to 3 % of total supplies.

Analysis of the official statistics shows that the energy efficiency level in Ukraine is still low. This can be proved by the data on the GDP energy intensity. In Ukraine it 2.5-3 times as much as in majority of advanced countries of Europe and the world as shown in Fig. 1.

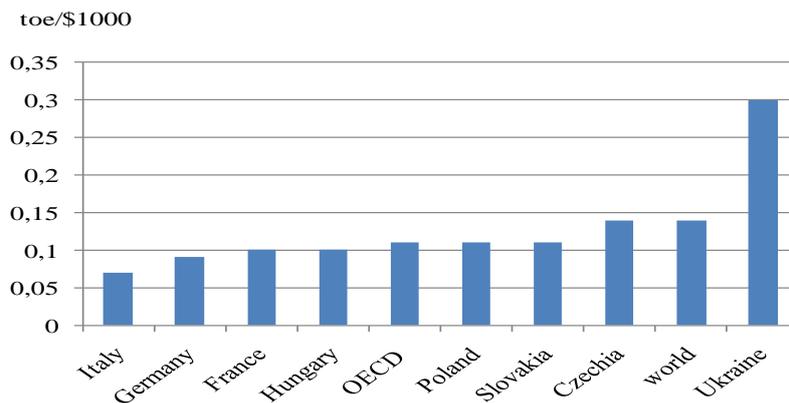


Fig. 1. Ukraine’s GDP energy intensity as compared with other countries

Source: created on the basis of [3]

What place in the global movement for energy efficiency belongs to Ukraine? Unfortunately, Ukraine is one of the most backward countries in Europe in terms of efficient energy use and saving.

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Results of the studies conducted by the World Bank experts testify to this fact. The report of February, 2017 presents the comparison data of 111 countries representing 96% of the world population and consuming 91 % of energy resources on the basis of the data available in 2015 [4].

The document provides insight into achievements in implementation of the policy of energy efficiency, energy affordability and government support of the renewable energy sector. In terms of efficiency Ukraine ranks 45th. Among the reasons of the low analytical estimation the experts mention the insufficient level of promoting public awareness of importance of energy saving and potentials of increasing energy resources efficient use; insufficient economic motivation of businesses, public utilities and the state sector to save energy as well as lack of high quality standards for energy consumption.

In terms of government support of the renewable energy Ukraine lies in the 64th place. According to experts, this results from the insufficient level of the state stimulation and support of renewable energy sources use, the complexity of using the existing power mains for transferring energy from the sources.

The report data is a marker of the necessity to create an institutional framework of energy security and an effective mechanism of stimulating innovations in energy saving. Thus, in search for solutions of the energy trilemma it is essential to consider efficiency increase as a means of Ukraine's energy security and sustainability provision.

Ukraine's intention to become a full-fledged member of the EU and the assumed obligations following the EU – Ukraine Association Agreement execution urges the country to implement the reform of the energy sector that involves the necessity if development and implementation of statutory basis of the reforms.

Ukraine's government have approved the energy strategy "Security, Energy Efficiency, Competitiveness" for the period up to 2035. The Verkhovna Rada of Ukraine has adopted laws of the "energy efficiency package". These documents determine the main directions of reforming efficient resource use, create a platform for Ukraine joining the all-European energy system and provide the opportunity of starting work of the Energy Efficiency Fund founded within the framework of the Paris Agreement with the purpose of supporting energy saving measures.

As regards the analysis of the current situation in the field of efficient energy use in Ukraine, it can be noted that over 75% of the total energy consumption is formed in industry and the housing and utilities sector. It is in these sectors that investment activities and energy efficiency measures should be stimulated before everything else.

The housing and utilities sector accounts for 44 % of energy resources consumption. Thus, it is the point where efforts should be made to save energy. Also, it is a source of a significant decrease of expenses of the State budget.

High energy intensity of the industrial and housing and utilities sectors is a result of a long period of use of cheap energy resources, Russian natural gas and Ukrainian coal in particular. Affordable prices stimulated neither the government nor the population to use them economically. But the concurrence of critical circumstances in recent years – the war conflict in the east of the country, high dependency on imports, and significant deterioration of fixed assets has resulted in a situation where energy efficiency issues have become crucial for the national economy maintenance and renewal.

The main reason for inefficient use of energy resources in the country's housing and utilities sector is the unsatisfactory technical conditions of buildings and low energy culture of the population. This means that the priority steps in the sphere of the energy efficiency increase in the housing and utilities complex could be:

- energy audit of each facility of the complex to detect problems;
- all-round installation of utility consumption meters;
- planning implementation of energy saving measures with investment and their payback calculations;
- further stimulation of heat consumption reduction through weatherization of walls, balconies, floors and ceilings and installation of energy saving windows;
- revision of energy efficiency standards for residential houses under construction and development of the effective mechanism of their enforcement monitoring;
- modernization of heating systems in houses and installation of automatic temperature controllers on heating units.

