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Удосконалення методологічних засад статистичного обліку витрат на охорону навколишнього природного середовища в контексті розвитку відновлювальних джерел енергії

Статтю присвячено удосконаленню методологічних засад статистичного обліку витрат на охорону навколишнього природного середовища в Україні в контексті розвитку відновлювальних джерел (вітрової та сонячної енергії). Зазначено, що будь-які дослідження сфери обліку витрат на відновлення навколишнього природного середовища, розвиток відновлювальних джерел енергії потребують розрахунку й аналізу показників, в основу яких покладено статистичні дані. Тому проблеми удосконалення статистичного обліку є однією з основних у вивченні вищевказаних питань.

Ключові слова: *альтернативні джерела енергії, вітрова енергія, сонячна енергія, витрати на охорону навколишнього природного середовища, сателітний (допоміжний) рахунок.*

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Совершенствование методологических основ статистического учета расходов на охрану окружающей среды в контексте развития возобновляемых источников энергии

Статья посвящена совершенствованию методологических основ статистического учета расходов на охрану окружающей среды в Украине в контексте развития возобновляемых источников (ветровой и солнечной энергии). Отмечено, что любые

исследования сферы учета затрат на восстановление окружающей среды, развитие возобновляемых источников энергии требуют расчета и анализа показателей, в основе которых лежат статистические данные. Поэтому проблемы совершенствования статистического учета являются одной из основных в изучении вышеуказанных вопросов.

Ключевые слова: *альтернативные источники энергии, ветровая энергия, солнечная энергия, расходы на охрану окружающей среды, сателлитный (вспомогательный) счет.*

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Improving the Methodological Framework for Statistical Accounting of Environmental Protection Expenditure in the Context of Renewable Energy Sources

The article is devoted to improvements of the methodological framework for statistical accounting of environmental protection expenditure in Ukraine in the context of renewable energy sources (wind and solar energy). It is argued that any study focused on accounting of environmental protection expenditure or development of renewable energy sources needs computations and analyses of indicators based on statistical data. Problems of improvements in statistical accounting are, therefore, have critical significance for such studies. The important objective is related with improvements of statistical accounting of the capacities generating energy from alternative sources *and costs on their installation and modernization, which will enable to compare data all the levels, reveal main tendencies, patterns and changes, assess indicators and take sound decisions on environmental protection.*

The article contains an analysis of statistical indicators on alternative energy sources and their recording in the satellite account of environmental protection expenditure. The sources of data for reporting wind and solar energy indicators in the satellite account of environmental protection expenditure in Ukraine are shown.

The satellite account of environmental protection expenditure is constructed using information from various sources. The study demonstrates that the official statistical observation by form 1-Environmental expenditure (annual) "Environmental protection expenditures and environmental payments" can be used as the main source for indicators of capital and current environmental protection expenditure in Ukraine.

Therefore, the sources of administrative information, i. e. data collected for other purposes and characterizing selected aspects of environmental protection expenditure, should be used to improve the existing methodological framework.

Keywords: *alternative energy sources, wind energy, solar energy, environmental protection expenditure, satellite account.*

Introduction. Environmental protection is a challenge of the global scales, which cannot be faced without proper recording of environmental protection expenditure on the whole and capital and current expenditure on renewable energy resources (wind, solar etc.)

in particular. The energy efficiency is continuing to increase at the accelerating rates, with the share of renewable energy sources in the electricity generation growing in Ukraine and elsewhere. This raises the need in scientific studies encompassing the problems related with harmonization of human interests with the nature capacities. Solutions to these and other problems of effective nature use require adequate accounting of expenditure on installation of the capacities for electricity generation from alternative energy sources.

Due to the planet's transition to alternative means of energy supply, statistical bodies in Ukraine face problems of developing a methodological and analytical framework for constructing a set of comparable and reliable data to build a system of environmental economic accounting (SEEA) in Ukraine and implement the environmental protection expenditure account (EPEA) [1; 2; 3].

As shown by analytical data of global experts, the energy generating capacity based on renewable energy sources has been growing at the accelerating rates; by 2023 it is expected to cover 30% of the global electricity demand. As a result, the increasing public awareness and the overall economic interest to technologies related with renewable energy sources, including solar energy, development and improvements of statistical accounting of expenditure on solar energy generation will lay the foundation for setting the effective environmental economic policy, including the one on management of national and trans-border resources; the latter is supposed to lay the solid ground for streamlining investment to electricity generation from renewable energy sources with consideration to market conjunctures and social needs in the electricity. Besides that, the increasing output and consumption of "pure" electricity generated from renewable energy sources is a key factor for reduction of CO_2 emissions and fight against global warming.

