MODELING AND FORECASTING OF NET INCOME FROM THE COUNTRY'S ELECTRICITY SUPPLY

Rabim Alikulovich Fayziev*
Professor Deptatment of Mathematical Methods in Economics Tashkent State University of Economics, Tashkent, Uzbekistan
zktdiu@yandex.ru

Feruz Mustafoevich Kurbanov
Deputy Chairman for Investments of JSC "National Electric Grid of Uzbekistan", Tashkent, Uzbekistan
f.qurbonov@uzbekistonmet.uz

ABSTRACT

The article analyzes the net income from electricity production in the energy system of the Republic of Uzbekistan for 2005-2020 and developed proposals for its improvement. The mathematical model of this process is analyzed, and on the basis of the goal to be achieved in 2030, the net income from the supply of electricity to the country until 2030 is determined.

CCS CONCEPTS

• **Electricity, production, electricity supply, net profit, mathematical modeling, forecasting.**;

ACM Reference Format:
Rabim Alikulovich Fayziev* and Feruz Mustafoevich Kurbanov. 2021. MODELING AND FORECASTING OF NET INCOME FROM THE COUNTRY'S ELECTRICITY SUPPLY. In *The 5th International Conference on Future Networks amp Distributed Systems (ICFNDS 2021), December 15, 16, 2021, Dubai, United Arab Emirates.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3508072.3508149

1 INTRODUCTION

All over the world, countries are facing energy shortages in the energy supply they need to develop their economies. This situation has become a topical issue in Uzbekistan as well.

Electricity supply and revenue generation is one of the priorities of every country. Therefore, scientific research is conducted and conclusions and recommendations are developed to create an uninterruptible power supply and generate revenue. The following is an analysis of several studies devoted to solving these problems, and conclusions and recommendations have been developed to increase the benefits to the country's energy system.

The Decree of the President of the Republic of Uzbekistan "On the Action Strategy for the further development of the Republic of Uzbekistan" [8] analyzes the large-scale reforms implemented in the country during the years of independence and defines the Action Strategy for 2017-2021. Paragraph 2 of the third of these five priorities, entitled "Priorities for Economic Development and Liberalization", is dedicated to "deepening structural change, increasing its competitiveness through modernization and diversification of key sectors of the national economy." reduction of resource consumption, widespread introduction of energy-saving technologies in production, expansion of the use of renewable energy sources, increase of labor productivity in various sectors of the economy " [1]. In this regard, it is expedient to analyze the economic indicators of electricity supply in the Republic of Uzbekistan during the years of independence for 2017 and beyond, and economic and mathematical modeling of these processes.

ICFNDS 2021, December 15, 16, 2021, Dubai, United Arab Emirates

ACM ISBN 978-1-4503-8734-7/21/12…$15.00
https://doi.org/10.1145/3508072.3508149

2 LEVEL OF STUDY OF THE TOPIC

Nock D., Levin T. & Baker E. [2] developed a methodology for finding the optimal expansion of the energy system to maximize social benefits, as it implies an equal distribution of electricity use, taking into account budget constraints. This is different from traditional models, which reduce the cost of meeting the demand for electricity. The authors formulate the problem of planning the expansion of production in the form of a program to maximize the number of linear utilities and use it in the analysis of the situation in a country with low income and limited power supply infrastructure. This methodology will help decision makers assess the social trade-off between improving energy access, reducing energy inequality and poverty, and increasing overall electricity consumption when working within budget constraints in their countries.

Belaïd F. & Harbaoui M. [3] developed an empirical model to study the relationship between renewable and non-renewable electricity consumption, GDP, and carbon emissions using panel data from 9 Mediterranean countries between 1980 and 2014. Using PMG ARDL panel and panel econometric methods, the heterogeneity and interdependence between the panels were examined to verify long and short-term dynamic relationships, as well as the accuracy of the proposed model. The results obtained by the authors prove with panel empirical evidence that there is a short-term two-way relationship between gross domestic product, renewable energy consumption and CO_2 emissions, non-renewable energy consumption, GDP and renewable energy consumption.

