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# DETERMINATION OF ENERGY EFFICIENCY BARRIERS TAXONOMY IN SOCIO-ECONOMIC MODEL OF UKRAINE

Об'єктом дослідження є соціально-економічна модель України в розрізі енергоефективних чинників впливу. Одним з найбільш проблемних місць є виявлення, ідентифікація бар'єрів енергоефективності та їх мінімізація. Процес впровадження енергоефективних технологій пов'язаний зі складністю та тривалістю просування на ринку, та досить високою їх вартістю, та гальмується цілим рядом перешкод, бар'єрів енергоефективності.

Проведено аналіз сучасного стану соціально-економічної системи України. Визначено основні характеристики бар'єрів енергоефективності соціально-технічної системи у співвідношенні до вже виявлених у зарубіжних системах, ідентифіковано нову групу бар'єрів розриву енергоефективності. Впровадження таксономії бар'єрів енергоефективності, їх ідентифікація в кожному індивідуальному проекті впровадження енергоефективних технологій покращує їх просування та підвищує економічний ефект цих технологій.

В ході дослідження використовувалися абстрактно-логічний метод та порівняльно-статистичний аналіз для дослідження теорії й практики теорії бар'єрів енергозбереження у світі та в Україні, а також для виявлення перспектив подолання бар'єрів. Визначено сукупність критеріїв, що формують бар'єри енергоефективності для України. Ці етапи передбачають проведення системно-структурного аналізу для визначення наявності бар'єрів енергоефективності, а також описання їх прояву. Крім того, ті бар'єри, що наявні у соціально-економічній моделі країни, але не описані у основній теорії, були структуровані та описані. Для реалізації цих етапів було адаптовано базову структуру бар'єрів енергоефективності в українську соціально-економічну модель, а також виведено групу бар'єрів, властивих для України. Завдяки цьому в українську наукову літературу та поняття ділового обороту було введено термінологію «таксономія бар'єрів енергоефективності», що до цього використовувалося лише закордонними вченими.

**Ключові слова:** бар'єри енергетичної ефективності, таксономія бар'єрів, розрив енергоефективності, впровадження теорії розриву енергоефективності.

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## 1. Introduction

Economic and organizational problems of energy efficiency have been studied by Ukrainian scientists for more than ten years. The problem of energy efficiency has gone beyond the narrow professional study and perception, if before it was taken care of by physicists, power engineers, electricians and economists, now it is being written about by sociologists, political scientists and journalists.

The theory of energy-efficiency gap was chosen as the basic model of the problem research methodology, as this theory has not been studied in detail by Ukrainian scientists. The theory reflects the following situation in the socio-technical system: despite the potential energy efficiency, technical and technological opportunities to improve energy efficiency are not fully used due to a number of reasons of different nature. Such reasons in foreign literature are usually investigated using the terminology of energy efficiency barriers.

## 2. The object of research and its technological audit

The object of research is a socio-economic model of Ukraine in terms of energy efficiency factors. The socio-economic model

of Ukraine is characterized by certain features. These features are inherent in the transition economy. The market structure of Ukraine is not fully formed. Regulatory state mechanisms, acting in the social interest, create market skew. Production infrastructure is characterized by depreciation of fixed assets. External borrowings and the presence of domestic debts contribute to the imbalance of market infrastructure. The excess of the share of imports over exports does not contribute to the inflow of foreign exchange earnings, and causes an imbalance between the domestic market and the national currency. High energy intensity of gross national product (GNP) requires comprehensive energy efficiency decisions.

One of the most problematic places is the detection, identification of energy efficiency barriers, their minimization. The process of introduction of energy efficient technologies is associated with the complexity and duration of market promotion, and their relatively high cost, and is hampered by a number of obstacles, energy efficiency barriers.

## 3. The aim and objectives of research

The aim of research is determination of the taxonomy of energy efficiency barriers in the socio-economic model of Ukraine.

To achieve the aim of research the following scientific objectives are identified:

1. Make a theoretical substantiation of energy efficiency barriers in relation to Ukraine.
2. Develop a scientific and methodological approach to the assessment of energy efficiency barriers.
3. Adapt the basic structure of energy efficiency barriers to the Ukrainian socio-economic model.
4. Introduce the terminology «taxonomy of energy efficiency barriers» in the Ukrainian scientific literature and the concept of business turnover.

#### 4. Research of existing solutions to the problem

In the 21st century, the strategic goal for the world's socio-technical functionality is to increase energy efficiency. The set of energy saving and energy efficiency measures that each state implements within its state within its technological structure is obliged to ensure not only its competitiveness, but also the longevity of the global ecosystem.

