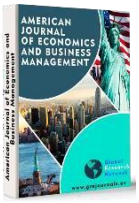

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Article

Energy Factor as a Basis for Efficient Development of Economic Sectors

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Abstract: This study analyses the impact of energy efficiency within the fuel and energy industry on economic growth in Uzbekistan. The primary objective is to assess the influence of sustainable energy infrastructure on GDP through enhanced resource accessibility, environmental sustainability, and energy security. This research use mathematical modelling and cross-country regression analysis utilising data from the World Economic Forum (2009-2019) to examine the relationships among the sub-indices of the energy performance index (EAPI), namely economic development, environmental sustainability, and energy availability. Notable findings indicate a strong correlation between a robust energy infrastructure and GDP growth, with the energy access sub-index showing the most significant impact. The policy implications highlight the imperative for Uzbekistan to emphasise reliable energy supply and security to promote sustained economic growth. Investing in sustainable energy sources and reducing carbon-intensive fuels is recommended to enhance economic stability and environmental health, aiding Uzbekistan's transition to a sustainable and digital economy.

Keywords: Energy Efficiency, Economic Growth, Energy Access, Environmental Sustainability, Energy Infrastructure, Uzbekistan, GDP, Policy Implications.

1. Introduction

The sustainable development of the fuel and energy industry is crucial for facilitating economic progress. Numerous circumstances in the energy industry impede the prompt and comprehensive delivery of fuel and energy resources to customers. This results from socio-economic, geographical, environmental, and climatic factors, as well as the unequal distribution of fuel and energy supplies [1].

The energy factor profoundly influences a nation's economic growth, as it is crucial for the continuous and dependable provision of fuel and energy resources—such as gas, electricity, and thermal energy—essential for the proper operation of the economic system and the sustenance of the populace. A significant issue in the contemporary economy is enhancing the efficiency of fuel and energy resource delivery to the national economy. An efficient and dependable energy security system can ensure sustainable socio-economic growth in the areas [2]. The enhancement of population welfare and the national economy escalates the need for fuel and energy resources. Both industry and society are reliant on FER. Considering the aforementioned, let us examine the correlation between the sustainable development of the fuel and energy sector and economic growth.

Energy efficiency is essential for fostering economic progress, especially in emerging nations where sustainable energy availability may greatly influence

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industrialisation and social advancement. Worldwide, energy consumption patterns have transitioned towards more sustainable resources, highlighting the imperative to reconcile economic growth with environmental conservation [3]. In this environment, energy efficiency transcends a technological difficulty, emerging as a complex issue that influences economic policy, resource allocation, and social equality. The focus on energy efficiency, especially in the fuel and energy industry, has been crucial in discussions over sustainable development.

Uzbekistan, a rising nation with a growing population, faces unique energy challenges due to its geographical, economic, and environmental conditions. A robust and efficient energy infrastructure is important to meet increasing demand and foster economic growth. Studies demonstrate that improving energy availability and sustainability in Uzbekistan's fuel and energy sector positively impacts GDP growth, hence strengthening economic security and stability [4]. However, current research lacks a thorough analysis of the relationships between specific elements of energy infrastructure, such as the sub-indices of the Energy Architecture Performance Index (EAPI), and economic indicators. This study investigates the complex relationship between energy availability, environmental sustainability, and economic development in Uzbekistan.

2. Materials and Methods

This study utilises mathematical modelling and cross-country regression analysis to evaluate the relationship between energy efficiency in the fuel and energy sector and economic development in Uzbekistan. Data spanning from 2009 to 2019 were sourced from the World Economic Forum, focussing on the Energy Architecture Performance Index (EAPI) and its sub-indices: economic growth and development, environmental sustainability, and energy access and security. The study aims to measure the direct and indirect impacts of energy infrastructure on GDP growth through the examination of these metrics.

The regression model employs GDP per capita as the dependent variable, with the EAPI sub-indices as primary independent variables, with control variables such as population size and land area. The significance and influence of each variable on GDP growth were examined utilising statistical approaches that ensure the reliability and repeatability of the findings [5]. This technique provides a comprehensive understanding of the interactions among many elements of energy infrastructure, namely those related to sustainable energy sources, supply security, and economic indicators.

