International Journal of Engineering & Technology, 7 (4.8) (2018) 332-338

International Journal of Engineering & Technology

Website:www.sciencepubco.com/index.php/IJET

Research paper

Ways of Buildings Energy Efficiency Increase in EU Countries and Ukraine

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Abstract

Directions of implementing energy saving and energy efficiency policies in international practice, in particular in European Union countries are considered in the given work. It was defined that in the majority of the countries there occurred a considerable decrease in GDP energy intensity during 1990-2016 due to energy efficient technologies implementing. Investments into energy sphere were considerably increasing under compensation at expense of systemic investment decrease into oil and gas sphere. Investments into energy efficiency according to the world regions are reviewed. It was noted that the highest result in energy efficiency sphere in all the global community are achieved in the European Union (EU). The highest level of import dependence in observed in two strategically important sectors, which are oil and gas. According to the aims and priorities of steady development, energy efficiency is defined as the most effective way of energy security increasing. A review of energy efficiency condition in Ukraine compared to world and European experience was made. Particular attention is paid to the energy efficiency condition in construction.
Standards for specific energy consumption as for new buildings are substantially strengthened in EU member states, and calculation procedure for the buildings energy efficiency is obligatory in all countries. It is established that only a complex thermo-modernization of an existing housing stock can significantly affect the reduction of energy consumption.

Keywords: *energy efficiency, energy saving, condition review, construction, strategies and programs.*

1. Introduction

Energy sphere of the world, separate regions and countries is undergoing large-scale changes including intensive renewable energy technologies implementing, realizing strategy of energy efficiency and energy saving increase, prevailing role of electricity in energy consumption is increasing comparing to oil products all over the world. Changes in global economic and energy policies are observed due to the intensive development of the Chinese economy and emergence of growing volume of the US shale gas and oil extraction at the world market.
Energy efficiency increasing by 2040 will reduce the need for extraction and production of energy growth; without energy efficiency the volume of ultimate consumption should have increase by more than two times.
Increasing energy efficiency in the construction and utilities sector in Ukraine requires a detailed analysis of world experience and its implementation in Ukraine in order to ensure energy independence and energy security of the state.

2. Aims and objectives of the work

The objectives of the given work include analysis of global tendencies and European Union measures on energy efficiency increase in production, construction and utility sector aimed at generalization and implementing the obtained experience into the relevant branches of economy in Ukraine.

3. General global tendencies in energy efficiency increasing and energy saving technologies development

According to the Enerdata (Enerdata World Bank, Global energy database) [1], during 1990-2016 due to implementing energy efficient technologies there was the following dynamics observed in the world: energy intensity of world GDP reduced by 31.5%, with a slight annual increase in total energy consumption (20%) and almost unchanged energy consumption per capita. At the same time global GDP amount in 2000-2016 increased by 77% (fig.1). GDP energy intensity changes dynamics, energy consumption and energy consumption per capita in 1990-2016 are presented in the diagram (fig.1).

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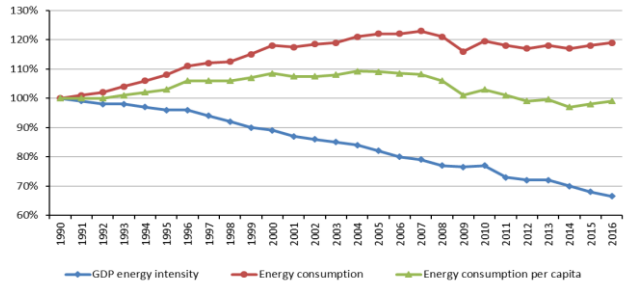


Fig.1: GDP energy intensity changes dynamics

According to Enerdata [1], during 2000-2016 GDP energy intensity is reduced in the USA by 37,1%, in EU countries in general by 26,5% including the Great Britain 39,3% reduction and German 2,3% reduction under with GDP 33%, 25%, 32%, 21% growth respectively. In China over the period specified GDP increased by 3,25 times under energy intensity reduction by 53% (fig.2).

Total amounts of natural energy saved in 2016 as a result of increasing the efficiency of ultimate energy consumption compared to 2000 make about 30 EJ in the IEA member countries and 23 EJ in developing countries [2]. About 40% of these amounts is attributable to a reduction in the cost of electricity generation from coal and 11% to a decrease in global demand for natural gas. General amount of investments into energy sphere all over the world was equal to more than $1.7 trillion in 2016 which makes 2,2% of global GDP amount.

