DIRECTIONS FOR INCREASING ENERGY RESOURCE EFFICIENCY THROUGH THE TRANSITION TO A "GREEN" ECONOMY

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Annotation: Nowadays, issues of ecological sustainability and rational use of resources are coming to the agenda on a global scale. In particular, the need to transition to the principles of the "green" economy in industrial sectors is steadily increasing. Excessive consumption of energy resources, environmental pollution, and the increase in carbon dioxide emissions are creating serious problems for humanity. Therefore, the introduction of energy-saving technologies, the wide use of renewable energy sources, and the increase of energy efficiency in industry have become one of the global priority directions.

Keywords: industry, green economy, investments, green energy, renewable energy sources, energy resources

Introduction

The energy sector is one of the main components of the economy, and its development means the development of the economy. In recent years, the protection of the environment, the efficient use of natural resources, and the increase of ecological problems have required the further development of the energy sector and the search for new energy sources. Renewable energy sources are currently the fastest-growing energy sources. "Renewable energy is energy that is obtained from natural processes and is replenished faster than it is consumed" [5].

Renewable energy sources refer to types of energy that can be continuously restored naturally without harming the environment. They include the following:

- Solar energy – obtaining electricity and heat energy from sunlight;
- Hydropower – energy obtained from rivers, dams, and other water flows;
- Wind energy – energy generated from the movement of wind;
- Geothermal energy – using natural heat sources coming from the Earth's interior;
- Ocean energy – energy obtained from sea waves, currents, or the rise and fall of water levels;
- Biomass and bioenergy – production of energy from organic waste (for example, wood, agricultural residues, municipal solid waste, biogas, biofuels).

Research Methodology

In the research process, the trends of renewable energy resources in the transition to a "green" economy in industrial sectors were analyzed. In the article, conclusions

and suggestions were given using methods such as a systematic approach, analysis, synthesis, and generalization.

Analysis and Results

If we look at the production capacity of renewable energy sources in recent years in the world, the use of hydropower and wind power occupies the highest positions. In 2020, 7,458,042 GW of electricity was obtained from renewable energy sources worldwide. In 2022, this figure reached 8,439,671 GW. In this, the share of hydropower, wind, and solar energy is considered large.

As in the development of any sector, financial resources play an important role, for the development of renewable energy sources, stable financing is also necessary. In order to attract investors in this field, it is necessary to increase the profitability level of projects and reduce investment risks.

At present, attracting investments in renewable energy sources is mainly carried out through the following financial sources:

- net profit of enterprises and corporations;
- internal reserves of enterprises and corporations;
- funds accumulated by credit-bank system institutions;
- issuance of securities;
- budget funds at various levels.

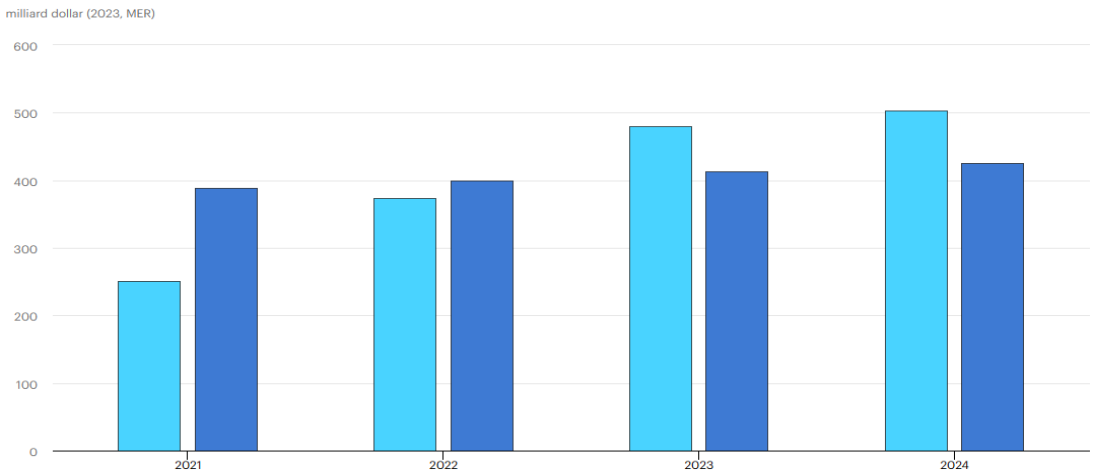

Figure 1. Global annual investments in solar energy and other electricity production sources, 2021–2024 [13]

Currently, investments in solar and wind energy are increasing year by year. Global investments in solar energy amounted to 10 billion dollars in 2004, and by 2019 this amount increased to 140 billion dollars [12]. According to forecasts, by 2030 renewable energy technologies will occupy the largest share in the field of production and consumption, and renewable energy will become cheaper. Investments in solar energy alone amounted to 480 billion dollars in 2023. By 2024, this amount increased

to 503 billion dollars. Investments in other sources amounted to 413 billion dollars in 2023, and 426 billion dollars in 2024.