To augment scientific rigour, the research employed a scatterplot visualisation to illustrate the association between GDP per capita and EAPI ratings, highlighting how improvements in energy efficiency may promote economic growth. The results from this model offer a foundation for policy recommendations aimed at advancing energy security and sustainability in Uzbekistan, suggesting that targeted improvements in energy accessibility and infrastructure can bolster economic resilience.

This methodological approach integrates quantitative research with policy relevance, facilitating Uzbekistan's overarching objectives for sustainable development [6].

3. Results

We examined the correlation between the sustainable development of the fuel and energy sector and the growth of gross domestic product by mathematical modelling and cross-country regression analysis, utilising WEF data from 2009 to 2019.

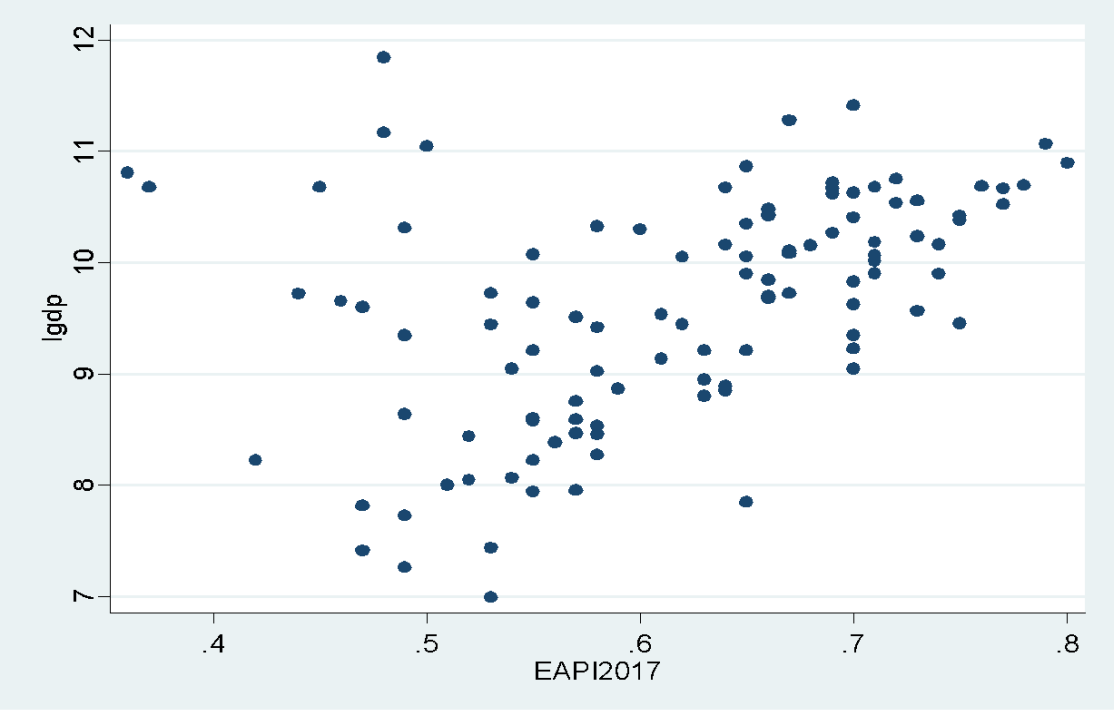

Figure 1: Scatter diagram of the relationship between GDP per capita and EAPI (energy architecture performance index) for 2019

The study enabled us to formalise a scatter diagram (Fig. 1.) (from Scatter), which substantiates our conclusion that energy-efficient infrastructure within the energy sector significantly influences economic development and is pivotal in the enhancement of national GDP [7].

The EAPI index has three sub-indices: economic growth and development (EGD), environmental sustainability (ENSUS), and energy access and security (ENAS), which are derived from nine factors (Table 3.6.).