Ukrainian scientists, developing this topic, already have a base of developments in the field of energy saving and energy efficiency. However, they are considered by them in a narrow, local sense, not covering the general problems of the socio-technical system.

Having studied the scientific and theoretical achievements of Ukrainian scientists, it is possible to identify a number of patterns. Thus, most scientists, when analyzing energy saving problems, pay the greatest attention to the emergence of prerequisites for energy efficiency of energy resources, namely financial and technological support, development of innovative technologies and alternative energy sources. These factors are necessary to ensure energy efficiency.

The presence of such factors, in itself, does not guarantee that their impact will be extended to the socio-economic system in terms of reducing energy intensity. On the contrary, the effect may be zero or insignificant. This socio-economic phenomenon is called in the world «the theory of energy efficiency gap».

In their relations with the Ukrainian state, global financial, grant, state and non-state institutions use the terminology of energy efficiency barriers to assess the state and recommendations on energy efficiency inside Ukraine. This fact is another reason for Ukrainian science to develop the theoretical and methodological basis for the theory of energy efficiency gap and the integration of the concept of energy efficiency barriers in the Ukrainian socio-economic system.

Foreign scientists have developed a set of indicators of a wide range, which can be described as reasons to prevent the introduction of energy efficiency measures. The author considers it expedient to extend the foreign experience of studying energy efficiency fuses to the socio-economic model of Ukraine.

Among the main works on the theory of energy efficiency gap, found in the resources of world scientific periodicals, can be identified [1–3] – as works in which market barriers are formulated. However, the barriers of the market are considered in detail in the works [4, 5]. These works delimit market barriers. A significant contribution to the theory of energy efficiency gap was made by works [6, 7], although the authors failed to form an exhaustively complete taxonomy of energy efficiency barriers.

Along with this, the authors of the study [8] identify technological barriers that can't be attributed to the gap in energy efficiency, but which are certainly important for certain specific situations. In the works [9, 10] barriers to the lack of experience and opportunities are identified. These barriers can't be considered new because they fit well into Sorrell's class of organizational barriers, and the works [11–13] are devoted to energy saving, but the normative and technical base on this issue has not been developed.

In the work [14] the problems of energy saving are considered and it is identified as a priority area of the development of Ukraine. However, this paper does not fully reveal the priorities for the development of the energy sector of the economy, given the world experience. And in the work [15] the author emphasizes the importance of public administration mechanisms in the field of energy efficiency. Given the various forms of ownership in Ukraine, the author identifies the mechanisms of public administration for all these forms. In this work it would have been necessary to pay attention to the interaction of enterprises of all forms of ownership in achieving energy efficiency.

Thus, the results of the analysis allow to conclude that the problems of energy efficiency are considered in different contexts by Ukrainian and foreign scientists. Foreign scientists are trying to identify all the reasons that cause obstacles to the advancement of energy technologies, and Ukrainian ones are paying attention to the technology itself, and the reserves for the creation of such a technology. First of all, Ukrainian scientists analyze energy conservation, while foreign scientists have long used both the concept and the term «energy efficiency».

The theory of energy-efficiency gap is chosen as the basic research methodology. The theory describes a situation in the socio-technical system when the existing technical and technological opportunities to improve energy efficiency, despite their potential economic efficiency, are not fully used due to reasons of various kinds. These reasons in foreign literature are accepted to investigate using the terminology of energy efficiency barriers [16].

In the work [17] American economists and scientists first introduced the concept of «theory of energy efficiency gap», thus beginning research in this direction [18].

A group of scientists [19] was the first to systematize and classify the existing social and institutional barriers in 1980. This group of authors formed five non-price categories of energy efficiency barriers:

- 1) inconsistency of incentives: the economic benefits of energy conservation are not always obvious to the agent, whose responsibilities include the implementation of measures to improve energy efficiency;
- 2) lack of information: the efficiency of the market of energy efficient technologies depends on the availability of adequate information about these technologies among its participants;
- 3) regulatory system: if a cost-effective technology or method of energy saving contradicts existing standards or rules, their implementation will be difficult or impossible;
- 4) market structure: cost-effective technologies may not be available on the market or may be restricted;
- 5) traditions: if a cost-effective measure or technology requires a change in consumer habits or contradicts some social principle, it can be rejected [18].