Global investments into energy sphere increased by 6% in 2016 as compared to 2015 altogether with their compensation at expense of systemic investment decrease into oil and gas sphere, which faced reduction by more than quarter over that period, as well as investment decrease into energy production sphere by 5%. In 2016 electrical energy sector for the first time outstripped the oil and gas sector at the pace of energy efficient technologies implementation with a leading position in terms of investment amount.

In 2016 global investments into energy effectiveness in energetics grew by 9% and reached 231 bln US dollars. Chinese The growth rates were the highest (24%), while having the largest share of global investment in Europe. Among all of economy sectors, energy efficiency investments are prevailing in construction sector (US $ 133 billion or 58% of global investment in 2016), with majority of investments in this sector directed to heating / air conditioning and lighting [2].

Success in energy efficiency sphere provides general energy spending saving amounting 540 bln US dollars, predominantly in buildings exploitation and industry segments. The International Energy Agency in its updated Energy Security Policy 2016 proposed an integrated set of energy efficiency recommendations covering 25 areas of activity in seven priority areas. This list includes inter-industry activities, buildings, household appliances, lighting, transport, industry, electricity supply systems and other areas of activity. This set of recommendations was generalized by IEA in 2015. The IEA's recommendations for implementing energy efficiency policy are divided into the following groups: intersectoral measures, industry, buildings, etc.