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Considerable positive changes in utilizing energy reserves could be achieved through:

- introduction of the energy consumption monitoring system at energy intensive industrial enterprises;
- creation of the system for monitoring, evaluating and reporting energy consumption and efficiency at the level of individual enterprises, companies, holdings and industries;
- inclusion of energy efficiency indices into state standards for equipment, materials, constructions and transportation means;
- development of economic stimuli of their implementation; regulatory documents reconciliation with demands for decrease of production energy intensity [5].

In addition, across the country the complex of measures aimed at the national economy's energy efficiency increase should provide for: an obligatory state appraisal of project solutions in terms of energy efficiency; development of a system of financial and economic incentives to ensure consumers' interests in rational energy resources use; a continuous awareness-raising campaign on energy saving and foreign practices popularization.

Implementation of the above conceptual recommendations in the course of energy reforms can result in considerable positive changes in the country's energy balance, increase significantly the national product competitiveness in foreign markets, enhance foreign trade balance indices as well as increase the population's ability to pay their energy bills and for associated services.

Considering the above within the energy trilemma solution, it is necessary to deal with energy efficiency increase provision from the point of view of stimulating the economic development and creating prerequisites for free and fair energy market functioning.

The urgent task of increasing energy efficiency is creation of conditions for attracting investors' interest in investing into this industry. One should assume that Ukraine does not have enough positive experience of investing large energy saving projects using resources of consumers (commercial entities, large businesses, and population). Due to it and some other reasons (obligations of Ukraine to the EU and IMF, low paying capacity of the population and high risks of investments in long-term capital-intensive projects), Ukraine's State budget is forced to be one of the sources of direct investments in the country's energy efficiency, saving and security. A demonstrative example of the government's participation in providing energy efficient increase is the program of "warm credits" launched in 2014 and implemented by the State Agency on Energy Efficiency and Energy Saving of Ukraine.

Can we consider, the course for providing energy security stated in "The National Action Program on Energy Efficiency for the period up to 2020" [6] and aimed at reduction of the final internal energy consumption in Ukraine by 9 % or 6.5 mln toe and achievement of intermediary index of energy saving of 5 % in 2017 as the one being successfully implemented? From the authors' point of view we cannot. The main reasons that slow down Ukraine's progress in terms of the economy's energy efficiency increase are:

- grave limitations of the country's internal financial resources;
- low investment activity national and foreign investors due to specific character of doing business under oligopoly, corruption and absence of independent judicial authorities;
- rather low sensitivity of the economy to high technologies on the whole due to the different essential layout of the country's political and economic life.

The major and most sensitive parameter of the economic efficiency is energy resources prices. The second component of the energy trilemma that influences directly the formation of prerequisites for enhancement of the economy and integration into the EU economic space is fair pricing for energy carriers, creation of the free energy market.

In accordance with the Memorandum with the IMF of February, 2015, the after signature period has seen multiple considerable increases of energy tariffs for the Ukrainian population. The declared aim of the increases is elimination of cross-subsidization when low prices for people are artificially maintained at the expense of high prices for industries that is inadmissible under free energy market conditions.

The electricity tariffs as well as those for gas, heat and water for the population are gradually reaching the tariffs of the European countries. However, the average income is 25 times lower [5].

Tariff increase is one of the major factors of inflation growth in Ukraine in 2016. Also, it is one of the major factors of impoverishment the population that is hardly adapting to high prices and often remains

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without means of living. At the same time, tariff growth results in extra income for companies-suppliers, however, without any guarantee on their side to forward these additional resources to provide repair and modernization of energy facilities obsolescence and wear of which has come their limits.

Absence of the system approach to the solution of the problem has resulted in the fact that in family budgets of over 60% of Ukraine's population life supporting expenses exceed their income. This testifies to the insufficient quality of the reforms implemented and low social responsibility of the country's management before the population.

To partly level the total negative consequences of energy cost growth for the population, the government uses two-rate tariffs that depend on the amount of consumed energy and the time of the day, and subsidy system. In 2016, 7.7 mln households were subsidized to compensate housing and utilities costs that is by 42.2 % greater than in 2015.

Macroeconomics and state finance experts understand that the mechanism applied in Ukraine is not progressive. It produces extra loads on the budget, does not stimulate implementation of energy efficient measures and feeds negative phenomena in the national economy such as reallocation of the GDP in favor of the big capital at the expense of main population groups, the extensive character of the energy business activities and inflation growth.

The rational opinion is that on the necessary enhancement of the system of subsidizing the low income population in direction of substituting the monetary form for the subsidy one. This can reduce the pressure on Ukrainian families' budgets. However, it cannot provide for implementation of the fair energy pricing principle. Creation of the free energy market without considering the specific character of the Ukrainian economic model cannot be successful.

In fact, practices show that rational energy use can be profitable for a state, businesses and population. Energy efficiency increase is a promising business-model for any society and its members who are concerned about their future. Here, it is essential to establish balanced relations between the government and business to support innovative activities in this market sector.