Subsequently, energy efficiency barriers were identified and systematized from different angles [20, 21], but a group of scientists in [22] most broadly and fully generalized the categories of barriers. This work has become one of the main ones on the theory of barriers. It formulates the most complete taxonomy of energy efficiency barriers. The author divided economic barriers into *non-market barriers* and *market failures* and introduced two new groups of barriers, which he identified as non-economic – *behavioral* and *organizational*.

This is very important because, depending on the socio-technical development of the state or region, which is primarily affected by the development of market infrastructure of the state, the impact of non-economic barriers on the implementation of energy efficiency measures may be significant or predominant.

### 5. Methods of research

The study uses such research methods as:

- abstract-logical analysis – during the study of the essence of the concepts and definitions of the theory of energy saving barriers in the world, namely the study of the works of foreign scientists on the formation of the theory of barriers and its derivation for different countries;
- comparative and statistical analysis – during the study of the current state and prospects of overcoming energy efficient barriers in Ukraine;
- system-structural analysis – during the formation of a set of criteria that form barriers to energy efficiency for Ukraine.

### 6. Research results

It is necessary to analyze the socio-technical system of Ukraine in order to identify factors that have been developed in the features of this system, which hinder the implementation of energy efficiency measures or offset their results. To achieve this, the author turned to the taxonomy of energy efficiency barriers developed by foreign science as a reasonable and tested model of obstacles to reducing the energy intensity of the gross national product (GNP) of the state. The taxonomy of barriers derived as the most perfect for these conditions will be analyzed in terms of the Ukrainian economic model.

Let's present the taxonomy of S. Sorrell [22] in Fig. 1.

Let's describe how each of the barriers is reflected in the Ukrainian realities. The main part of the barriers to energy efficiency by S. Sorrell is *economic barriers* subdivided into *non-market barriers* and *market failures*. To *non-market barriers* belong *heterogeneity* of economic agents in

relation to energy efficient technologies, latent (hidden) cost of technology implementation, difficult access to capital and risk of investments [16]. Consider their features and factors that are characteristic to each of these barriers in Ukraine.

Presence of *heterogeneous barrier* [16] is characteristic when there is a certain gap in the technology used, which is effective for most institutions and enterprises and is ineffective for a certain class of consumers. The group of consumers for whom the consumption technology has proved ineffective have a disparate nature and have no common interest, and consist of different consumers who are not connected in any way. An example of such a barrier in Ukraine for the population and enterprises can be the availability and further abolition in January 2017 of the night electricity tariff. This abolition significantly increased the costs of private households and enterprises for electricity, because they used the night tariff, carrying out maintenance and diagnostics of equipment or used them in everyday life. With the abolition of this tariff, most did not feel any changes, but for those who took advantage of the night tariff, the blow was significant.

The next barrier among non-market ones is *latent cost of technologies* [16]. And this is one of the most typical barriers in Ukraine. Energy efficient technologies are not always objectively overestimated and this is found everywhere, from private and state-owned enterprises, to newly created united territorial communities (UTC) when implementing projects or in the association of apartment building co-owners (AABC) who decide to improve their living conditions. In recent years, this barrier has been successfully combated, attracting public and grant funds for educational work, but a considerable amount of work still needs to be done to overcome it.