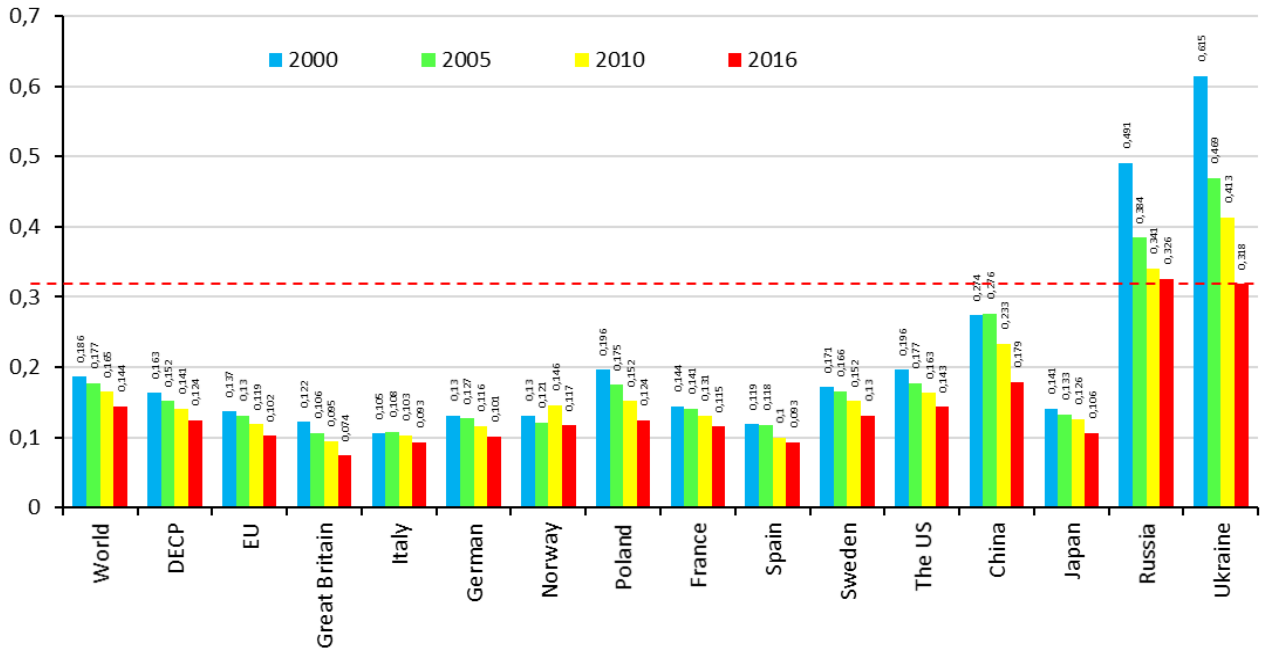


Fig.2: GDP energy intensity in 2000-2016

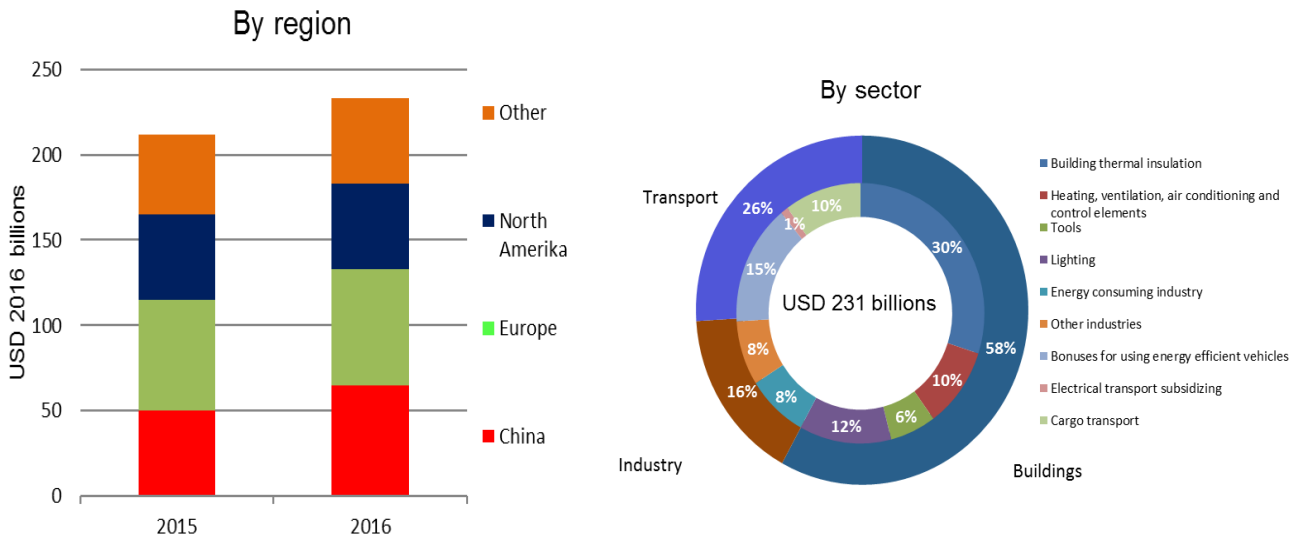


Fig.3: Investments into energy efficiency by the regions and sectors

Implementation of financially justifiable investments is facilitated by the basic measures that make the basis of energy efficiency policy strengthening: energy efficiency standards in such sectors as buildings, industrial equipment, fuel efficiency using; demand management programs; increase in energy efficiency as a condition of granting for capital repairing subsidies; coordinated plans for heat supply; stimulating the financing of energy efficient projects by banks and leasing companies.

According to the International Energy Agency, the best results in the field of energy efficiency as for the entire world community have been achieved in the European Union (EU). It is projected in the IEA's World Energy Outlook 2017 [2] survey that due to the implementation of energy efficiency policies in the EU, demand for natural energy will decrease by 15% by 2040 under 55% economic growth.

The European Union becomes one of the most energy-saving economies regions in the world. Due to efficient use of fossil fuels, implementing of alternative sources of energy and energy-efficient technologies in the EU countries, demand for oil will reduced by almost 40% by 2040; total demand for coal will decrease by 65% (continuing a long-term downward trend), natural gas will also reduce its share in the energy balance. According to the European Commission (EC) expert assessment, the EU today significantly depends on energy resources import, which accounts for 53% of the energy consumption.

The highest import dependency level is observed in two strategically important sectors – oil and gas. In 2010, the European Parliament and the EU Council adopted "Energy 2020 basic energy policy document. Strategy for Competitive, Sustainable and Safe Energy (Energy Strategy)". The Energy Strategy identifies the following energy and climate change goals for the period by 2020: reducing greenhouse gas emissions by 20%, increasing the share of renewable energy sources to 20%, and increasing energy efficiency level by 20%.

Reducing ultimate energy consumption has affected economic indices and the corresponding structural changes in various sectors the EU countries economy, especially in the most energy intensive industries. As a result, already in 2015, the EU member-countries achieved the target index of 2020 (1483 million tons of oil equivalent) in terms of ultimate energy consumption, defined by the Energy Strategy by 2020.