Stefan D., Catalina C., Cristian S. & Vasile J. [4] the aim of the article is to determine the link between energy, CO_2 emissions, economic growth, and urbanization on a global scale. To achieve the goal, the authors used a number of statistical methods to study the cointegration between variables, the impulse response function to track the impact of the shock that occurred, and finally studied their types. Empirical results confirmed the existence of a long-term correlation. The separation of impulse functions and variance allowed the authors to understand how variables change: how renewable energy consumption, energy types, economic growth,

CO_2, and urbanization are explained by other variables. Empirical results are of interest to researchers, regulators, and investors.

Bridge B. A., Adhikari D. & Fontenla M. [5] studied the impact of electricity on income, education, health, and labor productivity in Nepal. Simultaneously, the set of equations was evaluated using the three-step least squares method. The authors found that connecting households to electricity has a very large and significant impact on income, education, and agricultural productivity. The positive effects of electricity on health have been found. The impact of electricity on income was measured directly and through intermediaries in education, health, and agricultural production. The tremendous impact of electricity on quality of life has been shown to be important evidence of the addition of energy poverty to the development debate.

Kantar E. & Keskin M. [6] the study used hierarchical structuring methods to study the relationship between energy consumption and economic growth in a sample of 30 Asian countries covering 1971-2008. These countries are divided into four panels based on the World Bank's income classification, namely upper, upper middle, lower middle and lower income. In particular, the authors used data on per capita electricity consumption and real gross domestic product (GDP) to determine the topological characteristics of countries. The relationship between electricity consumption and economic growth is shown. In addition, the initial loading method was used to study the value of statistical reliability. Finally, a cluster linking procedure was used to follow the cluster structure. The results of the structural topologies of these trees are as follows: identified different groups of countries according to their geographical location and economic growth; identified a strong link between energy consumption and economic growth.

Niu, S. et al. [7] analyzed the causal relationship between electricity consumption and human development and assessed the trend of electricity consumption. These research models were created using panel data from 1990-2009. For 50 countries, it is divided into four groups by revenue. GDP per capital, consumption expenditure, urbanization rate, birth rate and adult literacy rate were selected as indicators of human development. The results of the authors show that there is a long-term two-way causal relationship between electricity consumption and the five indicators. Moreover, the higher the country's income, the higher the electricity consumption and the higher the level of human development. In addition, the variables of the four income groups differ significantly. In particular, as incomes increase, electricity consumption will increase to GDP and consumption expenditures, but the level of urbanization, life expectancy at birth, and adult literacy will decrease. This has been shown to be mainly due to the increase in rates for convergence in high-income countries. It has been shown that electricity is included in basic utilities to increase the supply of electricity to the poor to improve human development.

Taghizadeh-Hesary F., Rasoulinezhad E. & Shahbaz M. [8] conducted a model evaluation using panel evaluation of a generalized method of the moment system for 35 Asian countries between 2000 and 2017. According to the authors, the main findings confirm that the transition in the energy sector (transition from fossil fuels to renewable energy sources) will have a positive impact on electricity consumption in high-income and average Asian countries. In addition, the authors of the results note that inflation, electricity pricing, and population growth in electricity consumption in middle- and lower-middle-income Asian countries are higher than in high- and middle-income Asian countries. The bottom line is that the relationship between the power industry and the transition economy is very sensitive to countries income levels and macroeconomic stability. This means that Asian countries with different income levels must first take measures to increase economic and overall stability, then the transition from fossil fuels to green energy and increase technological efficiency in the electricity generation sector.

Nguyen C. P. & Su T. D. [9] the study sought to examine the impact of public spending on energy poverty in a global sample of 56 developing countries. In particular, the study primarily examined the impact of government spending on the four indicators of energy poverty. Second, the role of institutional quality as a game rule in society as a result of public spending has been explored. Finally, the channels through which government spending affects energy poverty were examined. The results are important when using multiple panel evaluations. First, public spending has an impact on energy poverty, which means that increasing public spending can reduce energy poverty to a certain extent; however, any excessive consumption from this oscillation point will damage the energy well-being. Second, institutions serve as a crucial catalyst in shaping the quality of public spending. Third, the impact of government spending is transmitted in two ways: through economic growth and income inequality.