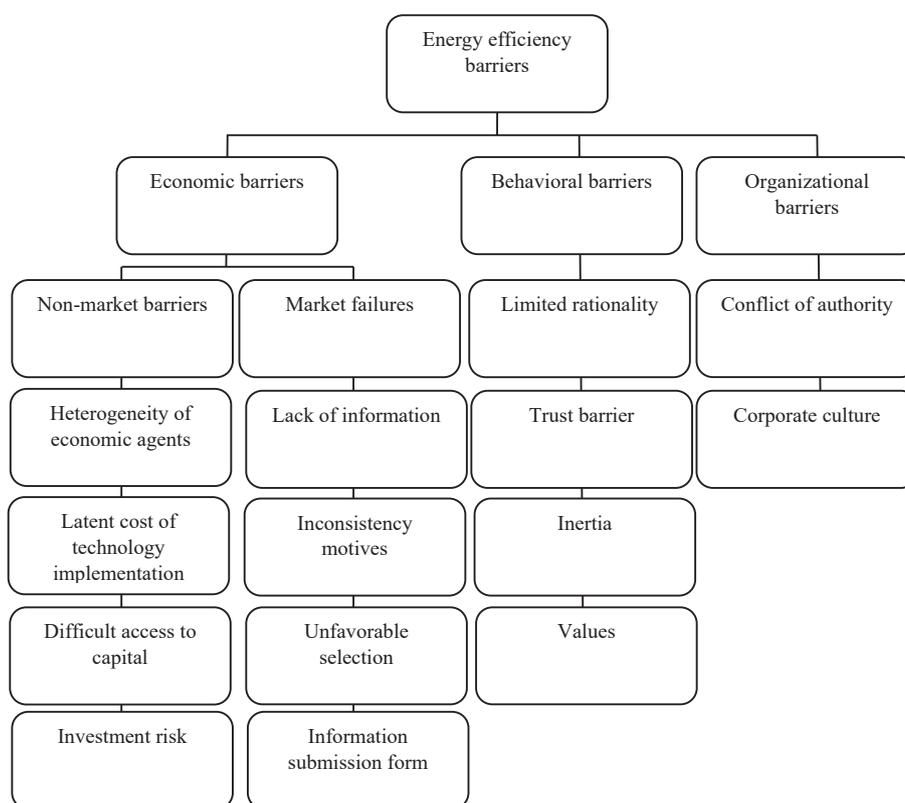


Fig. 1. Energy efficiency barriers by S. Sorrell [22]

The essence of the barrier is that the cost of energy audit work is not taken into account when implementing projects, conducting economic or engineering works and research. Besides, the cost of disposing of surplus materials, equipment and consumables used in the work, as well as the creation and maintenance of an energy management system is not included. Obtaining of permits, binding of the project to the territory, change of assortment and market cost of materials, change of direct labor costs, expenses for training and advanced training of personnel, assignment of experts, creation of permanent commissions, etc. can also be overlooked [23].

The barrier they are currently trying to overcome is *difficult access to capital* [16]. The effect of this barrier was discussed above. It should be added that the lack of information about the borrower causes distrust in financial institutions. Particularly high levels of distrust can arise in small businesses as well as households. This applies not only to the introduction of energy-saving technologies, but to any projects to modernize the existing technological base. As studies have shown [24–26], this problem is important in many countries of the world. At present, attracting funds from state organizations, foreign grant organizations and private funds weakens the effect of this barrier in the state. This is especially true for UTC, which raise funds to modernize their own infrastructure. However, this applies to small funds. There are still obstacles to raising significant capital, such as high interest rates in banks and the need for significant collateral.

The last of the non-market barriers – *investment risk* is especially noticeable in eastern Ukraine, where the armed conflict continues. This barrier is characteristic not only for energy efficient, but also for any other innovative technologies. The unstable situation and the outflow of labor force do not contribute to the inflow of investment, but in recent years more and more Ukrainian companies are attracting funds from foreign partners as investments. This requires compliance with foreign quality standards for independent audits, but with each passing year, attracting foreign investment becomes more accessible.

The next group of economic barriers is *market failures: lack of information, inconsistency motives, and unfavorable selection*.

Firstly, the lack of information on the technical and technological parameters of products and technologies, especially those related to energy performance and feasibility of using a technology or product, encourages customers to make sub-optimal decisions. Such decisions in turn lead to the expansion of the market for energy-consuming goods, and energy-efficient and energy-saving technologies do not receive adequate funding [17, 27]. Secondly, as a result of rapid improvement of technologies there is a moral aging of a subject and the equipment and in a new time interval they become not optimal. Thirdly, the result of energy savings can be difficult to assess, given the conditions (climatic, industrial) in which the technology or object is operated [16]. Thus, in the case of improper use or use in conditions with high humidity, the use of LED lamps is inefficient, and when there is a fog, the use of single-crystal solar panels is also inefficient. In addition, some organizations still do not have computer software, and older staff, like most of the country's population over the age of 50, does not have digital technology at all or are not at a sufficient level to perform their duties. This

is also reflected in the lack of digitalization of data that is publicly available in developed countries, such as periodicals and library materials. Insufficient awareness and untimely access to information pushes the development of the country and society back.

It follows from this barrier that when market participants do not have equal access to information, the next two barriers arise, namely «*inconsistency of motives*» and «*unfavorable selection*».

Inconsistency of motives, or, as this barrier is called, inconsistency of incentives [28]. The barrier arises when the final beneficiary is not those organizations or individuals who have implemented energy saving measures or are investing in energy saving. This can happen when, as a result of energy conservation in a particular unit of the organization or enterprise, the benefits are noticeable only at the level of the entire enterprise, and the units themselves do not receive any benefits or incentives [18].

