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FEATURES AND DEVELOPMENT TRENDS OF FAMILY FARMS IN UKRAINE

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Private farm households' activities play a significant role in supplying population of Ukraine with agricultural products. Given that private farm households are operated by family members, it is advisable to create such farm based on the work of a rural family members.

The peculiarity of this form is not only joint economic activities of all members of a peasant family, and the use of common property, but also the distribution of products, or income earned, according to the contribution of each member of the family who are all at the same time equal owners of the entire production.

The article investigates the functioning features of family dairy farms, presents the ways and mechanisms of transition of private farms to commercial farming, and identifies the main development tendencies of modern family farms in Ukraine. Using the recommendations presented in the articles will enable private farm household members to create individual family farms that meet the requirements of the European Union on marketable livestock products as well as increase the amount of income from economic activities

Keywords: *households, personal peasant farms, family farm, government authorities, the gross agricultural production.*

Introduction. Private farm households' activities play a significant role in supplying population of Ukraine with agricultural products. For a long period of time these farms have been providing the population of Ukraine with both vegetables and animal products. Above all in the livestock industry milk and meat of cattle and pork was produced and supplied to the local markets by the private farm households.

However, Ukraine's accession to the European Union stipulates agricultural production based only on the marketable product that will lead not only to the inability of sales of personal farm households, but also to additional expenses of these household members related to the impossibility of obtaining government assistance for farming, forced transfer of this form to other forms of management, or the sale or transfer of a long term lease of land, payment of fines, penalties and other unforeseen expenses.

In addition, Article 8 of the Law of Ukraine on personal peasant farming states that members of the private farms are persons who provide themselves with work and belong to employed population and, in accordance with the requirements of the European Union, these members are not eligible to receive financial unemployment compensation.

So, in order to maintain and increase income of the private farm households' members it is necessary to create the conditions for marketable agricultural production. In livestock farming the most realistic way to meet such requirements is to create livestock farms that meet European standards for livestock production.

Given that private farm households are operated by family members, it is advisable to create such farm based on the work of rural family members. This activity relates to family-based activities. The peculiarity of this form is not only joint economic activities of all members of a peasant family, and use of common property, but also the distribution of products, or income earned, according to the contribution of each member of the family who are all at the same time equal owners of the entire production. However, in peak workload periods or in case of other necessity not only labor of wage workers, but also junior family members can be used on the family households, which also complies with the European Union requirements on the employment of minors in agriculture. All the above mentioned aspects determine the relevance of the present article.

Analysis of recent research and publications. The issues of family farms were studied by such famous scientists as Gorovy V.P. [1], Melnik L.J. [2], Onishchenko O.M. [3], Shulsky M.G. [4] etc. However, despite the significant theoretical developments in this area organizational forms of family farms functioning remain ungrouped, areas of use of foreign experience of their development in Ukraine are poorly defined.

The aims of the article. Generalization of the groundwork in the field of family farms, namely the study of the conditions and factors of their development, grouping of organizational forms of their functioning and definition of perspective directions for their development.

The main material research. Dairy industry is one of the leading sectors of the agro-industrial complex of Ukraine. The market share of this sector in the total output of food and processing industry amounts to 19 % [5]. On the market of raw milk over a period of 2000-2012 an actual monopoly was held by small and private family farms.

In 2013, the private sector's share in total milk production was 77,5% (in 1990 - 24.1%, in 2000 - 70.9%, in 2005 - 81%, in 2009 - 80.7%) [6]. In the current structure of the private farm households' sector (less than two cows per family) to manage seasonality, as well as the quality of milk is almost impossible. Some agricultural manufactures and processers solve these issues at the level of cooperation with agricultural cooperatives and through investments in refrigeration, transportation equipment. Through such steps much better performance can be achieved. Thus it's essential to help everyone who intends to establish a small family farm that will allow to manage seasonality, create alternative income for a family as well as increase the efficiency of milk collection.

In Ukraine, the process of creation of family farms is gradually gaining steam, in many cases, through the expertise and technical assistance of missions of the leader states in the development of family cooperation: Poland, France, Canada, the USA, etc. Accordingly, despite numerous legal and bureaucratic obstacles, there are grounds for their development at the local level: the desire of peasants to do this, the relevant land areas, and governmental facilitation in the provinces.

Family farm is a form of agricultural production based on the family labor organization and addresses the needs of a rural family, as well as receiving income from the marketing of products. These family farms can be livestock farms producing milk, beef, pork, lamb, poultry meat, eggs and the like.

