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ОБЪЕДИНЕНИЕ ЭНЕРГЕТИЧЕСКИХ ИННОВАЦИЙ И ОБРАЗОВАНИЯ: СТРАТЕГИЯ УСТОЙЧИВОГО ЭКОНОМИЧЕСКОГО РОСТА И ЭКОЛОГИИ

Аннотация. *Статья рассматривает роль энергетических технологий и образовательных инноваций для устойчивого экономического роста и качества жизни. Охватываются возобновляемые источники, системы хранения, водородные технологии и умные электросети, их влияние на экологию и безопасность. Подчеркивается важность объединения науки и образования для подготовки специалистов.*

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UNIFICATION ENERGY INNOVATION AND EDUCATION: A STRATEGY FOR SUSTAINABLE ECONOMIC GROWTH AND ECOLOGY

Abstract. *The article examines the role of energy technologies and educational innovations for sustainable economic growth and quality of life. Renewable sources, storage systems, hydrogen technologies and smart power grids are covered, as well as their impact on the environment and safety. The importance of combining science and education for the training of specialists is emphasized.*

Introduction: The modern global economy is undergoing important changes due to new challenges: resource depletion, climate change and the need to ensure energy security in unstable conditions. The solution to these problems is the transition to sustainable development, which combines economic growth, social well-being and ecology.

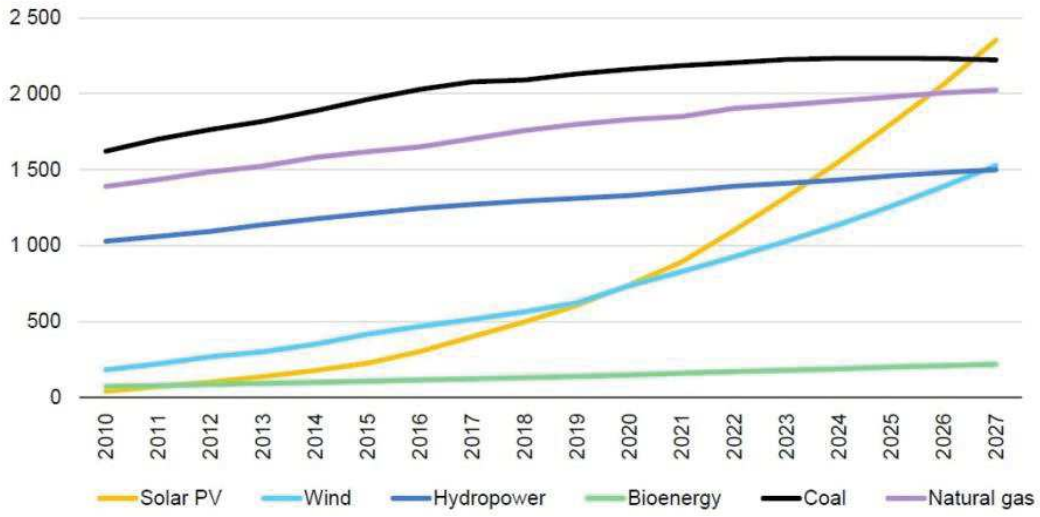
Advanced energy technologies play a key role in this process and are changing the economy and society as a whole. However, technical breakthroughs do not guarantee success. Their implementation depends on science and education. Therefore, it is important to ensure a link between technology, science and education [1].

In recent years, renewable energy sources (RES), such as solar and wind energy, have been actively developing, which are becoming cost-competitive. Currently, RES have a significant impact on the global electric power industry, but they are unstable and require new solutions for their collection and use. Therefore, energy storage systems are of key importance. Researchers are working not only on lithium-ion batteries, but also on more affordable sodium-ion batteries that can solve resource problems [2].

An extremely promising direction is "green" hydrogen– hydrogen produced by the method of electrolysis of water using electricity from renewable energy sources.

It solves the problem of long-term and off-season energy storage. Investments in infrastructure for the production, transportation and use of hydrogen are shaping a new global technological landscape. Smart grids are a key part of this process. They use sensors, big data technologies, and artificial intelligence to control energy flows in real time. This allows consumers to actively participate in the energy market: for example, they can choose dynamic prices or sell excess energy generated by their solar panels [3].

Scientists predict that renewable energy sources in the world will grow by 2,400 GW in the period 2022-2027 (Picture 1) [4].



Pic. 1 – Cumulation power capacity by technology, 2010-2027

The introduction of modern energy technologies improves environmental safety. Reducing the burning of fossil fuels reduces greenhouse gas and pollutant emissions, which in turn improves urban air quality. This leads to a reduction in diseases, a reduction in the burden on healthcare and an increase in labor productivity, which is economically beneficial.

The training of specialists for the energy industry of the future cannot be limited to traditional engineering specialties. We need programs that combine knowledge in physics, chemistry, materials science, computer science, economics and ecology. Students should know the entire technology lifecycle, from research to product launch and disposal.

Carbon capture technologies are being developed in industry to reduce emissions. Despite the fact that they are expensive, it is important to implement them in order to become carbon neutral. This is especially important for the cement and petrochemical industries. Environmental safety is developing rapidly and creating new jobs. But the main problem is that the technology that is taught at universities is significantly different from what the industry needs. And this is what hinders innovation and the development of the industry. To train good specialists, you need something more than the usual technical specialties. First, programs are needed that combine knowledge in physics, chemistry, computer science, economics, and ecology.

Students should understand the importance of this work, as well as navigate the process itself, from research to food processing. To succeed in energy and environmental protection, it is necessary to change the education and science system. The creation of joint research and educational projects can help solve many problems, for example, the development of new batteries or smart grids. This will accelerate the adoption of technologies in the industry and enter new markets.

Conclusion: The article shows that modern energy technologies and methods of energy conservation are the basis for new economic growth that improves life and protects nature. Emission reduction Technologies (CCUS) help reduce environmental damage, but their success depends on a country's ability to develop these technologies, which requires a strong educational and scientific system. It is important to support not only individual "green" projects, but also to create an integrated innovation system combining education, science and economics. Investments in the renewal of educational programs and scientific infrastructure, as well as in energy and

environmental entrepreneurship are the keys to a sustainable future and economic security. This is the only way technological progress can improve people's lives and promote economic growth.

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ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ ВЛИЯНИЯ ПОПЕРЕЧНОГО ШАГА УСТАНОВКИ ТРУБ СО СПИРАЛЬНЫМИ РЕБРАМИ НА ТЕПЛООТДАЧУ ШАХМАТНЫХ ГОРИЗОНТАЛЬНЫХ ПУЧКОВ ТРУБ В РЕЖИМЕ СВОБОДНОЙ КОНВЕКЦИИ ВОЗДУХА

Аннотация. *В работе представлены результаты экспериментального исследования теплоотдачи к воздуху в условиях свободной конвекции горизонтальных одно-, двух- и четырехрядных шахматных пучков равносторонней компоновки из оребренных труб теплообменников охлаждения. Коэффициент оребрения труб φ = 21, межтрубный шаг 90 и 120 мм.*