Hashemizadeh, A., Ju, Y., Mojtaba, S., Bamakan, H., & Phong, H. in [10], the investment risk factors of renewable energy in the Belt and Road Initiative countries were investigated. They are identified and divided into five groups: economic, technical, environmental, social and political using the TODIM (Interactive Multi-Criteria Decision Making) method. The identified factors are then weighted using a fuzzy-analytic network process (F-ANP), and the various renewable energy sources are ranked using COPRAS, MABAC and GRA methods under uncertainty. A sensitivity analysis of investment decision making with a focus on the commercial value aspect of renewable energy projects is conducted. The results of this study are useful for evaluating investment projects and expanding their international markets.

The main purpose of the study Prabatha, T., Karunathilake, H., & Mohammadpour, A. [11] is to compare and identify the strengths and weaknesses of different methods of mathematical modeling used in energy planning for renewable energy systems connected to the grid. As an example, demonstrate various methods for multi-criteria optimization with and without uncertainty (i.e., robust optimization, linear optimization, Taguchi orthogonal array method, and Monte Carlo simulation). The optimization results, as well as the time and effort for evaluation, were compared for different methods. The results show that robust optimization can be used to develop a decision model based on uncertainty. This significantly reduces the estimation time compared to other methods. Although the presence of uncertainties can alter the optimal configuration of a planned energy system, the method of estimation itself does not significantly affect the results. The results of this study will allow energy planners and researchers to compare different multi-criteria optimization methods and select the best ones for planning renewable energy projects, especially in the pre-project planning phase.

Qiu, S., Lei, T., Wu, J., & Bi, S. in [12], a long-term planning system for alternative energy sources was used to forecast the demand for final energy consumption in China. A new mixed integer linear programming model was developed to optimize the energy structure, infrastructure projects, and operation schemes under constrained greenhouse gas emissions. In addition, economic, feasible and sustainable energy planning is obtained. The results show that the rate of electrification, demand for clean hydrogen, and other energy needs in China will increase significantly. Coal production capacity will be concentrated, the integration of oil production and refining will be phased in, and non-fossil energy production will increase significantly. China's total greenhouse gas emissions from energy consumption between 2017 and 2060 will be approximately 262,783 million tons of CO_2 equivalent.

The study [13] Meng, J., Hu, X., Chen, P., Coffman, D. M., & Han, M. proposes the Electricity Supply Sustainability Index (ESRI), which is an indicator of the sustainability of a country's electricity supply. Starting with an initial set of individual indicators from a structured selection process, ESRI calculates for 140 countries around the world. Thirty-eight combinations of eight normalization methods and six aggregation functions were considered to account for the reliability of the resulting sustainability index. The results show a clear tendency to rank resilient countries with high and low scores in all combinations. However, ranking disparities become large for countries with average scores, especially if their scores exhibit high variability. In addition, differences in rankings are quantified using the rank difference index (RDM), which identifies the categorical scales and the minimum aggregator as the most different. Finally, the effects of different levels of aggregation function compensation are discussed. The results of this study aim to provide guidance to policymakers on how the results of composite indices depend on the assumptions and approaches chosen.

Gasser, P., Suter, J., Cinelli, M., Spada, M., Burgherr, P., Hirschberg, S., Kadziński, M., Stojadinović, B., Resilient, F., Frs, S., Sec, S. C., Federal, S., & Eth, T. in [14] explores the national contribution to global energy consumption from different perspectives in the global supply chain and is intended to complement current policies to reduce energy consumption. In developed countries, energy consumption has remained stable from 2000 to 2014, while in developing countries it has almost doubled (e.g., China and India). Most developing countries are producers whose energy consumption based on production and final production exceeds that based on consumption, with the exception of India after the global financial crisis. In contrast, developed countries are consumers with higher consumption-based energy consumption. At the industry level, the service sector is the largest contributor to consumption-based energy consumption and income. The analysis in this study can create opportunities for all parties in the supply chain to reduce fossil fuel consumption.