Over the recent 17 years European Union economy has been growing steadily, as a result of which GDP amounts have increased by 25% altogether with GDP energy intensity decrease by 25,5% in 2016).

According to the goals and priorities of the sustainable development strategy, energy efficiency is identified as the most effective means of increasing energy security, competitiveness, reducing greenhouse gas emissions and other pollutants into the atmosphere. Implementation of this direction is envisaged in all sectors of the economy (industry, transport, energy, housing and communal services, construction complexes and households) by implementing the relevant provisions of the EU directives, regulations and National Energy Efficiency Action Plans of the EU member states.

An important stage in the EU development became formation of a unified regulatory framework for energy development and energy efficiency improvement. Since 2006, the EU has been implementing the European Energy Policy (Energy Policy for Europe) and the Strategic plan on Energy technologies (Strategic Energy Technology Plan) to reduce costs and improve energy efficiency.

The measures of the "Energy Efficiency - 2011" Plan are aimed at achieving the target of 20% energy saving in the EU, assistance in implementing the EU Road Map for the transition to a competitive low carbon economy in 2050, as well as enhancing energy independence and supply security. According to the EC, the implementation of the "Energy Efficiency - 2011" Plan should ensure a significant increase in the level of energy saving in the public sector and introduction of new minimum requirements for energy efficiency of equipment and appliances, saving up to 100 million tons of conventional fuel for non-renewable energy production from 2012 to 2010 with annual lowering the ultimate energy consumption by EU member-countries by 1,2%. According to an expert assessment (COM (2015) 80 final), each additional 1% of energy saving reduces the gas imports volume by 2.6%. According to the IEA estimation, every dollar invested in energy efficiency will turn out to be 4 US dollars savings, at the same time such a project will be completely paid off in about four years.

4. Strategies for the building's energy efficiency increasing in EU countries

The European Parliament adopted a number of energy efficiency directives and regulations to organization achievement of the goals set by the Energy Strategy for 2020, including the Directive on the energy performance of buildings of the ESDP-2010. In the EU countries, until 2012, normative documents on certain aspects of energy efficiency operated, therefore, it became necessary to adopt a regulatory act that would provide an integrated approach to energy conservation policies at all stages of production, transformation and energy consumption.

2012/27/EC Directive on energy efficiency adopted on October 25, 2012 became the document providing changes to certain pro-

visions of the previous directives. The Directive establishes general measures on improving energy efficiency within the EU, defines the rules aimed at eliminating barriers at the energy market impeding energy efficiency increase.
The vast majority of EU countries are planning to significantly reduce ultimate energy consumption in 2020. Among the proposed areas of energy efficiency increasing, the most important role is given to combined heat and power production. Taking into consideration the fact that heating and cooling systems in the EU consume more than half of the energy resources in the region, about 75% of which is non-ecological fossil fuels, one of the main directions of the Energy Union is development and non-alternative implementation of medium and long-term programs for reforming inefficient heating systems (air conditioning), which will contribute to reducing the energy resources import and the level of the European Union countries import dependence.
The EC and the EU member states governments have identified the priority of energy efficiency policies in the residential sector. More than 40% of natural energy consumption in the EU falls on the building. Almost two thirds of this energy is spent for residential buildings and one third on nonresidential ones. At the same time two thirds of the energy consumed by the building is spent for providing the work of heating systems, ventilation and air conditioning. According to Euro Commission estimations, amount of energy consumption by buildings may be 30% reduced in case of implementing economically efficient measures.

Table 1: Dynamics of GDP amount and energy intensity in 1990-2016

Regions/ countries	GDP Energy intensity										GDP with RES	
	1990	2000	2005	2008	2011	2013	2014	2015	2016	2000-2016 %/ year	2000, BUSD	2016, BUSD
World	0,219	0,186	0,177	0,166	0,161	0,155	0,151	0,147	0,144	-1,6	63176,393	111806,987
EU-28	0,164	0,137	0,130	0,119	0,113	0,111	0,105	0,104	0,102	-1,8	14795,760	18515,360
Ukraine	0,501	0,615	0,469	0,373	0,375	0,155	0,336	0,320	0,318	-4,0	235,915	327,215