In accordance with Article 6 of the Law of Ukraine on personal peasant farming property used for private farming, can be owned by one person, be common partial or common joint ownership of its members. Given that the establishment of family farms occurs on the basis of family business, assets created belong to family members as the common joint property. In accordance with Article 368 of the Civil Code of Ukraine the common joint property is joint ownership of two or more persons without specifying the shares of each of them in the ownership whereof, property acquired as a result of joint work and for the general funds of family members, is their common joint property, which they possess and enjoy together. In this case, all the income earned from the activities of the family farm is distributed according to the contribution of each member of the family in production activities, and in the case of allocating a share of the property which is in common joint ownership, it is assumed that the shares of each of the co-owners of the common joint ownership are equal.

The family farm is created on the basis of private ownership, its production activities are associated with marketable agricultural production as a result of the sale of which income is received, and wage workers may be involved in production process. Therefore, the family farm is a form of private enterprise.

In accordance with Article 113 of the Commercial Code of Ukraine private enterprise is a company operating on the basis of private ownership of one or more citizens, foreigners, stateless persons, and his (their) labor or the use of hired labor. At the same time, in accordance with the Law of Ukraine on state registration of legal entities and individuals-entrepreneurs, a private company to be registered with the local government.

Having analyzed the conditions of operation of family farms in Ukraine, we identified their following features:

- absence of hired labor for all the work on animal care is perform only by family members;
- limited, as a rule, financial capacity of owners;
- insufficient in most individual and family farms acreages for providing livestock with own fodder production;
- location of such farms usually in the settlements, which limits their size and requires additional environmental measures. On the other hand, there is usually water and electric energy supply, which is an advantage;
- animal care is usually provided by unskilled workers, including children, in addition, it's usually a by-work for them, the duration of works is limited, and serviceable time is either before or after the main work;
- the size of a family farm is determined either by financial means or availability of labor, or fodder base, or location of a particular peasant household;
- the need, as a rule, for use of the simplest means of mechanization and automation as well as manual labor;
- compliance with the principle of reducing labor costs and work time expenditures for production;
- the need to apply the principles of self- and mutual learning (animal animal) and animal self care in livestock management technologies;
- the minimum number of components of the feeding diet and a minimum of work and costs to prepare fodder for feeding;
- widespread use of universal, easy to manufacture and operate mini machinery;
- commonality of technologies and equipment, combination of advanced technology, the principles of mechanization of processes and organization of production with minimum cost of labor, energy and resources and the requirements of animal physiology.

Incomes of private peasant household are usually small, and therefore the costs associated with the construction of a family farm require thorough elaboration. In addition, most private farms are not able to implement large-scale projects such as the construction of livestock farms at their own cost and expense. Therefore, members of peasant fami-

lies need to raise the necessary financial resources from other sources. These sources can be funds borrowed from banks or funds of the state or local budgets.

Necessary capital raising from these sources is preceded by the development of a family farm construction business plan. In accordance with the Law of Ukraine On investment activity [7] and the Order of the Ministry of Economic Development and Trade of Ukraine No. 724 d.d. 19.06.2012 "On Approval of the form of project (investment) proposals, on the basis of which an investment project is prepared, for the development of which public support may be provided, the Procedure and forms of investment project development, implementation of which may be provided by government support "[8], the structure of the business plan of a family farm construction investment project is as follows:

Summary - This is the section of the business plan which displays brief conclusions. It is necessary for quick reference of stakeholders with the content of the investment plan and the results of the investment project implementation, as well as the definition of the prospects for future cooperation.

In the first section of the business plan of the investment project to build a family farm (General aspects) it is formulated the goal of the realization of the family farm building investment project, the main objectives of the project and its content. However, both the head and the members of the individual farm household or private enterprise must clearly understand for what purpose and why they will implement the investment plan and the task assigned to them.

The main objectives of the project. Depending on the capacity of the project and the amount of investment required these objectives may vary. Thus, for the realization of an investment project to build a family dairy farm four objectives can be formulated: to assess the dairy market in the area; to develop an investment plan; to assess the financial performance and return on the project; determine the socio-economic consequences of the investment project implementation.

The second section of the business plan of a family farm building investment project - "Public policy to support livestock production". This section lists all the laws and regulations that govern the direction of state or regional support, as well as their specific features. Considering in the investment project of all possibilities offered by national, regional and local programs, as well as financial compensation from these sources can significantly reduce the investment costs of the project.