Literature review. Significant contributions in the analysis of environmental economic accounting are made by Ukrainian scientists V. Danylko, A. Yerina, O. Ielisieieva, L. Momotiuk O. Osaulenko, N. Parfentseva, A. Sydorova and others. It should, however, be noted that the problem related with analysis of the environmental protection expenditure on the whole and the ones on technological processes involved in electricity generation from renewable energy sources has not been adequately solved. Finding ways for its solution becomes increasingly important in the environmental economic policy setting, because a comparative statistical analysis of the expenditure by nature protection purpose, including ones on technologies for electricity generation from renewable energy sources, in order to link them to the National Accounts System (NAS), will help public power bodies take sound political decisions on environmental protection.

The article's objective is to analyze and improve the existing methodological framework for statistical accounting of environmental protection expenditure, with emphasis on the ones related with introduction and operation of technologies for electricity generation from renewable energy sources (wind an solar) in Ukraine.

Results and discussion. The data from global and European communities show that the output of electricity generated from renewable energy sources have been rapidly growing, being able now to meet the demand for nearly 1/5 of the total global electricity consumption, with the overal capital investment in the renewable energy and fuel sources exceeding 289 billion USD in 2018 [4].

It should be noted that electricity from renewable energy sources is generated in Ukraine and beyond by the three categories of entities:

- ✓ legal entities: companies and organizations;
- ✓ physical persons-entrepreneurs;
- ✓ households.

With respect to the national statistical accounting, it needs to be stressed that the principle reporting document containing data about electricity generation from renewable alternative sources is the official statistical observation, form No 11-МТП "Report on energy supply and use" [5; 6; 7]. This report contains the data about the installed capacities, types of power plants and sub-types of generating plants. The data about the overall capacities and generation of electricity from alternative sources are recorded in the section "Other power plants", by:

- ➢ wind power plant;
- ➢ solar power plant.

As a consequence, the output of electricity from alternative renewable sources (solar and wind) is recorded in the national statistical accounting only in "Report on energy supply and use" by the following statistical indicators:

- ✓ the installed energy capacity of wind power plants (WPP) as of December 31 of the reporting year;
- ✓ the installed energy capacity of solar power plants (SPP) as of December 31 of the reporting year;
- ✓ the share of the installed capacity as of December 31 of the reporting year;
- ✓ the output of supplied electricity;
- ✓ the share of supplied electricity;
- ✓ the rates of growth/reduction in the output of supplied electricity (compared to the previous year);
- ✓ the scopes of thermal power used;
- ✓ the rates of growth/reduction in the scopes of thermal power used (compared to the previous year);
- ✓ the scopes of thermal power losses;
- ✓ the rates of growth/reduction in the scopes of thermal power losses (compared to the previous year).

According to the data from the State Statistics Service of Ukraine, the overall capacity of wind power plants was 476 thousand kW in 2018, which is 26.7% less than the previous year; the overall capacity of solar power plants made 1201 thousand kW, which is 66.3% higher than the respective period of the previous year. In overall, the electricity supply of the above mentioned producer categories in 2018 made: 1182 million kW of wind electricity (26.2% less than in the previous reporting period) and 1103 million kW of solar electricity (45.5% more) [8].

The detailed data on the structure of electricity generation and the power plant capacities are shown in Figures 1 and 2.

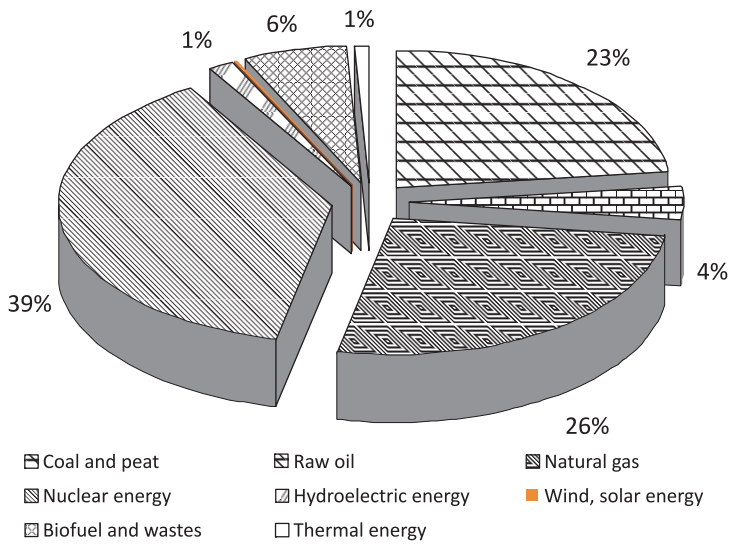

Fig. 1. The structure of electricity generation in Ukraine

Source: constructed by the authors using the data from the State Statistics Committee of Ukraine

As shown in Figure 2, thermal power plants have the largest share in the total installed capacities of power plants operating in Ukraine (46%). The share of wind power plant capacities in the total capacities of electricity generation in Ukraine has been stable at only 1% in the latest two years. But solar electricity could increase its capacities by 1% to reach 2% in the total electricity genering capacities in Ukraine.