In order to achieve this goal and implement provisions of the "Energy 2020 Strategy for Competitive, Sustainable and Safe Energy", the Energy Efficiency Buildings Directive (EEBD), Directive 2010/31/ЄС (Energy Performance of Buildings Directive, EPBD) was adopted, the provisions of which set energy efficiency requirements for buildings.
EPBD major objective was defined as creating at the national level the basis for increasing residential and public buildings energy efficiency including establishing a number of energy consumption and energy efficiency quantitative indicators for newly erected buildings, existing buildings, buildings engineering systems, constructing materials and frameworks manufacturing.
The Directive suggests the necessity of obtaining energy performance certificate, EPCs. The information referring energy passport for public buildings ought to be in the open access.
According to the Euro Parliament suggestion, a number of additional demands were adopted in the final draft of the document, including the following:

- each EU Member State should develop and implement appropriate energy efficiency measures and establish an independent quality control system in the construction sector, taking into account national characteristics and economic opportunities;
- target values and indicators of national energy efficiency requirements should be established considering the structure of natural energy consumption (kWh / m^2) or alternative energy consumption indicators;
- during the reconstruction of existing buildings, energy efficiency measures must be taken and, where possible, renewable energy technologies must be applied;
- developing and implementing specific requirements for the energy efficiency of heating, ventilation and air conditioning systems;
- all new buildings, starting in 2020, must meet the requirement of "zero" energy consumption (public buildings - from 2022). Defining of the term "zero" energy consumption is left for every EU member state;
- each building should have a power passport with a reflection of actual indicators and a plan of improving the building energy efficiency.

In EU member states, the requirements for specific energy consumption standards by new buildings are being increased [3]. A building should not necessarily use less energy, but it should reduce its flow from external thermal and electric networks by increasing the thermal insulation and recuperation; own production (using solar panels, collectors, heat pumps, wind turbines) and direct solar heating.
Today, the construction of buildings that consume more than 60 kWh/m^2 annually (the standard definition of "low energy house") is not allowed in the EU. Starting from 2019, the maximum allowable specific energy consumption by the building will be equal to 15 kWh / m^2 annually (standard "passive house"). Starting from 2020, a large-scale transition to the construction of "zero-energy" buildings should start. In the perspective there are buildings that will produce more energy than consume (the standard is "home energy plus").
With the introduction of the EPBD directive, the procedure for calculating the buildings energy efficiency is obligatory in all EU countries. The buildings energy efficiency calculations and verification of the norms compliance at the design stage are obligatory for the designer. In the passport of each European structure it is indicated which standard of energy consumption it meets [4].
In Denmark, Portugal, Sweden and Ireland the results of calculations are presented in the form of annual consumption of final energy by the building. In Germany, France, Holland and Greece this is done in the form of annual consumption of natural energy. In Spain and in Finland it has the form of individual elements heat transfer coefficient of the building enclosing structure. In Norway the results of calculations are presented in the form of energy consumption and heat transfer coefficients. Building energy efficiency standards are gradually being enhanced and accompanied by requirements for control with appropriate penalties for non-compliance with standards
In Germany, for example, energy-efficient buildings are those meeting the energy saving standard, which means having annual energy consumption from 30 to 70 kWh / m^2. The annual energy consumption by a 'passive' building should not exceed 15 kWh / m^2 according to the national standard. Currently, the most common types of energy-efficient buildings in the country are efficient buildings of KfW-55 and KfW-70 standards. The 'KfW' abbreviation comes from the 'Kreditanstalt für Wiederaufbau' state bank name, a credit institution for reconstruction programs. The 55 figures in the title of the standard means that the maximum allowable value of annual natural energy consumption and heat losses by such a building is only 55% from the minimum values set by the relevant national energy saving directive. In addition, the annual natural energy consumption by such a building should not exceed 40 kWh / m^2 of useful area of the building.
In Ukraine there are no developed normative legal acts regarding indicators of a 'passive' house, but a 'passive' house is usually considered to be such one, the energy consumption of which does

not exceed 40 kWh / m². Average houses in the country today consume not less than 120 kWh / m² (on average 150 - 260 kWh / m²). The cost of buildings with low power consumption will be more rational compared to the cost of a building with high power consumption. In Europe, while constructing an energy-saving home, the cost increases by 5% only and they are paid off already in the first 7 to 10 years of operation.