The third section of the business plan of a family farm building investment project - "Sales Analysis". This section analyzes the local demand for the targeted for release livestock products. According to the practice of investment projects development this section should include the following subsections:

1 The demand for products.

2 Competition in the industry.

3 Sales volumes, price and income.

Definition of demand for the products. Here it is necessary to investigate the dynamics of consumption of similar products by residents of the region and the need for it.

For example, in Kiev region almost 934 thousand tons of milk and dairy products were consumed, accounting for about 10% of the total consumption of these products and is the highest index in Ukraine. Consumption of milk and dairy products compared to 2000 increased by only 3.8%. At the same time, according to the World Health Organization norms minimum annual per-capita consumption for milk and dairy products is 341 kg, which is 1.6% more than the level achieved in Kiev region. Currently, the total population in Pereyaslav-Khmelnitsky region is 58.7 thousand people, which in 2010 consumed about 12.3 thousand tons of milk, in particular 210 kg per one person. In accordance with the World Health Organization norms, every resident of Pereyaslav-Khmelnitsky region annually underconsumes more than 131 kg of milk and dairy products. Thus the effective demand of Pereyaslav-Khmelnitsky region consumers is much higher than 3.6 tons of milk per year, so family farm dairy products can be realized within the area.

The fourth section of the business plan of a family farm building investment project - "Assessment of financial condition." Given that the implementation of the investment project on family farm construction takes place in the newly created private enterprise, the enterprise may not have the financial or credit history. However, this history may be present in its predecessor - the personal farm household. Presenting this section in the business plan of the investment project may significantly affect the decision-making on credit granting to private enterprises, and hence the realization of the investment project.

The fifth section of the business plan of a family farm building investment project - "Technical Analysis". Here we consider the technical aspects of the project, in particular related to land allocation for buildings and structures projects. Cost of construction projects is estimated, and if necessary, design contractors are determined, which will deal with the working out of the projects for construction and reconstruction of facilities, land allocation, need for production facilities is calculated, options are analyzed and economic feasibility of acquiring technical facilities is determined. In addition, it allows for the necessity of organizational arrangements, as well as investigates the availability of the industrial infrastructure required for the project.

The sixth section of the business plan of a family farm building investment project - "Environmental assessment of the investment project imple-

mentation." Given that family farms can be built within the village territory there is a risk of causing damage to both the environment and the health of the inhabitants of this territory. Therefore, meeting the requirements for compliance with environmental regulations in the construction and operation of buildings or other facilities of family farms requires consideration in the farm construction. However, as a rule, these requirements are taken into account by providers of supplies or equipment, and the price of these items includes the expenses necessary to get rid of the environmental risks. Therefore, using the factory machinery or equipment family farm typically does not bear additional production or other costs.

The seventh section of the business plan of a family farm building investment project - "Investment Plan". This section provides detailed calculations to ensure the funding needs for capital expenditures in accordance with the list of technical facilities, production and administrative facilities, machinery and equipment, the cost of work related to support of the objects functioning, the acquisition or leasing of livestock, etc. In addition, it is also necessary to provide the plan of the acquisition, construction and commissioning of the investment objects, as well as the range of facilities and sources of investment financing.

In accordance with the practice of cattle farm building cost of works associated with the equipment installation and operation of the investment facility may be more than 50% of the total capital expenditure requirements.

The eighth section of the business plan of a family farm building investment project - "Financial appraisal of the project." This section provides estimation of the investment project implementation effectiveness by comparing the future income and expenditure (outflow and inflow streams). These calculations are required to determine the net present value and payback period of the project. According to paragraph 2.1.10.3 of Methodological recommendations on the development of business plans approved by the order of the Ministry of Economic Development and Trade of Ukraine No. 260 d.d. 06.09.2006, based on the production program, designed as part of the financial performance forecast, discounted cash flow model is formed. In this case, the overall result of the investment is calculated as the sum of the discounted cash flows for each year of the company development project implementation and the present (discounted) value of the residual value beyond the planning period (n years).

Payback period of the family investment in the project is the period during which the net income from the sale of farm produce fully reimburses investment costs.

This index is calculated by the following formula:

$$Pp = \frac{Fi}{NPa},$$

where Pp - payback period;

Fi - the amount of invested funds;

NPa- the average annual net profit

Matching the size of the investment against the projected investment results is carried out with the help of special methods and tools, including: discounting and compounding interest, calculation of the project net present value and internal income rate (internal threshold return level), dynamic (discounted) project payback period. Cash flow model building is based on the use of discounted cash flow techniques.