There currently exist a great number of approaches to and methods of stimulating efficient energy use in the world. The main question is whether Ukraine via its bodies of power is ready to facilitate the real, not declarative, support of development of transparent innovative competitive environment in this economic sector. To what extent can the government moderate corruption and personal interests of its representatives in this field? If appropriate conditions are created, business will join, optimize their own demands for energy and create new high technology production and services in this economic segment.

It is strategically important for Ukraine to create conditions and stimuli to develop a renewable energy industry as a guarantee of the sustainable development of the country considering interests of the generations to come. Ukraine has undertaken a number of international obligations to increase energy generation from clean sources technically achievable potential of which is assessed to be 98 mln toe annually.

Transition to use of renewable energy sources (RES) is very promising in terms of breakthrough in energy resource use from the point of view of sustainable development of the civilization, consideration of the interests of the generations to come, global environmental security provision, economic development increased affordability of energy sources and social justice.

In October, 2014 the Ukraine's Cabinet of Ministers approved the national action program for the period up to 2020 "The Program of the State Support of the Development of non-conventional and renewable energy sources" [7] and the Plan measures for its implementation. The main objective of the National Action Plan for renewable energy is achievement of the renewable energy percentage in the final energy consumption at the level not less than 11 %.

At present, about 230 companies are working in Ukraine's RES market. At that, the greater part of the produced energy (79.9 %) is generated by wind and solar industries. The remaining part of RES produces a little over 20 % of the total production.

Transition to non-conventional energy sources is a capital intensive process: 1 MW of solar and wind power generation costs approximately 1 mln Euros.

The necessity of developing renewable energy industry in Ukraine is determined by a number of factors, major factors being Ukraine's international obligations dependency on energy imports, high

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energy potential of the country as regards renewable energy sources and unfavorable environmental conditions in several industrial regions.

In Ukraine all methods and stimuli of renewable energy development are reduced to establishment of the green tariff for the energy produced from RES and tax and duty incentives when importing equipment for energy efficiency projects and for businesses working in the RES and non-conventional fuel sphere.

What results has Ukraine achieved in terms of non-conventional energy source use? In 2016, Ukraine introduced 120.6 MW renewable energy capacities that is 4 times as much as in 2015. Solar stations account for 99.1 MW or 82.3 % of the amount. The total capacity of object using the green tariff in Ukraine in 2016 made 1.1 GW.

It should be noted that, as compared with the EU countries, the percentage of the renewable sources in the energy balance of the country is still very low and does not exceed 3%. In spite of the close attention of investors to the field, that can be testified by building of dozens of solar stations of 1 to 20 MW within several recent years, the clean energy percentage has not increased among others due to the fact that most solar and wind stations are in the annexed Republic of Crimea.

Despite this fact, several positive factors facilitate enhancement of prospects of development of the non-conventional energy industry. One of them has a regulatory character – decrease of so called green tariffs, i.e. tariffs for purchasing the energy generated from non-conventional sources [8]. The second factor is the long-term state support of investments into RES for the whole payback period in this sphere declared by Ukraine's government. The third factor is sheer reduction in costs of technologies and equipment in the RES sphere.

Generally, it should be mentioned that Ukraine's solar and wind energy industry possesses great potential. But at the present stage of technology development there exist several restrictions caused by accumulation and storage of the generated energy. Conventional storage facilities are being replaced by hydrogen storage technologies, lithium-ion batteries and super capacitors.

Technology development causes appearance of new interesting solutions in the sphere of clean energy use, e.g. the "SolarGaps" startup that in 2016 entered the Ukrainian market with solar blinds that do not require large areas and can be installed in every flat or office.

Thus, within the energy trilemma solution energy efficiency should be treated as an instrument for environmental sustainability provision, a benchmark of transition to clean energy.

The above prerequisites provide Ukraine with an opportunity to keep pace with development of new energy efficient technologies. Transition to renewable energy sources means billions of dollars of investment into Ukrainian economy, thousands of new workplaces for Ukrainians, development of adjacent machine engineering and high-precision equipment industries, the qualitative services market.

Conclusions. For Ukraine as well as for other countries of the world solution of the energy trilemma is a topical problem: to provide consumers with reliable and affordable energy carriers, at competitive prices, generating and using the energy in such a way that to protect the environment and interests of the generations to come.

Ukraine's economic development at the modern stage demands necessary provision of the stable energy efficiency increase as energy efficiency in any form is a way to energy security, a stimulus of the economic development and a prerequisite for creating the free and fair energy market, an instrument of providing environmental sustainability and the final objective of the transition to clean energy.

The responsible social-oriented approach to implementing reforms in rational use of resources can safeguard interests of the state, business and people simultaneously. Energy efficiency increase is a promising development model for every society and its members who are concerned about their future. And it is of importance to establish balanced relations between the government and business to support innovative activities in this market sector.

The constructive position of Ukraine's government as for national economy efficiency increase and transition to RES use can attract billions of dollars of investment, create thousands of new workplaces, promote development of new technologies and create the qualitative services market. This is the correct way to the country's economic development and integration into the all-European economic space.

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