*Unfavorable selection* [16] can manifest itself in two forms. Without enough information, organizations can purchase technologies that will not fully meet their needs or are suitable for working in a given climatic or technical environment, as described above. In addition, energy-efficient technologies are generally expensive and do not involve test models, and buyers often turn to cheaper models and technologies because they lack comparability. This is especially common in Ukraine when purchasing household goods by the population, and may be the result of successful marketing moves of suppliers of technology or goods in relation to enterprises or organizations.

However, the impact of this barrier can be mitigated by reducing the impact of the «*lack of information*» barrier. Thus, using the experience of energy modernization of related enterprises or those located nearby, the exchange of experience and technology will reduce the impact of barriers associated with *market failures*.

The following it is suggested to consider groups of *behavioral* and *organizational* barriers. The first behavioral barrier is the barrier of *limited rationality*. In the works [24, 29], based on the results of several empirical studies of European automotive companies it is emphasized that this phenomenon is considered only a deviation from the logic of economic rationality in calculating the rate of return on capital and payback period of investment in energy efficient technologies [18].

This barrier is very common in Ukraine, with a number of clear manifestations. The energy market is not simple, technologies are changing rapidly, and the number of parameters that save is growing. In turn, the consumer seeks quick and simple solutions and sometimes does not know all the necessary variables to form a complete picture of energy consumption. It follows that decisions on the acquisition of technology are made taking into account the most expressive indicators, leveling others, which leads to not making the most profitable decisions for the company or within the project. It should be noted that this can be formed artificially, when certain service representatives deliberately distort the information, presenting it in such a light that consumers or the customer are inclined to a more favorable choice for the representative. In this case, the irrational choice is not from the lack of information, but from the limitations (educational, professional, time) of the decision-making agent.

In the works [16, 30] a separate barrier – *information submission form*, it is extremely important, who prepared

the information, in what form, time, place of submission, it must be clear and understandable for perception. This barrier is extremely important also because the manipulation of information in order to achieve self-interest at various levels, from domestic to public, can have catastrophic consequences. For example, in the transition period in Ukraine there is a mismatch between an employee education and the position held, personnel at enterprises perform the functions of lawyers, economists and accountants, and vice versa, the heads of specialized enterprises are people without professional education, as well as workers without training. Accordingly, these categories are not able to accurately reproduce information and perceive it professionally. These include distortions of statistics, reports, analytical notes and reports, and so on.

*Trust* – the barrier associated with access to information and its presentation. However, the presence of trust and respect for each other by consumers and representatives creates a favorable market environment. However, this barrier also exists in Ukraine, where limited information and lack of reputation, low social culture form this barrier both among end users of resources and among companies, enterprises and the state.

*Inertia* is the result of different attitudes to gains and losses according to research [31]. In the Ukrainian market, it is manifested through the failure to conduct regular surveys and surveys of consumer preferences. The manufacturer continues to produce goods that it believes will be of interest to the consumer. Inertia also exists within organizations and its consequence is the existence of such a concept as bureaucracy. Externally, this is characterized by the presence of latent demand for more energy-efficient technologies than those available on the market. In this regard, the least inert is the Chinese market, which, maneuvering in world market trends, instantly produces duplicates of things that are currently most in demand.

*Values.* An important driver of technological modernization of production and its transfer to more energy-efficient technologies are the value orientations of top managers of enterprises and organizations. First of all, it concerns ecological values [22]. Management's focus on environmental friendliness is extremely important, if environmental friendliness is cultivated as a value, then technological modernization and implementation of energy management become a priority and a necessity.

In Ukraine, more and more people are becoming environmentally conscious, the culture of careful consumption is gaining momentum, but it is not so common among companies. The tradition of saving consumption was brought to Ukraine by foreign companies, such as MTS. Every year, more and more companies are adopting this trend, introducing a culture of energy saving in offices and industries, and energy-saving industries are formed. For example, «Zeleny ptah» [32] – Ukrainian paper factory that produces it from secondary raw materials.

Finally, let's consider the last block of barriers – *organizational barriers*. They are defined as those that prevent the introduction of energy efficient technologies within organizations and enterprises [16].

So, *conflict of authority* is associated with the allocation and use of resources. This barrier is widespread, as responsibility for energy issues usually rests with non-senior engineering departments. Top managers often do not pay attention to energy saving problems, which is

why energy programs are not funded, profile departments are not provided with human and material resources. In addition, the opposite effect occurs, where more progressive and young top managers face obstacles in the face of more conservative engineers or financiers, who consider energy-saving measures a useless and unnecessary fashion trend. Therefore, opportunities to increase energy efficiency may be lost, despite their obvious technical and economic benefits.