The structure of electricity supplied by the Ukrainian power plants in 2018 is shown in Figure 3.

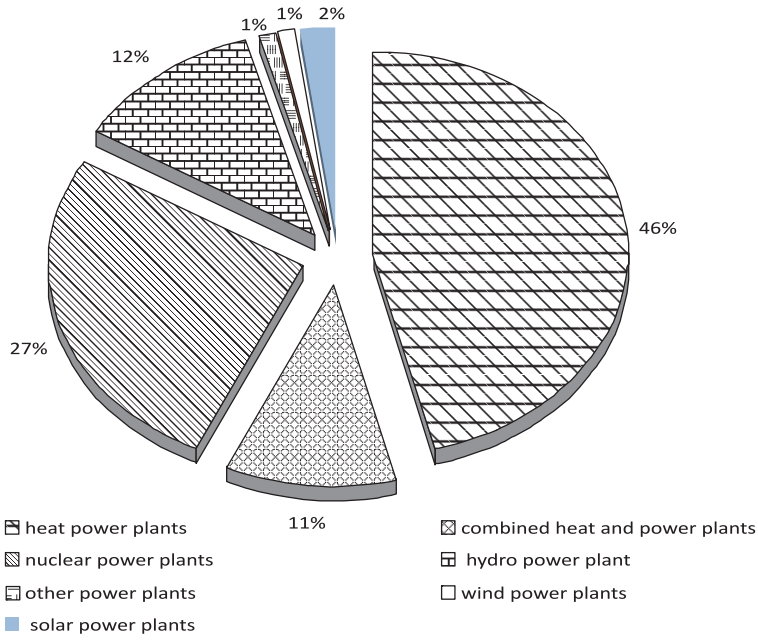

Fig. 2. The structure of power plant capacities in Ukraine, 2018

Source: constructed by the authors using the data from the State Statistics Committee of Ukraine

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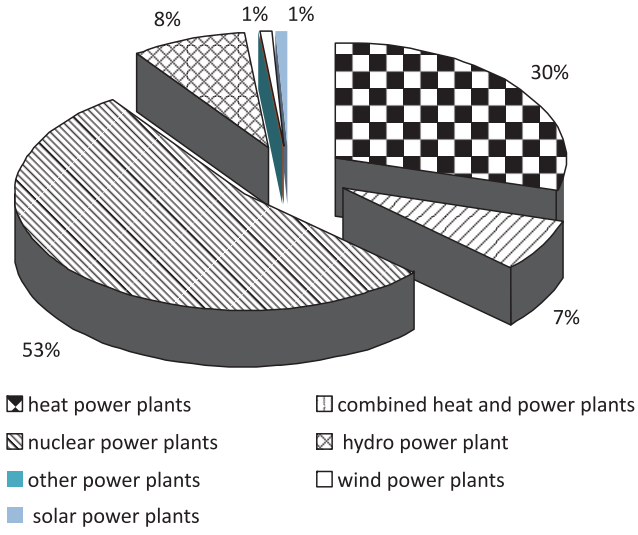

Fig. 3. The structure of electricity supplied by the Ukrainian power plants, 2018

Source: constructed by the authors using the data from the State Statistics Committee of Ukraine

As can be seen from Figure 3, the largest electricity suppliers in Ukraine are nuclear power plants (53%), followed by thermal power plants (30%). The electricity supplied by producers generating it from alternative renewable sources, namely wind and sun, accounts for only 2% of the total supply (1% each).

As regards the dynamics of primary energy supply in Ukraine in 2007–2017, the overal supply of wind and solar energy made 149 thousand TOE in 2017, which is 37.3 times higher than in 2007 (see Figure 4) [8].