The transition to "green" energy requires investment not only in renewable energy production and electrification, but also in sustainable infrastructure, energy-efficient buildings, and the decarbonization of industry. In addition, investing in the transition to "green" energy covers the entire supply chain of renewable energy, including all processes from research and development, production of critical minerals and components, to the installation and operation of solar panels, wind turbines, batteries, and other important technologies.

Over the past decade, a number of factors have led to an increase in the number of announced projects for investments in renewable energy at the international level, especially after the adoption of the Sustainable Development Goals (SDGs) and the Paris Agreement in 2015, as well as as a result of the incentive packages aimed at green infrastructure in 2021, investments accelerated. In 2022, after a sharp increase compared to 2021, the number of international projects in the field of renewable energy slightly increased (Figure 1). Investments in solar and wind energy were among the leaders, accounting for 89 percent of total projects. Wind energy projects are generally more expensive than solar projects and therefore larger [10].

Over the past decade, excluding Europe, half of the international investment projects in renewable energy accounted for solar energy. The European region is mainly considered a leader in investments in wind energy. For the African continent, solar energy is considered the cheapest and most suitable, therefore it accounts for two-thirds of all renewable energy projects. In North America, developing Asia and Oceania, the share of solar energy exceeds 60 percent.

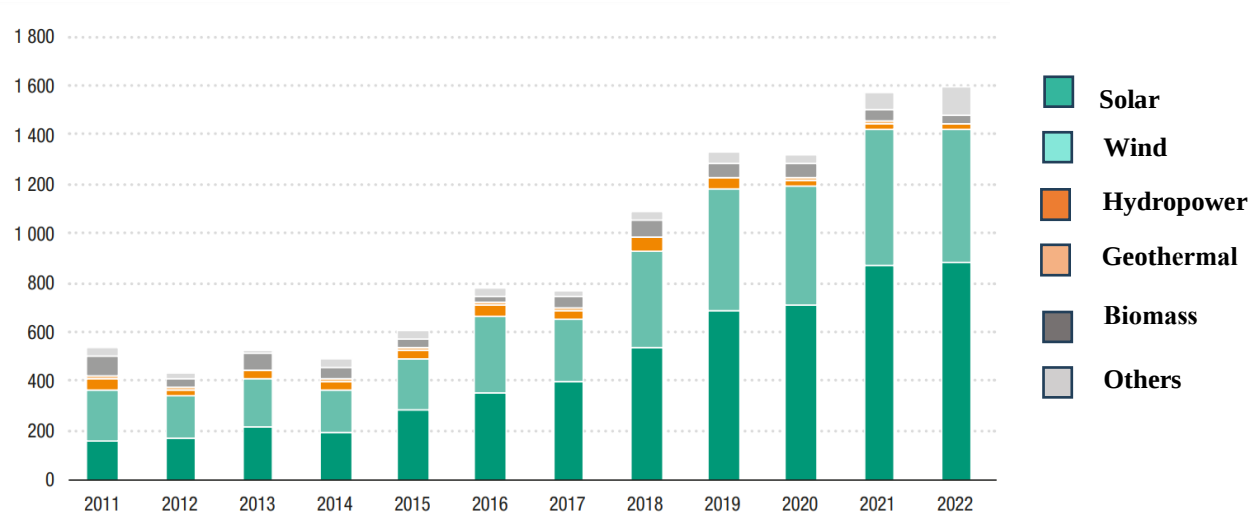

Figure 2. International investment projects in the field of renewable energy, by types, 2011–2022 (by number of projects) [10]

Among the new investment announcements in renewable energy in 2022, there are several mega-projects, including:

- The Ayana Karnataka wind and solar hybrid project in India — 2 GW capacity, worth more than 1.5 billion USD;
- The Masdar Tanzania renewable energy project — envisages the creation of a solar power plant with a capacity of 2 GW.

The average (lifecycle-based) cost of electricity generated from the above-mentioned sources, in English called the *levelized cost of electricity (LCOE)*, represents the average cost of producing 1 megawatt-hour of electricity over the entire service life of the energy project, taking into account investment, operation, maintenance, and other expenses.

When comparing the cost of electricity across different technologies, renewable energy technologies are generally cheaper than non-renewable (traditional) technologies. Despite having high capital costs, renewable technologies have lower operational (usage) costs and do not require fuel expenses.