Culture according to the work [33] is defined as a combination of knowledge, ideology, values, norms, laws and traditions that characterize a social group. Culture is an important variable in explaining the setbacks and failures of energy efficient technologies [18]. In Ukraine *corporate culture* is formed by a generally hierarchical structure «from top to bottom», where all directives come down from management and are executed by subordinates. Young and dynamic companies are implementing a horizontal management model, where everyone's opinion is important and each participant can contribute to the improvement of their own work processes.

Analyzing the economic situation, socio-cultural aspects and the current political situation in Ukraine, it is possible to identify five specific barriers.

1. «*Post-Soviet*». The socialist way of life was formed in a closed system behind the «iron curtain», and had such a characteristic feature as wastefulness. Society was not focused on economy, cost reduction and rationality, because it contradicted the basic doctrine of the state – building a society of general prosperity. On the other hand, a large and closed country was energetically self-sufficient, waged a comprehensive competitive process with the capitalist world, without the need for austerity measures, on the contrary, the course was to demonstrate superiority and wealth. In everyday life it was expressed in constant celebrations, almost all holidays were celebrated and personal solemn events on a particularly large scale. In the production sphere – compliance with the rules of use of materials, and for leftovers and shortages criminal liability was provided. In the Soviet state there was an unprecedented package of social services. As a result, savings were not embedded in the human consciousness part of Ukrainian society, according to the author; it is about 67 % of the population [34]. The author took as an indicator the population that at the time of the collapse of the Soviet Union reached 30 years old, that is, was born, grew and formed its own worldview during these times. This calculation is made inherited by the domestic production paradigm, which did not include the concept of economy, savings or rational use. This concept was not integrated into social and industrial culture and spread to the culture and perception of individuals and passed to our days.

The planned distribution of electricity in the production sphere and social infrastructure is another atavism attributed by the author to the post-Soviet barrier, the main thing in which is the observance of the established norms, which have been called «limits». If the amount of consumption set by the limit has not been used, in the next period the planned amount is reduced by the supplier, in case of overspending there is a penalty that exceeds the amount of overspending. It should be noted that the energy supply system is fiscal. Its normative and reporting documentation does not include such indicators

as energy saving or energy efficiency, there is no dialogue or interaction in this direction in the system «supplier» – «consumer». They interact as a «buyer» and a «seller», which does not contribute to the formation of social trust and the creation of an energy-conscious society.

Ukraine has inherited a significant bureaucracy, with a clear top-down vertical and a lack of horizontal interaction, which is also a post-Soviet atavism.

The post-Soviet barrier can't be attributed to *inertial*, because it is not a habit, but a specific state of consciousness and economic structure, which characterizes post-Soviet society.

2. *Reputational*. It so happened that currently in Ukraine there is no institution of reputation, including business. Reputation is an idea, a constant opinion that has been formulated in society as a result of human activity, company, state for a certain period of time. Reputation has real material indicators, according to which trust in its owner is formed. Reputation, according to the author, can be equated to a brand. Company brands are valued on their own, their products and services are more expensive, and easily promoted in global markets. Prominent English economist, Nobel Prize winner Simon Anholt in 2009 introduced the concept of «national branding». It is the so-called «hexagon of Anholt» that measures the Nation Brand Index: exports, governance, culture, population (people), tourism, emigration legislation and investment [35]. The cost of brands in countries such as Switzerland, the USA, the UK is more than a hundred times higher than their budget. The rating of the countries of the world «Brands of the countries» is annually published by various analytical editions. In 2019, according to the Future Brand Country Index (FCI 2019), Ukraine took 74th place.

Thus, the reputation barrier in Ukraine exists both at the state and corporate levels, as well as in public life.

3. *Oligarchic*. As a result of specific privatization that took place in Ukraine in the 1990s, the common property of the Ukrainian people became the property of several people. Thus, an oligarchic barrier has been formed, which is manifested primarily in the energy sector. For example, DETEK owns 1/4 Ukrainian energy market and supplies 85 % of thermal coal, 95 % of oil in Ukraine is extracted by Ukrnafta [36]. The privatization of energy industrial facilities in general has not led to the modernization of Ukrainian energy funds, but has strengthened the impact on the energy sector and related oligarchic capital industries, as well as on the consumption of energy resources by social infrastructure.

This barrier may seem like a double barrier of «*corporate culture*». However, highlighted by the author «*oligarchic*» barrier has large external manifestations. And last but not least, a number of laws were passed during the transition period and currently serve the interests of oligarchic capital.