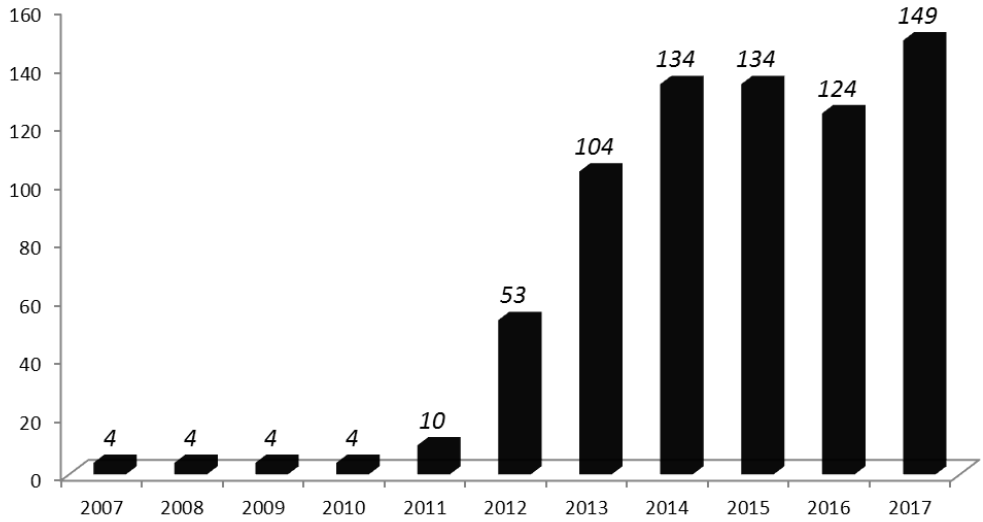

Fig. 4. The dynamics of primary energy supply in Ukraine in 2007–2017 (thousand TOE)

Source: constructed by the authors using the data from the State Statistics Committee of Ukraine

In addition, the data on the national capital (investment) and current environmental protection expenditure in Ukraine (on solar and wind energy in particular) are reported in the official statistical observation, form No 1-Environmental expenditure "Environmental protection expenditure".

The environmental protection expenditure includes all the categories of expenditure aiming at prevention, reduction or elimination of pollution, other types of dangerous environmental effects from economic or other activities when supplying services or using products, and at preservation of biodiversity and habitat.

According to the methodological guidelines on official statistical observations, capital environmental protection expenditure (investment) on is defined as an investment in acquisition of new or used tangible and intangible assets, in-house fabrication of tangible and intangible assets for internal use, capital reconstruction and modernization, aimed at environmental protection [9].

Current environmental protection expenditure is defined as an expenditure made to support (maintain and operate) an object (fixed assets with the environmental protection purposes) in the working conditions, which include in the total expenditure of the current period [9].

Expenditure categories like resource saving or energy saving are accounted for as environmental ones only when they are meant for environmental protection.

Environmental protection is defined as a set of measures aiming at prevention, reduction or elimination of pollution, other types of dangerous environmental effects from economic or other activities when supplying services or using products, and at preservation of biodiversity and habitat.

Capital and current expenditure on alternative energy sources (wind and solar energy) are recorded by category of nature protection measures (CEPA 1) "Protection of air and problems of climate change", by code D 35.11"Supply of electricity, gas, steam and con-

ditioned air" of the Economic Activities Classification – 2010, without breaking by type of electricity supply:

- prevention of creating the pollutants emitted in the air, through changing production processes or technologies;
- cleaning of flue gases and exhaust gases, ventilation emissions, for purposes of air protection, climate preservation and ozone layer protection;
- analytical measurements, control, laboratory research etc.;
- other expenditure related with air protection and problems of climate change.

Considering the abovementioned, capital and current expenditure on wind and solar energy, obtained by the official statistical observation, form No 1-Environmental expenditure "Expenditure on environmental protection, including capital and current expenditure", cannot be separated.

Because the share of renewable energy sources in the total electricity supply in Ukraine and beyond is expected to grow in the forthcoming decades, with electricity generation from alternative energy sources becoming increasingly more cost-effective compared with conventional power plants operated by burning of solid coal, national electricity producers need to attract international and national investment in electricity generation from renewable sources.

It should be noted that the United Nations Economic Commission for Europe (UNECE) provides permanent support to Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine for further improvements of the Strategic Environmental Assessment (SEA) and cross-border Environmental Impact Assessment (EIA), for prevention and elimination of the damage to the environment and human health, caused by economic growth. It helps develop a large program funded by EU and designed to make national economies "green" and promote sustainable development in six countries of the Eastern Partnership. This initiative is used by UNECE for supporting the countries' effort to fully harmonize the national law with the UNECE Protocol on SEA and the Convention on EIA, as well as with the respective EU Directives, and to apply it in an effective and regular manner. This assistance will be provided by UNECE in 2019–2022, with the total funding worth 2.6 million, as part of the program "EU4El Environment".