Cu, L., Martin, M., & Kravanja, Z. in [15], a synthesis of sustainable renewable energy supply networks in the EU-27, which proposes a phased transition to energy in the transportation and energy sectors to achieve the goal of carbon neutrality by 2050. Developed a multi periodic mixed integer programming model to maximize the net present value of sustainability, taking into account various biomass and waste resources to produce biofuels, renewable electricity, hydrogen, food, and bio products using different types of technologies. The results show that with further development of existing technologies, the goal of a carbon-neutral EU can be achieved without compromising food production. Wind farms have proven to be the most promising solution at present for the rapid expansion of electricity production from renewable energy sources, while the importance of solar photovoltaics is increasing over the years, reaching 43% of the share of electricity production from renewables in 2050. Moreover, energy transit in the EU could have a significant positive impact on the economic, environmental and social aspects of sustainable development, as more than 1.5 million new jobs will be created in the EU over the next 30 years.

Table 1: Net income from electricity supply in the Republic of Uzbekistan for 2005-2016 (thousand sums)

t	Years	Net income
1	2005	69592597
2	2006	88144517
3	2007	93446130
4	2008	113276557
5	2009	134008554
6	2010	150670653
7	2011	186359369
8	2012	217125571
9	2013	244859638
10	2014	323501398
11	2015	377976161
12	2016	410558121

Andreev, O., Lomakina, O., & Aleksandrova, A. in [16] the study is aimed at assessing alternatives to energy diversification in ASEAN member countries in the context of minimizing the risks associated with the creation of an energy portfolio. The country's energy diversification indicator based on the Shannon-Wiener index is used. Three scenarios based on an increase in the share of renewable energy are proposed to identify possible changes in the ASEAN member countries' energy market. The assessment of possible deviations from the expected results according to the described scenarios of increasing the share of renewable energy sources made it possible to identify the countries affected by positive and negative deviations.

3 RESEARCH METHODOLOGY:

Based on the economic indicators of electricity supply of the Republic of Uzbekistan, data graphs were created, their functions were selected and a model was developed. The reliability of the model was determined. Based on these models, forecast indicators for the next 2021-2030 have been determined

4 ANALYSIS AND RESULTS.

The indicators of net income from electricity supply in the Republic of Uzbekistan for 2005-2016 are given in Table 1

Based on the data in this table, we create a graph and mathematical model of net income from electricity supply in the Republic of Uzbekistan for 2005-2016 (Figure 1).

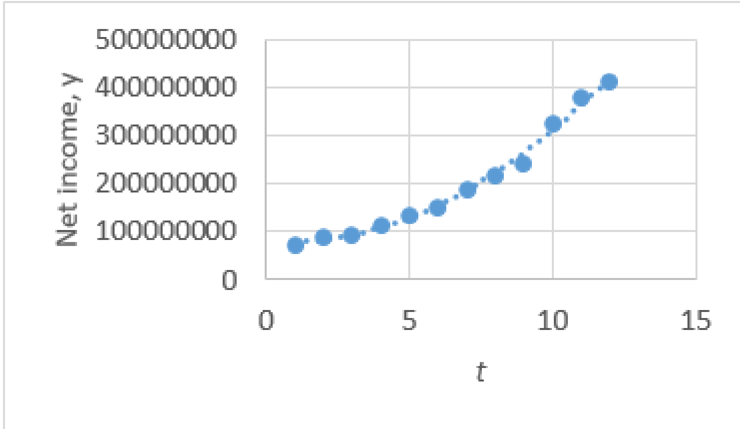

Figure 1: Net income from electricity supply in the Republic of Uzbekistan in 2005-2016