4. The author identified two parallel barriers – *communal* (insolvency barrier) and «*subsidy*», which is closely related to the public, but is not its double. These barriers have the same dimension but a different nature of origin. According to the State Statistics Service as of March 21, 2020 [37] indebtedness of the population for communal payments amounted to 2.19 billion euros.

- According to the author, the reasons for this could be:
- unbalanced economic policy of the state;
  - rising energy prices;

- unsuccessful privatization;
- depreciation of fixed assets of production and supply;
- high share of energy transportation costs;
- high energy consumption of social and residential buildings;
- low wages and pensions in general in the state.

The reasons for the communal barrier indicate its prevalence in the socio-economic system, and the monetary dimension – the intensity.

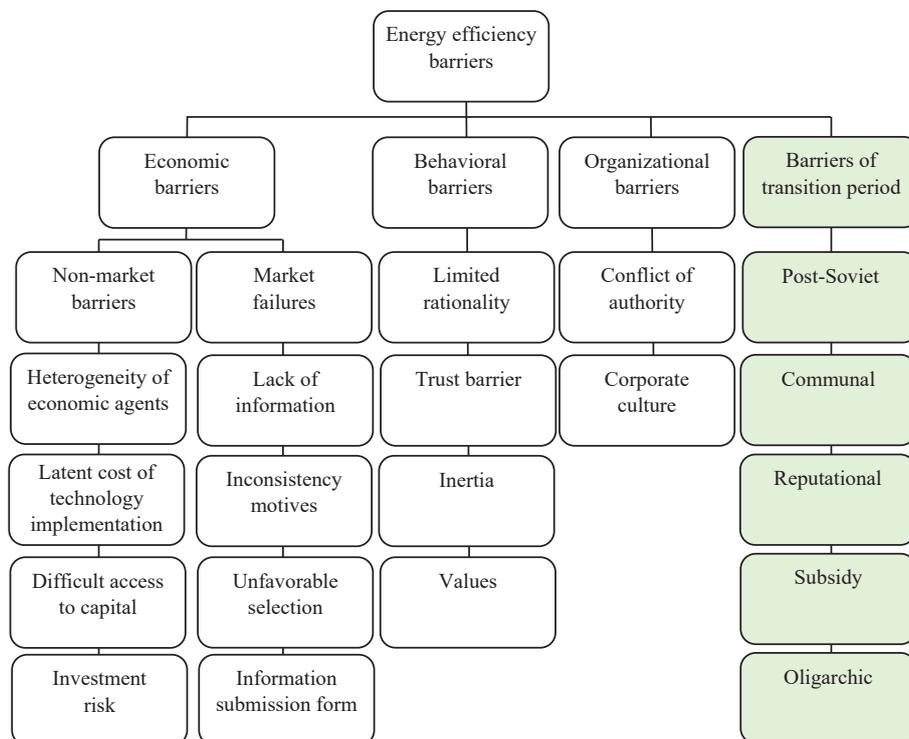
The barrier is manifested not only directly but also indirectly. The privatization of the Ukrainian energy sector took place under certain conditions, namely it was possible only under the condition of modernization of the acquired enterprises. In fact, the growing debt on the balance of housing and communal services (HCS) has given a literal and formal reason for the owners of privatized facilities not to comply with the conditions of modernization. The severity and scale of the problems in the housing and communal services are obvious, the technical condition of its facilities is unsatisfactory [38] and needs to be modernized, including with the involvement of funds and grants.

5. *Subsidy*. Subsidies for housing and communal services should be abolished, as they do not contribute to energy savings and do not solve the problem of debts for housing and communal services in general. According to the author, subsidies are covert financing of private capital in the form of subsidies and in the form of underestimation of labor resources of Ukraine. There is an urgent need to re-evaluate Ukraine's labor resources. The author believes that this would be justified in terms of the functioning of market infrastructure, integration into the world economic space and is economically justified as follows:

- share of the public sector in Ukrainian industry is so insignificant that the consequences could be ignored. For example; agriculture and forestry and fisheries – 1.4 %, industry – 11.6 %, mining and quarrying – 7.3 % (as of October 1, 2019) [39];
- Ukrainian commodity market in the price segment differs little from the world;
- ratio of able-bodied persons to pensioners is 44.56 %/16.3 %.

