

# Strategic Directions of Using Alternative Energy for Achieving Energy Saving in Industry

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**Abstract.** This article analyzes the industry of Uzbekistan and its development trends, energy consumption and efficiency of the industry. Interrelationships between production of industrial products and energy consumption in the regions were analyzed. The performed statistical analyzes revealed the problems of setting strategic directions aimed at achieving energy efficiency in the industry. Based on the results of the analysis, the priority directions for increasing the competitiveness of industrial enterprises in Uzbekistan and transitioning to "green energy" have been determined.

**Keywords:** Industry, energy, alternative energy, energy consumption, green energy, solar energy, energy efficiency.

## 1. INTRODUCTION

The first decree of the President of the Republic of Uzbekistan in the years of independence on the use of alternative energy sources, primarily solar energy, in Uzbekistan. It was adopted in 2013, but today this provision has lost its validity. However, in 2022 itself, many government decisions are being made in this direction regarding the use of the solar energy system. Decree of the President of the Republic of Uzbekistan No. PF-220 dated September 9, 2022 "On additional measures for the introduction of energy-saving technologies and the development of small-capacity renewable energy sources" strategic directions for all-round support of manufacturing business entities" have been defined. Also, the plan of measures to achieve the target indicators for 2022-2023 in these areas was approved, according to which [1]:

- Introduction of alternative energy sources in more than 34,000 objects in the regions, including 619 "New Uzbekistan" massifs and more than 28,000 households;
- To increase the share of alternative energy sources to 30% in the volume of energy consumption in more than 6,000 objects of ministries and agencies.
- High importance is attached to the purchase and installation of renewable energy sources at the expense of extra-budgetary funds.

By the decision of the President of the Republic of Uzbekistan dated February 16, 2023 "On measures to accelerate the introduction of renewable energy sources and energy-saving technologies in 2023" No. projects for the construction of wind power plants" and projects for connecting large-scale solar and wind power plants to power transmission networks on the basis of public-private partnership in 2023, "The plan for installing small-power renewable energy sources in public sector facilities and government offices" was approved. According to the specified tasks, the plans to obtain a total of 211.1 million kWh of additional energy in 2023 for the devices installed in the social sphere objects and state offices have been approved. Also, the plans to install 742.7 MW of solar panels on a total of 11,019 facilities, and to obtain 555.4 MW of energy from small FES to be built by local entrepreneurs have been approved. The results of such reforms provide an opportunity to increase energy efficiency in the country and accelerate the process of transition to "green energy".

In addition to the above, reforms aimed at the use of alternative energy in the industrial sector, which consumes the largest amount of energy, and the development of its scientific basis are also considered as priority directions.

## 2. REVIEW OF LITERATURE

A lot of research is being conducted by domestic and foreign scientists to achieve energy efficiency in industry and increase the efficiency of energy use. The reason is that the issues of reducing energy costs and increasing energy efficiency are largely dependent on the level of economic development and competitiveness of industrial enterprises.

In the study of Burganov R. A. [2] and others by world scientists the methodology of calculating the company's energy saving and energy efficiency indicators, taking into account all types of energy (energy, heat, mechanical, light, human, etc.) in the company's activities offers.

Giraudet L. G. It is based on the fact that the management of information flows is the most important direction in reducing energy consumption in the research conducted. [3]

Mao W. et al and in his studies, he developed scientific proposals on ways to calculate energy consumption and reduce it based on the use of Internet-of-Things (IoT) technologies in industrial enterprises.[4]

Kelchevskaya N. R., Shirinkina E. V., Atlasov I. V and the energy management factors that determine the success or failure of the implementation of energy efficiency measures in industrial enterprises have been identified.[5]

Galyautdinov I.M. [6] and in his studies ways to increase the economic efficiency of oil and gas industry enterprises based on the implementation of energy saving measures are proposed. Abdullayeva, M., & Shodmonov, S [7] carried out studies on the issue of reducing the cost of the product by reducing energy consumption. Mamatyusup M.N. [8] and the authors guidelines for effective use of electricity produced in Uzbekistan, analyzed the main reforms implemented in Uzbekistan on energy saving.