Discounted cash flow coefficient is calculated at the end of the year according to the formula:

$$k = \frac{1}{(1 + r)^n}$$

where: k - coefficient of discounted cash flows;

n - number of years;

r - the discount rate chosen.

The discount rate (r) characterizes the rate of return that investors receive under standard conditions on investment with the same content and degree of risk. This is a rate of return on investment necessary for investors. Typically rate of discount of the National Bank of Ukraine is taken for the discount rate.

Net Present Value (NPV) is the difference (balance) between future income and investment costs adjusted to equivalent conditions, i.e. the difference between income from the sale of a family farm production adjusted to the current value and the costs associated with obtaining these products. NPV indicates whether the investment will achieve the desired level of returns: positive NPV indicates that the receipts exceed the amount of investment that provides a profit above the required level of profitability; negative NPV indicates that the project does not provide a receipt of the expected level of profitability.

It seems advisable to carry out calculations of the effect of the family farm activities in the periods of the life cycle of the project. That is, in financial plan monthly expenses and income of a family farm during the period of formation of the main livestock herd are given. Thereafter costs and incomes are considered on a quarterly basis, and after reaching the project capacity on a yearly basis.

The ninth section of the business plan of a family farm building investment project - "Project Risk Assessment". The essence of risk is the possibility of shortfalls in the anticipated results due to the factors that were not taken into account when developing a business plan. As a rule, such factors include: partial underfunding of the investment project, technological and technical problems (lack of or delay in obtaining fodder, the breakdown of machines and equipment, insufficient qualified personnel, etc.), as well as specific problems encountered during implementation of the project (animal diseases, inap-

propriate managerial decision, unaccounted shipping costs etc.).

The tenth section of the business plan of a family farm building investment project - "Socio-economic impact of the project". Considering the possibility of obtaining funds from the state or local budgets private enterprise must determine what will be the social effect of the project implementation. These effects may be job security for members of a peasant family as well as hired workers, receipt of payments to local budgets, forestation etc ..

Thus, business plan for the initiation of dairy family farm developed in this way will allow the private farm household guaranteed attraction of investments to the project and to create an effective activity in rural areas, which will positively affect the well-being of rural family, socio-economic development of rural areas and food security of the country. In addition to developing a viable business plan, the specific aspects of dairy family farms designing must also be taken into account:

- determination of farm productivity;
- choice of the method of live-stock handling;
- feeding of animals;
- mechanization of production processes;
- organization of labor.

Capacity (size) of a farm is primarily determined by the number of cow population and their milk productiveness, and livestock herd size is dictated mainly by indicators such as the possibility of the available forage base and availability of labor resources. As for fodder base, then, on average, the size of the land shares is 4 - 6 ha for the shareholder, the number of shareholders in the family ranges from 2 - 4 people, and the need to feed one cow is about 2 hectares of land allocated for fodder base, then the size of the family farm in these conditions ranges from 4 to 12 cows. In the case land for forage production is insufficient and more feed is purchased additionally, another factor of the financial capability of the owner is added, and when the feeding of animals is performed only with purchased feeds, farm size is only limited by the financial capacity of the owner. Regarding labor resources, then given that the working members of the family during the day can each devote about 2 h to work on the farm, the family can have annual labor force sufficient to hold up to 10 - 12 heads of livestock. In the case of a larger number of workers farm size can be increased.

Selection of a method of keeping cows is determined by a number of criteria, the most important of which include: care for animals, feed consumption, technological, organizational, sanitary-hygienic, health, labor costs, operating costs and capital investment. An important indicator for the choice of the method of live-stock keeping on family farms, in our opinion, is animal self care, by which we mean the ability to perform operating processes by animals themselves, without engaging workers. This makes it possible to significantly reduce production labor costs and allows the animals to satisfy their physiological needs as they arise. In addition, the advantage of animals self-care is that most of the work that was previously allotted to mechanization and automation, animals do themselves. Staff remains basically busy with the transport of water, feed, products, manure, the execution of which is not regulated by the order of day. Having compared different methods of livestock keeping according to the criteria given above, we concluded that the most appropriate for the dairy family farm one is to apply loose pen system. Feeding of animals is performed following the ration on the structure whereof the type of feed depends (silage, haylage, concentrated feedstuff, etc.). Rations, which may be used are well known and are given in the reference literature. When choosing a feeding ration with consideration of specific features given above (minimum number of ration ingredients, minimum of work and means to prepare feed, forage long shelf life while preserving the quality to ensure the principle of animals self-care, own or co-production of feed, their purchase), it is offered to form the ration of the following ingredients:

- in summer - green and concentrated feedstuff;
- in winter - hay, root crops and concentrated feedstuff.