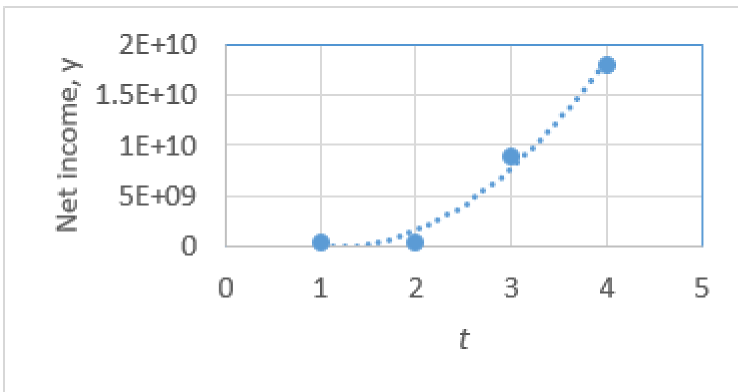

Figure 2: Net income from electricity supply in the Republic of Uzbekistan in 2017-2020

Table 2: Net income from electricity supply in the Republic of Uzbekistan for 2017-2020 (thousand soums)

t	Years	Net income
1	2017	434478129
2	2018	528724038
3	2019	8866351383
4	2020	18023020753

The dynamics of net income from electricity supply in the Republic of Uzbekistan in 2005-2016 can be expressed by the following mathematical model.

$$y = 3E + 06t^2 - 3E + 06t + 8E + 07;\ R^2 = 0,993 \qquad (1)$$

The fact that the value of the approximation accuracy in this model (1) is $R^2 = 0.993$ means that the model is able to express the dynamics of the indicators with a high degree of accuracy..

The indicators of net income from electricity supply in the Republic of Uzbekistan for 2017-2020 are given in Table 2

Based on the data in this table, we will create a graph of net income and econometric model of electricity supply in the Republic of Uzbekistan for 2017-2020 (Figure 2).

The net income from electricity supply in the Republic of Uzbekistan in 2017-2020 can be expressed by the following mathematical model.

$$y = 2E + 09t^2 - 5E + 09t + 3E + 09;\ R^2 = 0,9869 \qquad (2)$$

The fact that the value of the approximation accuracy in this model (2) is $R^2 = 0.9869$ means that the model is able to express the dynamics of the indicators with a high degree of accuracy.

The results of the analysis show that after 2017, positive results began to be achieved in the net income from electricity supply. Forecasts of net income from electricity supply in the Republic of Uzbekistan until 2030, calculated by model (2) are given in Table 3

Electricity supply in the Republic of Uzbekistan in 2005-2016 can be expressed by the following mathematical model:

$$y = 132,65t^2 - 821,9t + 51277;\ R^2 = 0.977 \qquad (3)$$

Table 3: Forecast of net income from electricity supply in the Republic of Uzbekistan for 2021-2030 according to model (2) (thousand soums)

t	Years	Net income
5	2021	2,8 E+10
6	2022	4,5 E+10
7	2023	6,6 E+10
8	2024	9,1 E+10
9	2025	1,2E+11
10	2026	1,53E+11
11	2027	1,9E+11
12	2028	2,31E+11
13	2029	2,76E+11
14	2030	3,25E+11
Total		1,30E+12

The fact that the value of the approximation accuracy in this model (3) is $R^2 = 0.977$ means that the model is able to express the dynamics of the indicators with a high degree of accuracy.

Based on the analysis, research and adopted documents in 2017, including the Resolution of the President of the Republic of Uzbekistan "On the strategy of further development and reform of the electricity industry of the Republic of Uzbekistan" [17], as a result of structural changes in the energy system significant changes have taken place. In particular, in 2017-2021, a number of enterprises launched additional capacity (3834.7 MW).

As a result, the supply of electricity in the Republic of Uzbekistan in 2017-2020 began to develop on the basis of the following mathematical model

$$y = 293,52t^2 + 1635,1t + 60254;\ R^2 = 0,9763 \quad (4)$$

The fact that the value of the approximation accuracy in this model (4) is $R^2 = 0.9763$ means that the model is able to express the dynamics of the indicators with a high degree of accuracy.

The results of the analysis show that after 2017, positive results began to be achieved in the energy system.

According to the concept of electricity supply of the Republic of Uzbekistan in 2021-2030, in 2030 the production of electricity will be 120.8 billion kWh per year [17].