Table 1. Power system productivity index (EAPI) indicators

Energy system facility	Indicator	Calculated on the basis of
economic growth and development	Energy intensity	Energy use per unit of GDP
	Support/barriers to growth	Cost of energy imports (% of GDP) Value of energy exports (% of GDP)
	Accessibility	Degree of artificial distortion of gasoline prices (index) Degree of artificial distortion of diesel prices (index) Electricity prices ($US per kW)
environmental sustainability	Ratio of low-carbon fuel sources in the energy mix	Alternative and nuclear energy (in % of total energy use, including biomass)
	Impact of emissions	Hydrocarbon emissions from energy production Methane emissions from the energy sector Nitrate emissions in the energy sector Average fuel consumption per passenger car

energy access and security	Level and quality of access	Electrification level (% of population) Quality of electricity supply (1-7 points) Share of population using solid fuels for cooking
	Diversification of electricity supply	Diversification of total primary energy supply (Herfindahl index)
	Self-sufficiency	import dependence (energy imports) Diversification of import partners (Herfindahl index)

The model for assessing the influence of the Energy System Productivity Index (EAPI) and its sub-indices on GDP growth, derived from empirical models of worldwide indices and their components, is expressed in a log-linear format:

$$log\ log\ (GDP_i) = \beta_0 + \beta_1 EGD_i + \beta_2 ENSUS_i + \beta_3 ENAC_i + \beta_4 POP_i + \beta_5 SURF_i + u_i,$$

$$i=1,\ldots, 108$$

The dependent variable log(GDPi) represents the logarithm of GDP per capita values, averaged from 2009 to 2016, while the independent variables are unspecified. EGDi represents the sub-index for economic growth and development, ENSUSi denotes the sub-index for environmental sustainability, ENACi signifies the sub-index for energy access and security for the year 2016, LPOPi is the logarithm of the population of country i, averaged from 2009 to 2016, LSURFi is the logarithm of the country's territorial size, and ui indicates the standard error of the regressions [8]. The variables LPOPi and LSURFi serve as control variables to enhance the statistical robustness of the findings.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lgdp	108	9.59389	1.035312	6.989185	11.84551
egd2	108	.527037	.1242868	.15	.75
ensus	108	.617037	.1542135	.18	.9
enas	108	.7034259	.1707332	.24	.95
lsurf	105	5.252333	2.02025	-1.203973	9.746729
lpop	105	2.657994	1.6199	-1.203973	

The regression analysis findings (Table 2) indicated that the impacts of all energy system productivity sub-indices (EAPI) are statistically significant and exhibit the appropriate indications. Nevertheless, the LSURFish results indicated that nation area does not influence GDP, corroborating the conclusions of previous studies. The economic growth and development sub-index influences GDP growth; specifically, a one standard deviation rise (0.12 points) in this sub-index results in a 6.1 percent increase in GDP [9]. The environmental sustainability sub-index adversely affects GDP. This phenomenon may be elucidated by the calculation of this indicator, which is derived from environmental emissions and the use of alternative energy, currently the most costly option. Thus, environmental conservation is crucial, however it concurrently hampers present economic progress to guarantee the sustainability of human development. The sub-index of energy affordability and security holds paramount significance in economic growth. A one standard deviation rise (0.17) in the subindex elevates GDP by 45 percent. This subindex reflects the significance of energy infrastructure by assessing the level and quality of power supply. The population index possesses considerable statistical importance. In this instance, the population expansion of a nation will adversely affect GDP per capita. Dividing by a larger quantity yields a smaller result.

4. Conclusion

This study's findings highlight the critical importance of energy infrastructure in promoting Uzbekistan's economic growth, particularly regarding the energy access and security sub-index, which exhibited the strongest link with GDP growth. The findings indicate that a well-organised and effective fuel and energy sector substantially enhances the nation's economic stability and growth. Nonetheless, environmental sustainability, although crucial, may impose a limitation on growth due to the substantial expenses linked to the shift to low-carbon energy sources. These observations indicate that for Uzbekistan to attain sustained economic growth, governmental initiatives must emphasise dependable energy availability and promote investment in sustainable energy technology. This study's results support policies designed to diminish reliance on carbon-intensive fuels and encourage cleaner energy options, in accordance with Uzbekistan's goals for sustainable development. Future study should investigate the long-term economic effects of certain renewable energy investments and evaluate the contribution of digital technologies in enhancing energy efficiency throughout the area.

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