Where possible, we recommend diversifying the diet by provision or purchase of silage and haylage in sealed rolls or bales. Existing means of mechanization of livestock enterprises were designed to serve a large number of livestock and use it on family farms, as a rule, is economically unviable. Therefore there is a need to develop and implement appropriate new technology, which could meet principles of animal care (self-service, individual approach, small volume, short distances, simplified technology, etc.) on these farms, as well as changes in production organization and work of people. From the engineering standpoint, this equipment must comply with versatility principle in performing single or different technological processes, be easy to manufacture and maintain, with a wide range of performance and cost-efficiency. To facilitate manual labor and increase productivity, if appropriate, it is proposed to use mini-machines (mini tractors, tillers, electrically operated mobile power units).

All work on livestock care, receiving and processing of products is performed by family members. Moreover, there may be occasions when all family members are employable and have before and after the work not more than 2 - 2.5 hours for animal care. At the same time production processes for animal care occur continuously, which requires either automation, or the widespread introduction of the principle of self-care. In such circumstances, we offer restricted work, that is the one that cannot be

switch to self-care (milking, primary processing of milk, standardized feeding), to be performed twice a day, in the morning and in the evening (before and after the main work); the work that is not directly related to animals (storage, preparation and distribution of feed, manure removal, maintenance and repair work, etc.) to be performed at any time convenient for the workers. In view of the aforesaid, we believe that having 2 - 2.5 hours per day per worker for animal care, the family may operate the farm size:

- up to 4 cows - one worker;
- up to 8 cows - two workers;
- up to 12 cows - three workers.

In the development (designing) of dairy family farms, we propose to use (consider) suggested above features in technology of keeping and care, animal feed rations, designs of mechanical means, methods and techniques of work organization and the organization of production (milk) on them.

Summary and Conclusions. Thus, it is obvious that family farming is an important part of the agricultural sector, but their potential is not fully taken advantage of. Development of family farms must be considered in the context of the changes taking place in regard to social relations. Family farms are one of the most efficient forms of economic activity in the agricultural sector that possess more than other types of households safety margin and the ability to survive in times of economic difficulty, the flexibility to adjust to the increased pressure of the global system of agribusiness, using different systems of adjustment behavior. At the same time, further stabilization and continued effective functioning of small forms of agricultural business in rural areas is not possible without the use of effective methods of public support for their development.

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8. Про затвердження форми проектної (інвестиційної) пропозиції, на основі якої готується інвестиційний проект, для розроблення якого може надаватися державна підтримка, Порядку розроблення та форми інвестиційного проекту, для реалізації якого може надаватися державна підтримка [Електронний ресурс]: Наказ Міністерства економічного розвитку і торгівлі України від 19.06.2012 №724 // Зареєстровано в Міністерстві юстиції України 2 серпня 2012 р. за №1308/21620. – Режим доступу: http://zakon2.rada.gov.ua/laws/show/z1308-12. - Назва з екрану.

Славкова О.П., Забуранна Л. Особливості та тенденції розвитку сімейних ферм в Україні

В статті розглянуті сучасний стан, проблеми та перспективи функціонування та розвитку сімейних ферм в Україні. Діяльність приватних приватних сімейних ферм відіграє важливу роль у забезпеченні населення України сільськогосподарською продукцією. Особливістю цієї форми підприємницької діяльності є не тільки спільне ведення господарської діяльності всіма членами селянської родини, а й використання загального майна, розподіл вирощеної продукції, та доходів, отриманих відповідно до внеску кожного члена сім'ї. У статті досліджуються особливості функціонування сімейних молочних ферм, наведені шляхи та механізми переходу особистих підсобних господарств до комерційних фермерських господарств, а також визначаються основні тенденції розвитку сучасних сімейних ферм в Україні. Розглянутий міжнародний досвід функціонування сімейних ферм та вимоги до створення індивідуальних сімейних ферм, які відповідають вимогам Європейського Союзу з виробництва товарної продукції тваринництва.