On June 27–28, 2019, the countries that are project beneficiaries, together with EU and international partners (OECD, UNECE, United Nations Environment Program (UNEP), UNIDO and World Bank), had a meeting in Brussels to set priorities, objectives and specific actions for the initial period, in order to ensure environmental protection in future, utilize environmental development capacities and launch mechanisms for effective management of environmental risks and impacts [10].

As mentioned earlier, environmental studies, including ones of expenditure on protection and rehabilitation of the environment, require computations and analysis of quantitative indicators based on statistical data. Problems of statistical accounting of "green" energy are, therefore, central ones in investigating scopes, structures and categories of expenditure on electricity generation from alternative sources. The main problem is comparability of data, which enables for data comparisons in order to find core development tendencies and patterns, changes that are in place, relationships of indicators, and to take decisions. Yet, statistical data from various countries are often incomparable due to methodological gaps in construction and dissemination of statistical data.

It needs to be emphasized that EPEA compiled using the structure of nature protection expenditure by the classification of nature protection measures by expenditure category (capital investment, including expenditure on capital repair and current expenditure) enables for full and reliable reporting of environmental data. But these indicators cannot determine the environment's significance in the economic life of a country. This objective can be achieved only by use of cost indicators, which methodology and methods will be compatible with the indicators applied for the valuation in other industries. These indicators constitute the basis of EPEA. They allow for a detailed analysis of the environment as an economic component of the National Accounts System [11–14].

As a result, the UN Statistical Department recommended all the countries to keep environmental economic accounts using the Central Framework of SEEA, to present the statistics produced in this way and continue the effort to find solutions for the rest of problems in this

field, in order to construct an even more inclusive set of nature environmental accounts, including energy ones.

As shown by the study, the main objective of environmental economic accounts is to estimate the actual environmental protection expenditure (including the one on wind and solar energy generation) in the structure of the overall expenditure that are actually used to prevent degradation of the environment or rehabilitate it.

To make EPEA complete, supplementary information needs to be used, including one on expenditure sources or costs of environment protection measures by industry. Thus, the demand for alternative energy sources results in targeted investment and inter-budget transfers, intermediate consumption required to launch the above measures, employment etc.

According to the Eurostat recommendations, environmental protection expenditure for non-specialized producers (non-financial corporations, by the Economic Activities Classification) is to be reported in Annex No 9 EPEA (Table 1). Note that this Annex has both main and supplementary modules for filling (Table 1 and Table 2) [15–16].

Table 1

Environmental protection expenditure by sector of non-financial corporations (section D) (non-specialized producers by the Economic Activities Classification) (the main nodule)

Expenditure	CEPA 1
(P1_ANC.3) Auxiliary output of environmental protection services	
(P51G_NP.3) Gross accumulation of fixed capital and acquisition minus non-financial non-production assets	

Source: [15–16]

Table 2

Environmental protection expenditure by sector of non-financial corporations (section D) (non-specialized producers by the Economic Activities Classification) (the supplementary module)

Expenditure	CEPA 1
(P51G_NP.3) Gross accumulation of fixed capital and acquisition minus non-financial non-production assets	
(INV_EOP.3) in cleaning	
(INV_IT.3) in integrated technologies	
(P2.3) Gross intermediate consumption	
(P2_EPS.3) Intermediate consumption of environmental protection services	
(P2_NEPS.3) Intermediate consumption (except for environmental protection services)	
(D1.3) Employee compensations	
(P1_ANC.3) Auxiliary output of environmental protection services *((P2_NEPS.3) + (D1.3))*	
(D29-D39.3) Other taxes minus production subsidies	
(P51C.3) Fixed capital consumption	
(P1_ANC_ESA.3) Auxiliary output of environmental protection services (related output of environmental protection services) *((P2_NEPS.3) + (D1.3) + (P51C.3) + (D29-D39.3))*	
(EMP.3) Number of worked days	
(P2_EPS_EXT.3) Gross intermediate consumption of environmental protection services	

Source: [15–16]

Conclusions and perspectives of further studies. The study shows that statistical accounting of the electricity generation from alternative energy sources (i. e. wind and solar), and capital and current expenditure on creation and renovation of wind and solar energy capacities needs further improvements. The following problems of alternative energy sources will be subject to further study:

1) to determine alternative options for main sources of data on building and re-equipment of solar and wind power plants;
2) to investigate the capabilities of existing official statistical observations;
3) to investigate the legislative framework for alternative energy sources;
4) to investigate the possibilities of installing solar power plants in households and determine the installation costs.

Results of this study will help enhance the reliability of reported data on the capacities and generation of wind and solar energy.

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