Improving energy efficiency - combines efforts to increase the efficiency of production processes, optimize the interaction of all elements of production, improve product quality, improve environmental friendliness of production, improve management efficiency, develop intangible assets of the company, which ultimately leads to an increase in output and ensures financial stability in industrial enterprises.

N.I. Suslov according to the opinion, energy efficiency is the income or production volume obtained from the use of a unit of energy spent in the form of various energy carriers (fuel, heat or electricity).[9]

In general, energy saving is an important area of development of industrial enterprises, as it is an activity aimed at more efficient use of energy resources, increasing the beneficial effect in the form of reducing the burden on the environment and the social aspect.

The main conditions for the development and implementation of energy-saving projects in industrial enterprises are as follows: reducing the share of energy costs in the cost of products as much as possible; calculating energy resources within the framework of the implementation of project activities. The strategy of managing energy-saving processes in industrial enterprises is to achieve a high-tech level of energy consumption and the efficiency of energy resource management based on the implementation of energy-saving projects.

### **3. ANALYSIS AND RESULTS**

Industry, as the most important economic sector for Uzbekistan, its contribution to the GDP will be 26.8 percent in 2022, and the growth will be 41.3 percent in 2017-2021. More than 80% of the industry in Uzbekistan is made up of the manufacturing industry, which indicates that the complex programs of industry development aimed at the production of products with high added value, increasing the country's export competence and international competitiveness at the expense of deep processing of raw materials, and the introduction of modern technologies are working effectively.

According to industrial statistics for the last years (2010-2022), the value added (in % of gross added value) of the manufacturing industry increased by 9 percent in 2022 compared to 2010 and amounted to 20.6 percent, while the value added in the manufacturing industry the picture of the annual growth of the value (in %) was on average 7.4 percent (Fig. 1).

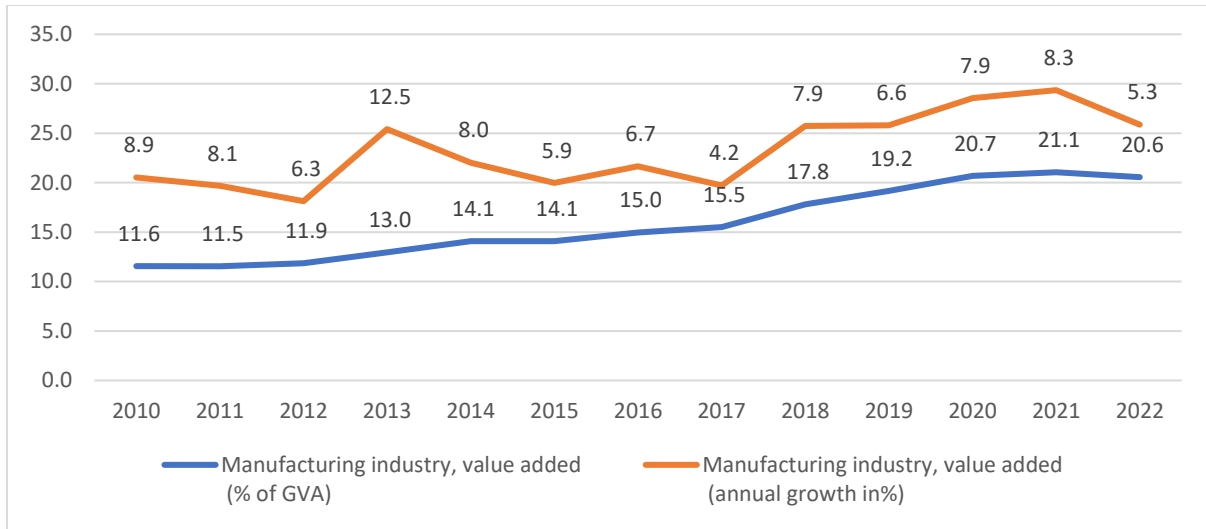


Figure 1. Added value of the manufacturing industry in Uzbekistan

In the Republic of Uzbekistan in 2022, 553,265.0 billion soums worth of products were produced, which increased by 5.7 percent on average in 2010-2022, and the minimum growth was 0.9 percent, and the maximum growth was 10.8 percent.