The other side of this issue is labor migration, according to public data, the number of Ukrainian workers abroad reaches six million. The terms of COVID-19 have shown that Europe can't do without Ukrainian labor, especially in seasonal work. The subsidy in this case does not act as an aid to vulnerable groups, but as a form of underestimation of Ukraine's labor resources. Underestimation of labor resources affects the amount of funds in the state economy and the speed of their turnover, the more financially capable the population is, and the faster the turnover of funds in the economy occurs. And if Ukraine does not immediately bring the salary to the European average (goods in Ukraine are bought at European prices), then let's continue to build the economies of other countries. Therefore, after increasing the financial capacity of the population, i. e. the establishment of European salaries and pensions, the abolition of subsidies not only stimulates energy saving, but also serves as a catalyst for ending wage and pension discrimination in Ukraine.

Using the research methods specified in Section 5, the above-described barriers for Ukraine are identified, and their totality is presented in Fig. 2.



**Fig. 2.** Energy efficiency barriers for Ukraine

The author generalizes the identified barriers to the group «barriers of the transition period». These barriers are formed as a result of the transformation of the socialist system into a democratic society and bear, on the one hand, signs of the shortcomings of this system and, on the other hand, the miscalculations of the transition period.

### 7. SWOT-analysis of research results

*Strengths.* Strengths of research and application of the taxonomy of energy efficiency barriers is to determine the main characteristics of energy efficiency barriers in Ukraine in relation to those already identified in foreign systems and the identification of a new group of barriers. The proposed identification allows to identify which barriers affect the regions, organizations, enterprises. The terminology «taxonomy of energy efficiency barriers» was introduced into scientific literature and the concept of business turnover. This will allow scientists to study this topic in more detail.

*Weaknesses.* The analysis shows that one of the most problematic places is the detection, identification of energy efficiency barriers and their minimization. The process of identifying barriers is complicated not only by the problem of their identification in each case, but also by the lack of experience and specialists who can identify barriers and assess their degree of impact. Also, it should be taken into account that each barrier has a different impact on the detection and disposal of the main barrier, which will significantly reduce the impact of other barriers.

*Opportunities.* Further integration of the theory of energy efficiency barriers into various socio-economic structures of the state is logical and expedient. Thus, it is expedient to divide the impact of barriers by levels and assess such impact at the state, regional and organizational levels. According to the level of barriers, only those structures

that have power at the appropriate level can reduce their influence. It should also be noted that, at certain levels, certain barriers, their detection and leveling are dominant, which will reduce the impact of other barriers and significantly improve the socio-economic condition of the region, enterprise, etc. To conduct such an assessment, it is necessary to develop an evaluation mechanism, as well as to disseminate knowledge about barriers among scientists. This is a new practice for Ukraine, but the results of research on the theory of energy efficiency barriers have been implemented in the world for over 20 years.

*Threats.* The process of introduction of energy efficient technologies is associated with the complexity and duration of market promotion, and their relatively high cost, and is hampered by a number of obstacles, barriers to energy efficiency.

Therefore, if the barriers and the degree of their impact were not identified correctly, the result of the measures taken may be much lower than expected. Such a mistake can lead to significant financial losses, so before carrying out activities and purchasing technology a detailed analysis of the impact of energy efficiency barriers should be carried out.

### 8. Conclusions

1. The theoretical substantiation of energy efficiency barriers in relation to Ukraine has been made. To do this, an analysis of the current state of scientific and theoretical base in the field of energy efficiency, developed by world science has been carried out. The knowledge degree of Ukrainian scientists on this topic has been estimated. It has been found that the theory of energy efficiency barriers covered by Ukrainian scientists is rather superficial and detailed attention to the study of this topic in terms of socio-economic model of Ukraine was not paid.

2. The scientific and methodical approach to an estimation of barriers of energy efficiency by creation of the taxonomy of barriers of energy efficiency has been developed for Ukraine. Using abstract-logical, system-structural, comparative and statistical analysis energy barriers that currently exist in Ukraine have been revealed.

3. The basic structure of energy efficiency barriers is adapted to the Ukrainian socio-economic model, which is to identify a new group of barriers inherent in this model. In the course of the research, a group of barriers was formed that are not included in the generally accepted taxonomy of energy efficiency barriers, but are inherent in the socio-economic model of Ukraine. These barriers were identified and described, as well as their main characteristics were identified and combined into a separate group of energy efficiency barriers.

4. The terminology of «taxonomy of energy efficiency barriers» was introduced into the Ukrainian scientific literature and the concept of business turnover by publishing the results of the research. Taxonomy makes it possible to systematize all the obstacles that arise in the introduction of energy efficient technologies. Due to the complexity, the taxonomy of energy efficiency barriers can be applied to different structures and objects. And the system approach, which is the basis of the method, eliminates the formation of gaps (miscalculations) in assessing energy efficiency problems at the studied facilities.

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