(4) Analysis based on the model shows that the current development model does not allow to achieve this goal. With this in mind, if we make the following modification to the model,

$$y_t = 293,52t^2 + 1635,1t + 60254 + by_{t-1} \quad (5)$$

and if we perform the following calculations,

120,8=105,957+98,745b,

We find that b = 0.15, which means that if the epergic production is increased by a factor of 0.15 each year compared to the previous year, the goal of 2030 can be achieved.

Suppose that the supply of electricity in the Republic of Uzbekistan in 2021-2030 (3) develops as a mathematical model. Assuming that net income develops in a similar way, model (2) can be expressed as follows

$$y = 2E + 09t^2 - 5E + 09t + 3E + 09 \quad (6)$$

Table 4: Forecast of net income from electricity supply in the Republic of Uzbekistan for 2021-2030 according to the model (7) (thousand soums)

t	Years	Net income
5	2021	30703453113
6	2022	49200000000
7	2023	72750000000
8	2024	1,009E+11
9	2025	1,3365E+11
10	2026	1,71E+11
11	2027	2,1295E+11
12	2028	2,595E+11
13	2029	3,1065E+11
14	2030	3,664E+11
Total		1,71E+12

By writing (5) as (3), we obtain the following

$$y = 2E + 09t^2 - 5E + 09t + 3E + 09 + by_{t-1} \quad (7)$$

in which case, as above, we assume that b = 0.15. As a result, we have the following (Table 4).

Comparing Tables 3 and 4, it can be seen that in 2030, net income growth of 325 billion soums can be obtained by calculating the current net income development with model (2). If we calculate with the model (7) it is possible to get 366.4 billion soums, or 41.4 billion soums of additional income.

If the power supply is organized on the basis of the indicators planned in the Concept of electricity supply of the Republic of Uzbekistan in 2021-2030 [17], it is represented by the following linear model:

$$y = 5,1336t + 62,925 \quad (8)$$

The fact that the value of the approximation accuracy in this model (8) is $R^2 = 0.9961$ means that the model is able to express the dynamics of the indicators with a high degree of accuracy.

In 2020, the net income from 1 kW of energy amounted to 251,251,107 soums. Taking this into account, assuming that the net income from 1 kW of energy in the coming years will be the same, we calculate the net income from electricity in 2021-2030 on the basis of the model (8) (Table 5).

Analysis of Tables 3–5 based on models (2), (7) - (8) shows that on the basis of model (2) the total net income from electricity in 2021-2030 is 1.30E + 12 thousand soums, on the basis of model (7) 1,71E + 12 thousand soums, and on the basis of model (8) 2,80E + 12 thousand soums. From this (8) model shows that more net income can be obtained. This does not take into account the cost of additional capacity to be commissioned. The calculation is appropriate for a case where so much electricity has been generated. In this case (8) the model requires more additional power to run. The (7) model, on the other hand, requires relatively less additional power to run.

5 CONCLUSION AND SUGGESTIONS.

The analysis of electricity supply indicators of the Republic of Uzbekistan for 2005-2016 shows that due to the fact that they do

Table 5: Forecast of net income from electricity supply in the Republic of Uzbekistan for 2021-2030 according to the model (8) (thousand soums)

t	Years	Net income
5	2021	2,23E+11
6	2022	2,35E+11
7	2023	2,48E+11
8	2024	2,51E+11
9	2025	2,74E+11
10	2026	2,87E+11
11	2027	3,00E+11
12	2028	3,13E+11
13	2029	3,26E+11
14	2030	3,39E+11
Total		2,80E+12

not meet the needs of the country, positive results have begun to be achieved on the basis of structural changes in 2017. However, it was found through mathematical models and analysis that these changes were also insufficient. Using these models, new models were developed to achieve the planned results and based on them, forecast indicators were obtained.