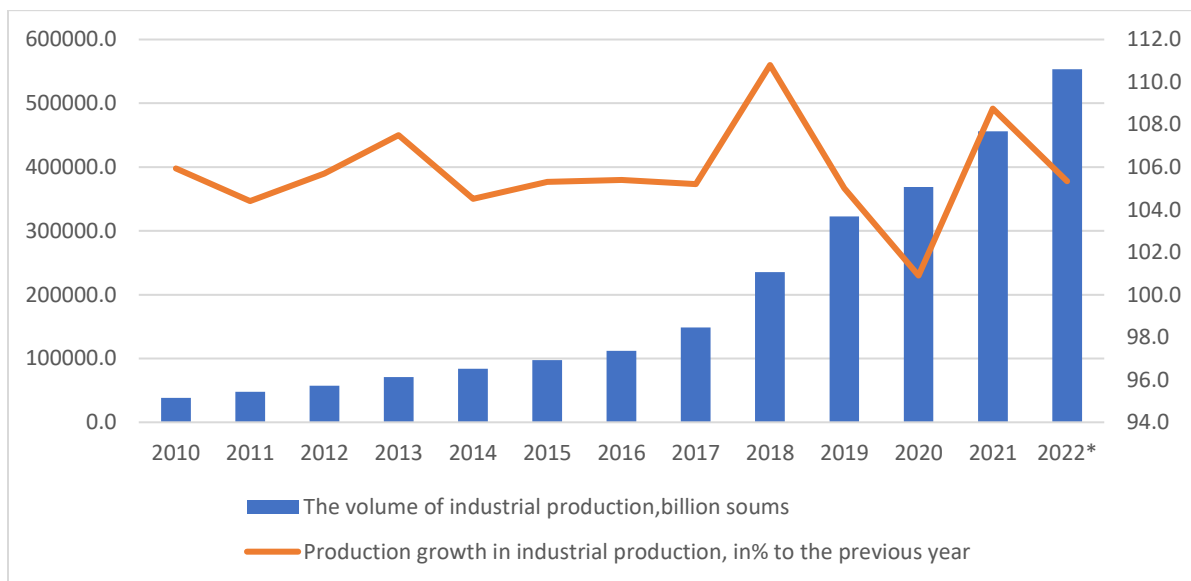


Figure 2. Growth dynamics of Uzbekistan's Industry

The industry of textile and light industrial products, chemical, pharmaceutical, rubber and plastic products, mechanical engineering, metallurgy, computers, electronic and optical products and electrical equipment production is widely developed in the country. Sanoatni energetika tizimisiz rivojlantirishning imkoni no. Industry is the main part of energy consumption. The total energy consumption in the Republic of Uzbekistan in 2022 will be 59109.3 mln. kW It was an hour, and the consumption increased by 1.3 times compared to 2016 (45058.8). In 2022, Tashkent sh. is considered to be the most industrially developed region of energy consumption. (11.6 percent), Navoi region (11.2 percent) and Kashkadarya (9.2 percent) regions. If we compare the production of industrial products and energy consumption in the regions, an uneven distribution can be observed (Fig. 3). For example, the share of the Republic of Karakalpakstan in the production of industrial products of the country is 3.1 percent, and the share of energy consumption is 2.55 percent, or there are cases on the contrary. Jumdan Kashkadarya region's share in the production of resupbilka industrial products is 4.09%, and energy consumption is 9.81%.