Within the "Passiv-On" project for a number of countries comparison of annual primary energy use for heating the premises according to the type of building is presented in the economic analysis 'Review of comfortable low-energy buildings'. The results of this analysis are shown in the diagram in Figure 4.

Currently existing in the number of EU countries characteristics of the buildings with energy balance close to zero (nZEB, near Zero-Energy Buildings) cover natural energy and share of EPE, and also take into account energy flows in different types of buildings. Most countries use natural energy indicators, but in some cases they only consider energy consumption for heat supply.

The experience of a number of EU countries testifies that only a complex thermo-modernization of the existing housing stock can dramatically affect the energy consumption reduction.

The key renewable energy directive for the EU is the '2009 Directive on Renewable Energy Renewal 2009/28 / EC', adopted by the European Parliament in 2009. The provisions of this directive are aimed at implementing measures to increase energy use with PDE. In majority of EU countries an obligatory minimum percentage of the use of EPE for energy supply of buildings has been set. In Germany the share of EPE is calculated on the basis of heat consumption for heating. Depending on the type of PDE and the building, this share varies from 15% to 50%. In Slovenia, the share of the use of EPE varies from 25% to 70% depending on the energy source. In Norway, the share of EPE is fixed and accounts for 40% of the clean energy needs of the building.

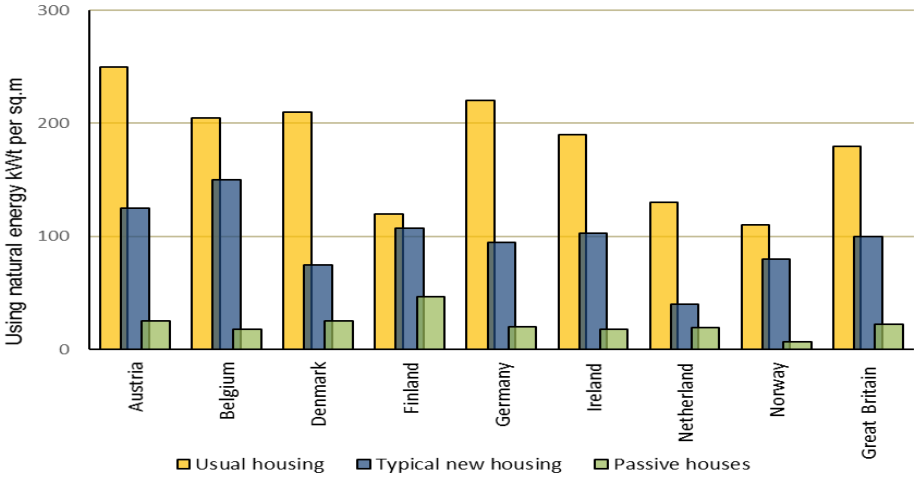


Fig.4: Annual use of energy for heating the premises, taking into account the floor space

In Germany in accordance with the main objective of Directive 2010/31 / EC on Building Energy Efficiency (EPBD), the primary responsibility for the proper implementation of the Directive belongs to the Federal Ministry of Transport, Building and Urban Development, the Federal Ministry of Economics and Technology and the Federal Ministry of the Environment, the Conservation of Nature and nuclear safety. The main provisions of the EPBD Directive are implemented within the framework of the German Federal Law on Energy Savings by legislating the requirements for thermal insulation of buildings; the efficiency of the heating, ventilation and hot water supply system; accounting for the cost of heating and hot water based on the volume of individual consumption.

The buildings energy-supplying is crucial for the implementation of the new energy policy in Germany. About 40% of the total energy consumption in the country accounts for the buildings energy supply. Considering this, the federal government has set an objective on achieving almost complete transition to the construction of buildings with a "zero carbon footprint" by 2050. To do this, until the period specified, it is necessary to reduce the consumption of natural energy (oil and gas) by 80%. For these purposes, the federal government annually allocates funds in the amount of about 2 billion Euros.

In Germany those buildings are considered to be energy-saving ones, which meet energy-saving standards, i.e. have an annual energy consumption of 30 to 70 kWh / m ^{2}. In addition to 'passive' buildings, in Germany, there are also the following types of energy-efficient buildings and buildings: the KfW 60 energy saving house (provides for annual energy consumption not exceeding 60 kWh / m^2), energy saving house KfW 40 (annual energy consumption is not exceeds 40 kWh/m ^{2}).