Ключові слова: *Господарства населення, особисті селянські господарства, сімейна ферма, органи державної влади, валове виробництво сільськогосподарської продукції.*

Славкова Е.П., Забуранная Л. Особенности и тенденции развития семейных ферм в Украине

В статье рассмотрены современное состояние, проблемы и перспективы функционирования и развития семейных ферм в Украине. Деятельность частных семейных ферм играет важную роль в обеспечении населения Украины сельскохозяйственной продукцией. Особенностью этой формы предпринимательской деятельности является не только совместное ведение хозяйственной деятельности всеми членами крестьянской семьи, но и использование общего имущества, распределение выращенной продукции, и доходов, полученных в соответствии с вкладом каждого члена семьи. В статье исследуются особенности функционирования семейных молочных ферм, приведены пути и механизмы перехода личных подсобных хозяйств в коммерческие фермерские хозяйства, а также определяются основные тенденции развития современных семейных ферм в Украине. Рассмотрен международный опыт функционирования семейных ферм и требования к созданию индивидуальных семейных ферм, которые отвечают требованиям Европейского Союза по производству товарной продукции животноводства.

***Ключевые слова**. хозяйства населения, крестьянские хозяйства, семейная ферма, органы государственной власти, валовое производство сельскохозяйственной продукции.*

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СУЧАСНІ ПРОБЛЕМИ ТА ТЕНДЕНЦІЇ РОЗВИТКУ СВІТОВОЇ ЕНЕРГЕТИКИ

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В статті розглянуто сучасний стан світової енергетики та проаналізовано структуру світового енергоспоживання. Доведено необхідність диверсифікації постачання традиційних джерел енергії. Обґрунтовано доцільність та перспективність стимулювання розвитку відновлюваних джерел енергії.

***Ключові слова:** енергетика, тенденції розвитку енергетичний простір, ресурсно-сировинні проблеми.*

Постановка проблеми. На початок XXI століття розвиток промислової інфраструктури та зростання чисельності населення планети призвели до колосального збільшення споживання природних ресурсів. Тільки за другу половину XX століття світове споживання твердого палива збільшилося у 2 рази, рідкого – у 8,5 разів, а споживання природного газу зросло майже у 10 разів.

Інтенсивно споживаючи природні ресурси для поліпшення умов свого життя за допомогою неухильно зростаючих по потужності технічних засобів, людство разом з тим значною мірою послабило природні основи власної життєдіяльності. В останні десятиліття XX століття уже не тільки фахівцям стало зрозуміло, що пануючий у світовому господарстві техногенний тип розвитку без урахування екологічних і соціальних наслідків господарської діяльності відтворює наростаючу лавину проблем і небезпек, які загрожують існуванню людської цивілізації.

Аналіз досліджень і останніх публікацій. Дослідженням проблем світової енергетики займаються вчені та науковці багатьох країн світу, оскільки енергетична безпека як окремої країни так і світу в цілому посідає одне з провідних місць в сучасному суспільстві. Найбільш відомими науковцями, що вивчають даний аспект є Лір В. Е., Макогон Ю. В., Нігматулін Р. І., Панченко М. П., Попель О. С., Преображенська Л. Б., Фортов В., Франчук І. А. та інші. Розробка виваженої та збалансованої стратегії енергетичного розвитку світу дозволить підвищити загальний рівень енергетичної безпеки кожної країни.

Мета статті – проаналізувати сучасний стан та узагальнити головні проблеми що існують на теренах світового енергетичного простору з метою виявлення найбільш перспективних шляхів його подальшого розвитку.

Виклад основного матеріалу дослідження. Глобальні екологічні, ресурсо-сировинні та демографічні проблеми змусили вчених шукати нові моделі стратегії управління енергетичним комплексом. Відповідно до новітніх оцінок експертів Міжнародного енергетичного агентства (МЕА) до середини XXI століття щорічне загальносвітове споживання енергії буде збільшуватися на 1,7%, при цьому в США споживання енергії зросте на 50%, у країнах Євросоюзу – на 18% [1]. Удвічі збільшиться споживання вугілля, яке майже не подорожчає і не зникне, відповідно в атмосферу потрапить у два рази більше пилу та сажі. Нафта і природний газ, у яких вуглецевих викидів менше, виростуть у ціні.

Виявляється, що енергетичні потреби світової економіки на 90% забезпечуються за рахунок викопних запасів непоновлюваних енергоносіїв – вугілля, нафти, газу та урану і тільки 10% становлять поновлювані енергоносії (рис. 1). На сьогодні не існує ефективного та безпечного джерела енергії, здатного відразу замінити традиційні органічні енергоносії.