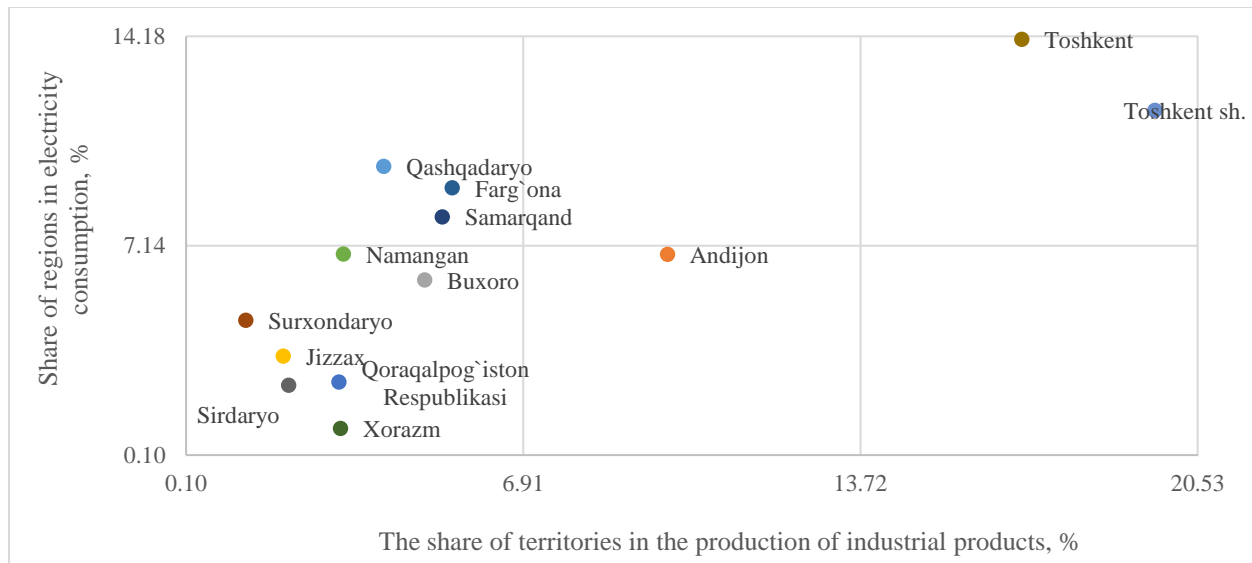


Figure 3. Interdependence of production of industrial products and energy consumption in the regions.

According to the data of Figure 3, Kashkadarya, Fergana and Samarkand regions can be cited as regions with high energy consumption in relation to the production of industrial products. Anjijan, Tashkent regions and the city of Tashkent are among the regions with high energy consumption compared to the production of industrial products.

In 2022, 24.7% of the total energy consumed in the country will be the contribution of the industrial sector. This indicator has been decreasing over the years. In 2001, the total energy consumption of the industry was 18791.2 mln. sq. hour, made up 38.8 percent of the total consumption. In 2010, this figure was 18,791.2 million. sq. hour and made up 35.7 percent. Electric energy is produced in all regions of Uzbekistan except Jizzakh region, and it is possible to observe an uneven distribution in terms of production scale. Statistics on the volume of electricity production in the cross-section of regions are presented in Table 1. From 2010 to 2022, a consistent increase in electricity production was ensured, and from 2017, a significant increase was observed. In 2022, electricity generation reached 74,269.3 million kWh, which indicates a significant increase in energy production. About 76% of the total energy comes from 4 regions: Kashkadarya, Navoi, Syrdarya and Tashkent regions.