5. Review of energy efficiency condition in the construction sphere in Ukraine

Ukraine belongs to energy-deficient countries according to provision basic types of natural energy, which necessitates significant import volumes. The country's level of energy dependence (over 51%) is largely determined by the inefficient use of energy resources [5]. In 2016, the country's economy consumed 33.2 billion cubic meters of natural gas. In terms of its own production, according to the NJSC 'Naftogaz Ukrainy', 20.1 billion cubic meters of gas are to be imported from more than 11 billion cubic meters of gas from the European Union.

The generating companies of the TPP UES of Ukraine for the production of electricity and heat in 2016 used 18.8 million tons of petroleum, of which 98.3% made coal; 1.3% - gas and 0.4% - fuel oil. In order to meet the needs of energy and other sectors of the economy, 15.6 million tons of coal were imported in terms of own production equal to 40.9 million tons.

According to the Institute of General Energy of NAS of Ukraine estimations, the potential of energy saving and energy efficiency in Ukraine is realized less than by half. Inefficient consumption of fuel energy resources increases the level of the country's economy import dependence and deepens the problems of its energy security.

One of the main indicators in determining the energy efficiency of each country's economy is the GDP energy intensity. Ukraine at present, with its high level of import dependence, is the most energy intensive country in Europe. The low efficiency of fuel and energy resources use is due to the high level of energy intensity of GDP in Ukraine, which in terms of purchasing power parity (PPP)

exceeded the energy intensity of the GDP of the EU countries by 3.12 times in 2016, including Great Britain by 4.3 times, Germany by 3.1 times, France by 2.8 times, Turkey by 2.7 times, China by 1.7 times, and the average value of the countries of the world by 2.2 times. In particular, in Poland, with its more than 2.6 times lower GDP energy intensity, its volumes are 3 times higher than the GDP of Ukraine [6].

According to expert estimations, only in the residential sector of Ukraine specific heat consumption is 2-3 times higher than in the EU countries, in particular, in multi-apartment buildings it is 150 ... 264 kWh / m^2. In European countries specific heat consumption in similar buildings does not exceed 90 kWh / m^2, in particular, in Germany - up to 70 kWh / m^2. In budget buildings, thermal energy consumption ranges from 130 to 250 kWh / m^2, while in the EU this indicator varies from 50 to 80 kWh / m^2. Entering the European level of energy costs in the country's buildings will enable saving up to 11.4 billion cubic meters of natural gas that makes the entire volume of its imports.

The legislative framework for energy efficiency in 2017 was supplemented by the Law of 22.06.2017 №2188-19 'On the energy efficiency of buildings', which defined the legal, socio-economic and organizational principles of activity in the field of buildings energy efficiency. The basic provisions of this law meet the requirements of the provisions of Directive 2010/31 / EC on the buildings energy efficiency. The law introduces the buildings thermo-modernization, promotion of the use of renewable energy sources, certification of buildings energy efficiency by an independent energy auditor, development and implementation of a national plan on increasing the number of buildings with near zero energy consumption, etc. The buildings energy efficiency is determined according to a methodology that takes into account the requirements of the legislative acts of the European Union, the Energy Community, harmonized European standards in the field of buildings energy efficiency. The approval of this methodology by the central executive body ensures formation of state policy in the field of construction.

According to the Ministry of Regional Development of Ukraine, annual losses of heat in the residential sector reach 60%, which is equal to $ 3 billion [7]. At the same time, the greatest energy losses occur in multi-apartment buildings, which make up 98% of all the residential stock of the country and consume up to 58% of gas and up to 34% electricity from total consumption. In order to solve this problem it is necessary to start the implementation of European countries practice: to develop and implement mechanisms for energy efficient measures co-financing, energy services, energy management, etc. Therefore, at present, among the main energy efficiency measures there is the promotion of investment in thermo-modernization of residential buildings and the construction of buildings with near-zero energy consumption, introduction of the buildings energy efficiency certification, energy audit and energy management, as well as ensuring 100% commercial accounting of gas consumption, electricity, heat energy, and water.