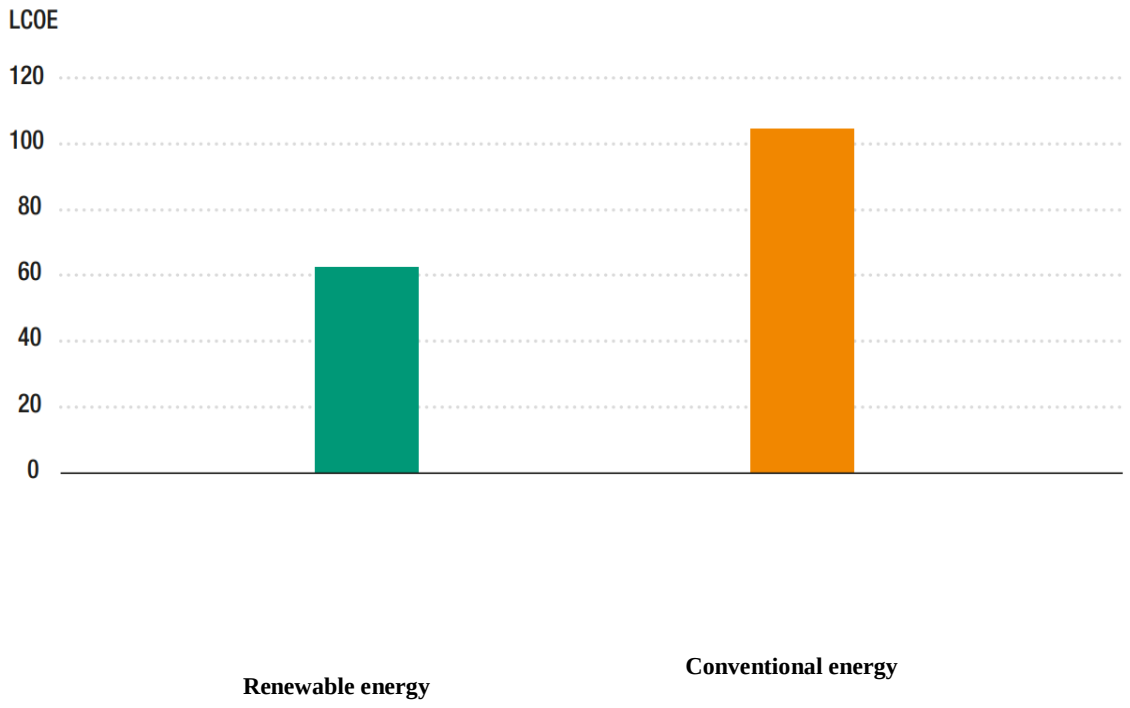

Figure 3. The cost of electricity from renewable and non-renewable sources in selected economies, 2022 (USD per megawatt-hour, average value) [10]

Table 1.

Investments in renewable energy sources by countries in 2021 [9]

Countries	Allocated investments, million US dollars	Share worldwide, %
China	266	35,2
USA	114	15,1
Germany	47	6,2
UK	31	4,1
France	27	3,6
Japan	26	3,4
India	14	1,9
South Korea	13	1,7
Brazil	12	1,6
Spain	11	1,5
Total	561	74,3

Among developed and developing countries, in 2020 China carried out more than 60% of investments in "green" energy, further strengthening its global leadership position. In 2021, the country's wind and solar power capacity increased by 19%, and investments directed towards electric transport also accounted for a significant share [11].

In 2022, the largest regional investments in renewable energy were made by China and Europe. China alone invested more than 270 billion USD, while Europe invested approximately 54 billion USD in renewable energy sources. The share of the USA was also high, with investments in clean energy amounting to 114 billion USD in 2022, representing a 17% increase compared to 2020.

The United States is considered one of the largest consumers of renewable energy in the world. In recent years, the majority of newly installed capacities have come from wind and solar energy.Germany ranks among the world's leading countries both as a consumer and producer of renewable energy. The state's onshore wind energy capacities are particularly well known. Spain, the United Kingdom, and France are also among the countries that have installed the world's largest wind power plants.

Foreign direct investments play an important role in financing the renewable energy sector. According to project financing data, nearly half of investments worldwide are carried out with the participation of foreign investors or shareholders. In terms of value, financing of international projects accounts for 55% of total renewable energy investments. The majority of these investments are made entirely by the private sector, with only about one-fifth involving local governments as

shareholders. However, such government-participated projects are usually larger in scale [6].

International projects are also usually larger in size, especially in costly renewable energy technologies, where public-private partnerships or sponsor consortia are required. Such projects, particularly in developing countries, also include other essential infrastructure needed for transmitting electricity to the energy system—such as power transmission lines or battery storage systems.

The World Energy Investment report provides new analyses on investment financing sources, showing that between 2018–2023 the majority of investment sources came from corporate funds. The next largest share was held by governments and state-owned enterprises, accounting for 37%.

The transition to "green" energy is one of the largest, longest-term, and most important investment megatrends in human history. Global commitments until 2030 demonstrate that there will be many opportunities for investors in the coming years. According to scientists' calculations [7], investments in renewable energy production, electricity grids, and storage systems are expected to increase from 1.2 trillion USD in 2024 to 2.4 trillion USD by 2030. At the same time, expenditures on energy efficiency and electrification must also increase from 669 billion USD in 2024 to 1.9 trillion USD by 2030.

Overall, this means an additional investment of 2.4 trillion USD. This places great responsibility on various investors and implies the need to find ways of cooperation and to overcome barriers quickly and effectively.

Conclusion

The transition to the principles of the green economy is considered a key factor in increasing energy resource efficiency in industrial sectors. The growth of the share of renewable energy sources, the increase in investments directed towards them, and the reduction of costs demonstrate that this process is accelerating. In the context of Uzbekistan as well, the introduction of renewable energy sources remains an urgent task for improving energy efficiency in industrial sectors, ensuring the rational use of resources, and guaranteeing environmental safety.

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