Table 1 Production of electricity in the region, mln. kW s

Years	2010	2015	2020	2021	2022
<b>O'zbekistan</b>	<b>51976,3</b>	<b>57658,1</b>	<b>66500,7</b>	<b>71364,6</b>	<b>74269,3</b>
Respublik of Karakalpakistan	3100,2	3451,3	4392,4	5233,9	5373,9
<i>regions:</i>					
Andijan	774,0	674,1	372,6	489,2	791,4
Buxara	5,7	4,9	6,2	7,4	1578,3
Jizzakh	-	-	-	-	-
Qashqadaryo	5837,7	6310,9	9770,7	13349,7	8499,0
Navoiy	7376,6	8864,0	11776,8	11117,5	11541,6
Namangan	0,2	0,1	5624,6	7083,9	6694,0
Samarqand	5,8	3,7	73,5	70,0	38,8
Surxondaryo	78,6	82,9	82,4	180,8	232,3
Sirdaryo	15278,3	16718,4	15249,1	16139,1	16991,0
Toshkent	17935,7	20049,6	18228,0	16653,4	19570,8
Ferghana	455,2	312,8	264,4	395,8	393,7
Xorazm	752,0	648,8	209,5	162,9	651,7
Toshkent city	376,3	518,0	433,5	480,6	1912,2

Pictures of high growth of electricity production in the Republic of Karakalpakstan were observed in 2020-2021. Electricity production in Andijan is somewhat inconsistent, with fluctuations observed in different years. However, in 2021, it increased significantly and reached 791.4 million kWh. Electricity production in Bukhara has relatively low growth trends until 2022. Electricity production in Kashkadarya has been growing steadily over the years. Samarkand: Electricity production in Samarkand has been relatively stable over the years with some fluctuations. The data show a general trend of increasing electricity production in most regions, especially in recent years. Some areas have seen significant growth due to industrial development and increased energy demand. 2021 is an important year for all regions, with sharp growth trends in energy production. Uzbekistan is consistently increasing electricity production with different growth rates in different regions.

According to my latest information of 2021, Uzbekistan is among the countries that are trying to gradually increase their attention to the production of electricity from alternative energy sources.

Due to the fact that Uzbekistan has the potential to use solar energy due to the abundance of sunlight, the main attention is focused on this alternative energy. One of the notable solar energy projects is the 100 MW solar power plant in Navoi region. It started operations in 2019 and is one of the largest solar installations in the country. The government is actively encouraging the construction of solar power plants on the basis of public-private partnerships to increase the production of solar energy. Wind energy is another alternative energy source with potential in Uzbekistan, especially in Karakalpakstan region. By 2021, Uzbekistan was at the initial stage of wind energy development. Several wind farms have been considered and developed. Uzbekistan's hydropower network is well developed, but it relies primarily on conventional hydroelectric power stations rather than small or micro hydropower facilities. In Uzbekistan, work and reforms in this regard are constantly being carried out, but in recent years more attention has been paid to the improvement and expansion of the hydropower infrastructure. Biomass and biogas alternative energy sources are rarely used in Uzbekistan. Production of biogas for energy purposes for limited projects related to the disposal of agricultural waste and organic matter are being directed at a high level of grand funds. Uzbekistan has a number of geothermal resources, but as of 2021, the development of geothermal energy was limited. The potential for using geothermal energy to generate heat and electricity exists, especially in areas with hot springs. Many government decisions are being made to diversify the energy complex of the Uzbek government and increase the share of alternative and renewable energy sources in the national grid. A regulatory framework and incentives are being developed to attract investments in the field of alternative energy. Uzbekistan is also exploring cooperation with international organizations and investors to support renewable energy projects.

Indicators of electricity production from alternative energy sources in Uzbekistan are shown in Table 2.

Table 2: Production of electricity from alternative energy sources in Uzbekistan, mln. kW Hour

Name	2015	2016	2017	2018	2019	2020	2021	2022
Electricity produced by solar power plants	0,003	0,3	0,7	0,2	0,1	0,03	49,0	435,8
Electricity produced by wind power plants	-	-	-	-	15,5	-	1,2	-

The electricity produced by solar power stations in 2015 was 0.003 mln. kW If it was an hour, in 2022 it will be 435.8 million. kW Made the watch. Taking into account that the main reforms on the use of solar energy began in 2021, about 400 mln. kW It is important that the hourly capacities are put into operation.