Three mathematical models of the net income of the power supply were proposed:

1. Model on net income of current power supply;

2. Model of accounting for net income in the amount of an additional known coefficient calculated in the current year compared to the previous year to achieve the planned goal:

3. A model based on planned indicators, taking into account the initial unit net income.

4. The proposed models will help improve the country's electricity supply.

REFERENCES

[1] Decree of the President of the Republic of Uzbekistan "On the Strategy of Actions for the Further Development of the Republic of Uzbekistan" No. UP-4947. https://lex.uz/ru/docs/3107042

[2] Nock D., Levin T. & Baker E. Changing the policy paradigm: A benefit maximization approach to electricity planning in developing countries. Appl. Energy 264, 114583 (2020).

[3] Belaïd F. & Harbaoui M. Renewable and non-renewable electricity consumption , environmental degradation and economic development: Evidence from Mediterranean countries. Energy Policy 133, 110929 (2019).

[4] Stefan D., Catalina C., Cristian S. & Vasile J. Understanding the multidimensional linkages among renewable energy , pollution , economic growth and urbanization in contemporary economies: Quantitative assessments across different income countries ' groups. Renew. Sustain. Energy Rev. 142, 110818 (2021).

[5] Bridge B. A., Adhikari D. & Fontenla M. Electricity , income , and quality of life ξ. Soc. Sci. J. 53, 33–39 (2016).

[6] Kantar E. & Keskin M. The relationships between electricity consumption and GDP in Asian countries , using hierarchical structure methods. Physica A 392, 5678–5684 (2013).

[7] Niu, S. *et al.* Electrical Power and Energy Systems Electricity consumption and human development level: A comparative analysis based on panel data for 50 countries q. Int. J. Electr. Power Energy Syst. 53, 338–347 (2013).

[8] Taghizadeh-hesary, F., Rasoulinezhad, E. & Shahbaz, M. How energy transition and power consumption are related in Asian economies with different income levels? Energy 237, 121595 (2021).

[9] Nguyen C. P. & Su T. D. The in fl uences of government spending on energy poverty: Evidence from developing countries. Energy 238, 121785 (2022).

[10] Hashemizadeh, A., Ju, Y., Mojtaba, S., Bamakan, H., & Phong, H. (2021). Renewable energy investment risk assessment in belt and road initiative countries under uncertainty conditions. Energy, 214, 118923. https://doi.org/10.1016/j.energy.2020.118923

[11] Prabatha, T., Karunathilake, H., & Mohammadpour, A. (2020). Community-level decentralized energy system planning under uncertainty: A comparison of mathematical models for strategy development. Applied Energy, September, 116304. https://doi.org/10.1016/j.apenergy.2020.116304

[12] Qiu, S., Lei, T., Wu, J., & Bi, S. (2021). Energy demand and supply planning of China through 2060. Energy, 234, 121193. https://doi.org/10.1016/j.energy.2021.121193

[13] Meng, J., Hu, X., Chen, P., Coffman, D. M., & Han, M. (2020). The unequal contribution to global energy consumption along the supply chain. Journal of Environmental Management, 268(April), 110701. https://doi.org/10.1016/j.jenvman.2020.110701

[14] Gasser, P., Suter, J., Cinelli, M., Spada, M., Burgherr, P., Hirschberg, S., Kadziński, M., Stojadinović, B., Resilient, F., Frs, S., Sec, S. C., Federal, S., & Eth, T. (2020). Comprehensive resilience assessment of electricity supply security for 140 countries. Ecological Indicators, 110(September 2019), 105731. https://doi.org/10.1016/j.ecolind.2019.105731

[15] Cu, L., Martin, M., & Kravanja, Z. (2021). Sustainable renewable energy supply networks optimization – The gradual transition to a renewable energy system within the European Union by 2050. 146. https://doi.org/10.1016/j.rser.2021.111186

[16] Andreev, O., Lomakina, O., & Aleksandrova, A. (2021). Diversification of structural and crisis risks in the energy sector of the ASEAN member countries. Energy Strategy Reviews, 35(December 2020), 100655. https://doi.org/10.1016/j.esr.2021.100655

[17] The concept of providing the Republic of Uzbekistan with electric energy for 2020-2030 years. 2020 year. 21, Innovation and Technologies) Journal.Vol. 11 No. 2 (2021). http://www.revistageintec.net/index.php/revista/article/view/1869