

**GREEN AND CLIMATE INNOVATIONS: INTERNATIONAL EXPERIENCE IN  
ECOLOGIZING INDUSTRY AND ENERGY (ON THE EXAMPLE OF UZBEKISTAN)**

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**Abstract:** This article discusses the current issue of transitioning to a green economy in the context of global climate challenges. It analyzes the international experience of leading countries (Germany, China, and Denmark) in implementing climate innovations in industry and energy. Special attention is given to the Republic of Uzbekistan, which, despite its historical dependence on hydrocarbon resources, is taking active steps to diversify its energy balance and green its industry. The article emphasizes that for Uzbekistan, the combination of international experience, favorable natural conditions, and targeted government policies presents significant opportunities for sustainable low-carbon development.

**Keywords:** Green economy, climate innovations, industrial ecology, renewable energy sources (RES), Uzbekistan, energy transition, green hydrogen, energy balance statistics, international experience, decarbonization.

The global economy is on the verge of a fundamental transformation driven by the need to combat climate change. The 2015 Paris Agreement set a course for keeping global temperature rise within 1.5-2°C, which requires a drastic reduction in greenhouse gas emissions. Industry and energy, as the primary sources of these emissions (accounting for around two-thirds of global CO<sub>2</sub> emissions), are becoming the epicenter of climate innovation. Green innovations are not only about technology, but also about new business models, financial instruments (green bonds), and management approaches aimed at creating a closed-loop economy with a minimal environmental footprint. Successful cases from different countries demonstrate a variety of approaches to the green transition. Let's explore some of them.

- Germany (Energiewende – “Energy Turn”): focused on the phased abandonment of nuclear and coal energy, mass development of RES. The Renewable Energy Sources Act (EEG) was adopted, guaranteeing a “green” tariff for RES energy producers. This stimulated an explosive growth of solar and wind energy, whose share in net electricity consumption exceeded 50% in 2023. Active introduction of green hydrogen, Power-to-Gas technology for energy storage, and digitalization of power grids (Smart Grids).

- China: From the "factory of the world" to the leader of green technologies: scaling up the production and deployment of solar panels, wind turbines, and electric vehicles. China is the global leader in terms of installed renewable energy capacity (over 1,200 GW as of the end of 2023) and produces more than 80% of the world's solar panels. The country has set strict targets for the share of renewable energy, provides direct subsidies to manufacturers, and has established a carbon market.

- Scandinavian countries (Denmark, Sweden, and Norway): creation of a comprehensive system of environmentalization with a focus on a circular economy and carbon neutrality. Denmark receives more than 50% of its electricity from wind, Sweden was one of the first to introduce a carbon tax (1991), Norway leads in the use of electric vehicles (more than 80% of new sales). These countries use carbon capture and storage (CCS) technologies, centralized heating systems based on biofuels, green public procurement.

From all of this, it is possible to highlight common successful practices, in particular:

- ✓ Clear long-term vision and political will

- ✓ A combination of regulatory measures (standards, prohibitions) and economic incentives (subsidies, taxes)
- ✓ Active attraction of private investments
- ✓ Development of “green” clusters and innovative ecosystems

Uzbekistan, which has a significant potential for renewable energy and is facing serious environmental challenges (including the consequences of the Aral disaster), has actively joined the global process of decarbonization. Based on statistical data from recent years, we will show key achievements, current renewable energy projects, and government support measures.

Here are the statistics for the energy sector: Current generation structure (2023-2024):

- More than 85% - natural gas
- About 10% - hydropower
- Less than 5% - coal, petroleum products, and renewable energy sources.

Targets that were approved in the “Development Strategy of Uzbekistan until 2030”:

- Bringing the share of RES in the installed capacity to 25% by 2030
- Reducing specific greenhouse gas emissions per unit of GDP by 35% by 2030.

In addition, the following key projects in the field of renewable energy sources have been reviewed and approved for implementation:

- Solar energy: Solar power plants with a total capacity of over 2 GW have been launched and are under construction (projects in the Navoiy, Samarkand, and Jizzakh regions).
- Wind energy: Wind parks with a total capacity of over 3 GW are being implemented (in Karakalpakstan and the Bukhara region).
- Hydropower: Modernization of existing hydropower plants and construction of small hydroelectric power plants.

The following environmental measures have also been taken in the industrial sector of Uzbekistan:

- Increasing energy efficiency: Implementing energy management systems at industrial enterprises and upgrading outdated equipment.
- Implementing the Best Available Techniques: Gradually transitioning to the best available technologies in the cement, chemical, and metallurgical industries.
- Developing green hydrogen: Exploring the potential for producing and exporting green hydrogen using solar and wind energy.

However, there are problems in the development of the green economy. The main challenges hindering development are:

- ✚ High capital intensity of green projects
- ✚ The need to modernize network infrastructure
- ✚ Technological dependence on imported equipment
- ✚ Lack of qualified personnel in the new green economy

To solve these problems, it is necessary to consider and implement the following recommendations:

1. Diversification of funding sources: Active attraction of green bonds, funds from international financial institutions (IBRD, EBRD), G2G (government-to-government) mechanisms, and PPP (public-private partnership). Creation of a specialized green bank or fund.
2. Development of the national production base: Stimulating the localization of renewable energy components (solar panels, wind turbines, and energy storage systems) through tax incentives and special economic zones.
3. Integration into regional green initiatives: Participation in CASA-1000 projects, the Green Corridor of Central Asia, which will allow exporting surplus green energy and diversifying the energy market.

4. Stimulating demand: Implementation of a system of green certificates, development of distributed generation (roof-top solar installations) through net-metering programs.

5. Creating an innovative ecosystem: Development of R&D centers for green technologies, educational programs on sustainable development and climate innovations based on leading universities.

International experience shows that successful greening of industry and energy requires a comprehensive approach that combines:

- ❖ A clear regulatory framework
- ❖ Long-term strategic planning
- ❖ Economic incentives for business
- ❖ Development of innovative infrastructure
- ❖ International cooperation

Of course, Uzbekistan, with its significant natural potential for the development of renewable energy sources and its political will for transformation, is at an early but promising stage of green transformation. The key factors for success will be:

- Consistent implementation of adopted strategic documents
- Attraction of modern technologies and investments
- Development of human capital
- Consideration of regional specifics and global trends.

The transition to a green economy is not only an environmental necessity, but also an opportunity for Uzbekistan to increase its energy security, create new high-tech industries, and strengthen its position in the Central Asian region.

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