The Energy Efficiency Program is aimed at stimulating the population, associations of co-owners of multi-apartment buildings and housing construction cooperatives to implement energy-efficient measures. It involves irreversible reimbursement from the state and local budgets of part of the loans amount for insulation of buildings, the purchase of boilers using any kind of fuel and energy (except for natural gas and electric energy), installation of units for water and heat, heaters with heat regulator, replacement windows for energy efficiency, lighting upgrades, etc.

The Plan of Measures for the Implementation of Energy Management Systems in Budgetary Institutions was approved by the Decree of the Cabinet of Ministers of Ukraine on April 26, 2017 No. 732-p. Implementation of this plan will enable establishing a systematic approach to implementation of energy management measures in the budgetary sphere. Positive effects of the introduction of energy management systems have already been received in the cities of Kyiv, Lviv, Vinnytsia, Zhytomyr, Chernivtsi, Korosten, Myrgorod, Lutsk, Kamianets-Podilsky and others. Following to the experience of the best cities, where energy management is implemented, the economy is: for Kyiv - 1.1 billion UAH for 3 years; for Lvov - UAH 18 million for the first 7 months; for Zhytomyr - 4.4 million UAH per year; for Korosten - 3 million UAH.

According to the Ministry of Regional Development of Ukraine data as of June 2017, the multi-apartment buildings equipment with common-purpose heat meters in Ukraine amounted to 70.5%. The highest provision with equipment is available in Kyiv (95.2%), Mykolaiv (92.5%), Dnipropetrovsk (89%), Kherson (88.4%), and Lviv (84.3%). The lowest rates are in Donetsk (38.7%), Luhansk (15.8%) and Ternopil (10.1%) oblasts.

In accordance with the Law of Ukraine of 04.06.2015 № 514-VIII 'On amendments to some laws of Ukraine regarding the provision of competitive conditions for the production of electricity from alternative sources of energy', the 'green' tariff is calculated in accordance with the Euro. This Law abolished the requirements for the 'local' component; introduced a green tariff for SES and WEEs of private households with a capacity of up to 30 kW and an appropriate increase was added to the 'green' tariff for the use of Ukrainian production equipment. According to the State Department [3,8] of Energy Efficiency, implementation of the Act provisions contributed to a significant increase in the number of private households installing solar panels on roofs of their buildings. If in the beginning of 2015 there were only 40such objects, then as of October 2017, 2323 households installed solar power installations with a total capacity of 37 MW, involving for this purpose almost € 35 million of investments.

The Energy Strategy of Ukraine for the period up to 2035 'Safety, Energy Efficiency, Competitiveness' (ЕСУ-2035), approved by the Cabinet of Ministers of Ukraine dated August 18, 2017 No. 605-p, defines the purpose and objectives of building the energy sector in accordance with the needs of the economic and social development of the country for the period up to 2035. The main goal of the development of energy for the period until 2035 is to ensure energy and environmental safety and the transition to energy efficient and energy saving use and energy consumption with the introduction and innovative technologies. The strategy foresees the introduction of passive house building standards. Increasing the energy efficiency and energy saving by reducing the volume of energy consumption and the level of dependence on their imports, increasing the competitiveness of Ukrainian goods on world markets, improving the environmental situation is one of the main directions of state policy in the field of energy security of Ukraine.

6. Conclusion

1. Investments in energy efficiency have increased significantly in recent years. The highest growth rates were in China, although the largest share of global investment was observed in Europe. Among all the sectors of the economy, energy efficiency investments predominate in the construction sector.
2. International experience shows that, in terms of lack of coordinated national policies and clear leadership at the highest level, measures on improving energy efficiency do not yield significant results.
3. The International Energy Agency (IEA) noted that the highest energy efficiency results in the entire world community are achieved in the European Union (EU). Over the last 17 years the GDP volume has grown by 25%, while the energy intensity of GDP has been reduced by 25.5%.
4. The EU countries experience of testifies about a significant economic benefit from investing in energy saving and energy efficiency. The EU recognizes the priority of energy efficiency policies in the residential sector.
5. Considering the high level of energy intensity of the Ukrainian economy, inefficient use of energy resources and energy import dependence, energy efficiency is currently the most important resource of energy security of the country, reducing import de-

pendence and guaranteeing the formation of the necessary potential for the economy of the state and society further development.

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