#### 4. CONCLUSIONS AND SUGGESTIONS

The development of strategic directions for the use of solar energy in Uzbekistan, especially in industrial enterprises, requires a multifaceted approach, taking into account the country's energy needs, economic goals and environmental aspects. Below are the main steps and strategic directions for the use of solar energy in the industrial enterprises of Uzbekistan:

Based on the results of the above analysis, it is important to define strategic directions for the use of alternative energy sources in the industry of Uzbekistan. This requires a comprehensive assessment of the solar potential of Uzbekistan,

taking into account factors such as solar radiation, climatic conditions and geographical location. In this regard, many projects are being implemented in scientific research institutes. In our opinion, it is appropriate to implement projects aimed at the development and deployment of industry in areas with the highest solar energy potential.

Development of a clear and supportive policy and regulatory framework for the use of solar energy, including incentives, subsidies and feed-in tariffs for industrial enterprises, is also required. A favorable regulatory and legal environment is required for investment in solar energy projects.

In order to encourage industrial enterprises to invest in solar energy devices, it is desirable to provide direct and not indirect benefits. Financial incentives such as tax credits, grants, and low-interest loans are offered as incentive mechanisms.

In order to ensure the existence of a qualified workforce capable of designing, installing and maintaining solar energy systems in industrial conditions, it is necessary to open professional educational institutions in this field and training courses for such specialties in HEIs, and to organize professional training of those working in this field.

In order to reduce energy costs in industrial enterprises, especially in large industries, it is necessary to introduce a mechanism for identifying areas where solar energy can be combined. It requires an energy audit for industrial enterprises.

Another mechanism is called "Grid integration". Such a mechanism is a plan for the seamless integration of solar energy into the national grid. Industrial enterprises are encouraged to introduce these systems by developing the network infrastructure that distributes solar energy from industrial facilities. Create tailored incentives for industrial companies to invest in solar energy, such as "net metering" programs that allow excess electricity to be sold to the grid, or incentives based on the amount of energy produced.

Promotion of public-private partnerships for industrial solar energy projects is a priority. Solar installations in industrial areas creation of a free competitive environment in this market based on the establishment of state partnership with private enterprises for development.

Explore modern energy storage solutions (such as batteries) to ensure a stable and reliable supply of energy from solar sources, especially for industrial processes that require uninterrupted power. .

As key energy efficiency measures in industrial enterprises, it is required to combine solar installations with energy-saving technologies and practices in industrial enterprises to maximize energy savings and reduce overall energy consumption.

In the event that the positive impact of alternative energy on the environment has been identified, high importance should be attached to the introduction of industrial standards in the country. In order to ensure that solar energy projects in industrial areas do not harm local ecosystems or communities, it is advisable to carry out environmental impact assessments and organize permanent monitoring based on the establishment of a government commission in this regard. Industrial facilities require a robust monitoring and maintenance system to ensure long-term reliability and performance of solar installations.

In order to improve solar technologies, increase efficiency and reduce costs, it is necessary to pay a high attention to the financing of the scientific research carried out in this regard. International cooperation is also important in this regard.

Funding, technology transfer and the use of best practices require cooperation with international organizations and countries with experience in the field of solar energy and broad involvement of initiators.

Increasing the awareness of the population about the advantages of solar energy in industrial enterprises, the positive impact on the environment and the economy is also very important. .

The implementation of these strategic directions for the use of solar energy in industrial enterprises in Uzbekistan will help ensure economic growth, reduce toxic gases and emissions, and generally increase the energy security of the country. In order to ensure the successful implementation of these strategies, it is important to involve relevant stakeholders, including government agencies, industry associations and energy experts. In addition, regular monitoring and strategy adjustments are necessary to adapt to changing conditions and evolving technologies.

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